The role of social factors in bilingual speech processing: the case of Galician New Speakers

Gisela Tomé Lourido

A dissertation submitted in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

of

University College London

Department of Speech, Hearing and Phonetic Sciences

University College London

2018

I, Gisela Tomé Lourido, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the work.

Abstract

It has long been debated whether speech processing remains flexible in adulthood. This thesis contributes to our understanding of this question by investigating bilingual speech development in a naturalistic setting. Galician 'new speakers' (*neofalantes*) are unbalanced bilinguals raised with Spanish as a primary language, who learn Galician at an early age in a bilingual environment, but in adolescence, decide to switch to using Galician almost exclusively, for ideological reasons.

Study 1 examined whether *neofalantes* changed aspects of their production and perception of Galician post-switch. Change was inferred by comparing this group to two control groups, Galician-dominant and Spanish-dominant bilinguals. Results showed that *neofalantes* pattern with Spanish-dominants in their perception and production of mid-vowel and fricative contrasts, but with Galician-dominants in their realisation of unstressed word-final vowels, a highly salient feature of Galician. However, Study 2 demonstrated that these shifts in production were not sufficient to enable Galician listeners to identify the *neofalantes*' accent as a distinctive variety. Instead, *neofalantes* were categorised as both Galician- and Spanish-dominant speakers. Study 3 used eye-tracking to investigate the effects of language dominance and long-term language switch on spoken word recognition. Results showed that recognition was slower for Spanish-dominants, however, the level of lexical activation of the confusable competitors was similar for Galician- and Spanish-dominant groups. Like in perception tasks, *neofalantes* behaved more simi-

larly to Spanish-dominant listeners.

These results indicate that despite early exposure to Galician, high motivation and almost exclusive Galician language use post-switch, there are limitations to what *neofalantes* can learn in production, perception and processing. However, although underlying categories appear hard to change, with modifications to production and perception constrained by early experience with a particular language, the resulting hybrid categories may function as opportunities to mark identity within a community.

Acknowledgements

First and foremost I would like to thank my first supervisor, Bronwen Evans, who has been, and will always be, an inspiration to me. I can't thank Bronwen enough for her enthusiasm about the project, generosity and dedicated support. Throughout these years, I have learnt a lot from her, not only about sociophonetics and speech perception, but also about teaching, writing and asking better research questions. I would also like to thank my second supervisor, Valerie Hazan, for her invaluable advice, encouragement and expertise.

I am also grateful to many people in Chandler House who have provided support throughout my PhD. In particular, many thanks to Paul Iverson, Stuart Rosen, Geoff Williams and Gaston Hilkhuysen, for their statistical and experimental advice, and Steve Nevard, Dave Cushing and Andrew Clark, for their technical support. I am also grateful to John Harris for his encouragement.

I would like to thank academics outside UCL who have also been a great source of inspiration for my research. Special thanks to Xosé Luís Regueira for generously sharing his time and expertise. I am also grateful to him and Elisa Fernández Rei for their assistance with data collection and insightful discussions on Galician phonetics and sociolinguistics. Many thanks to Antonio Cardenal for his help in providing and implementing the Galician forced aligner. I am also indebted to Manuel Blanco for giving me the opportunity of collecting data in his lab in Santiago. I thoroughly enjoyed learning about eye-tracking and perception from a completely different perspective. The eye-tracking experiment could have not been possible without the help of Cathi

Best and Jason Shaw. I am grateful to them for their valuable advice and feedback. Many thanks to Bernie O'Rourke for being supportive of my work and the New Speakers Network for providing funding to organise a workshop on new speakers varieties.

I would also like to thank my fellow PhD students and SHaPS researchers for creating the best work environment: Nada Al-Sari, Wafaa Alshangiti, José Joaquín Atria, Giulia Borghini, Laurianne Cabrera, Faith Chiu, Mauricio Figueroa, Sonia Granlund, Petra Hödl, Cris Hsu, Dan Kennedy-Higgins, Albert Lee, Kathleen McCarthy, Michèle Pettinato, Josiane Riverin-Coutlée, Tim Schoof, Yasu Shinohara, Jieun Song, Kurt Steinmetzger, Outi Tuomainen and Yue Zhang. Many thanks to Gwen Brekelmans for her invaluable help with teaching. I would also like to thank Ewan Dunbar for statistical and experimental advice and many inspiring conversations.

I am also thankful to Genaro Lourido Alonso and Marisol Ríos Noya for their help with the Galician stimuli and my Galician writing (Moitísimas grazas!). Special thanks to David Tomé Lourido (my dedicated pilot), Lorena Maneiro Boo and José Ángel Vila Vila for assisting with participant recruitment. I am also extremely grateful to those who have guided, encouraged and inspired me along the way: Roberto Catoira, Lupe Martínez, Begoña Ocampo and María Jesús Lorenzo Modia.

This thesis would have not existed without my Galician participants, who gave up their time to take part in the boring (and long) experiments without expecting anything in return. Grazas!

Finally, words are not enough to thank my parents, Gisela and Manuel, and my brother, David, for their unwavering belief and unconditional support.

Contents

List of Figures

List of Tables

Glossary

ANOVA Analysis of variance.

BLP Bilingual Language Profile.

CoG Centre of Gravity.

CORGA *Corpus de Referencia do Galego Actual*.

ED Euclidean Distance.

ERP Event-Related Potential.

F1 First formant.

F2 Second formant.

GD Galician-dominant bilinguals.

H High variety.

L Low variety.

L1 First language.

L2 Second language.

LFE Language Familiarity Effect.

MEG Magnetoencephalography.

MMN Mismatch negativity.

N400 An ERP component occurring around 400 ms.

NF *Neofalantes*.

PAM Perceptual Assimilation Model.

PAM-L2 PAM extension for L2.

SD Spanish-dominant bilinguals.

SLM Speech Learning Model.

VOT Voice Onset Time.

Chapter 1

Introduction

1.1 Theoretical background

Learning the sounds of a new language in adulthood is often very difficult. The sound system of the first language (L1) we learn influences the acquisition of subsequent languages (Best, 1995; Best & Tyler, 2007; Flege, 1995). This is the case even in bilingual contexts, where individuals have early exposure to their second language (L2; e.g., from early childhood) and listen to it on an everyday basis. Such bilinguals, dominant in one language, often find it very difficult to acquire phonetic categories that do not exist in their second, non-dominant language (Pallier, Bosch, & Sebastián-Gallés, 1997; Sebastián-Gallés & Soto-Faraco, 1999). Some have accounted for this difficulty by arguing for a lack of behavioural plasticity (e.g., Pallier et al., 1997). However, others have suggested that difficulties in acquiring new phonetic categories in an L2 result not from a loss of plasticity, but from a lack of use of the L2. For example, Flege and MacKay (2004) investigated the perception of English vowels by native speakers of Italian. They found that early learners who reported using their L1 (i.e., Italian) seldom resembled native English speakers in terms of their vowel discrimination, whilst those who used their L1 often, did not, suggesting that continued usage of the L1 affected acquisition of the L2. Indeed, theories of L2 perception, such as the Perceptual Assimilation Model (PAM: Best, 1994, 1995; PAM-L2: Best & Tyler, 2007) and the Speech

Learning Model (SLM: Flege, 1995), have proposed that L2 sounds are filtered through L1 phonetic categories. According to these theories, failing to create new phonetic categories is not a consequence of a reduction in neural plasticity. Rather, the mechanisms used for learning remain intact throughout the lifespan (Flege, 1995) and perceptual learning continues into adulthood (Best, 1995), but continued use of the L1 means that changes in perceptual processing due to language experience are reinforced, making it harder to acquire the L2 (Iverson, Kuhl, Akahane-Yamada, & Diesch, 2003).

This thesis aims to further investigate whether speech production and perception remain flexible across the lifespan by focussing on a different bilingual population. Similar to the participants in Pallier and colleagues' study (1997), this group grew up in a bilingual environment, where they were exposed to both Galician and Spanish from an early age on a daily basis, but were dominant in one language, Spanish. In adolescence, though, they decided to switch to using their non-dominant language, Galician, predominantly or exclusively. The switch, which involved 'abandoning' their dominant language, was a conscious and often effortful process, motivated by personal, identity-based reasons, e.g., cultural, ideological or political, as opposed to economic or work-related reasons (O'Rourke & Ramallo, 2015). This group are known as *neofalantes* (new speakers). Arguably, *neofalantes* have what could be considered optimal conditions for learning: they have early and extensive exposure to the non-dominant language, almost exclusive use of their new language post-switch and are highly motivated, and therefore, constitute an ideal population to examine whether experience with the L2, together with early and extensive exposure leads to the formation of new, native-like phonetic categories. This thesis investigates the consequences of *neofalantes*' long-term language switch on their speech perception and production.

1.1.1 *Neofalantes* as unbalanced bilinguals

Previous research has shown that even simultaneous bilinguals who were exposed to both languages before the age of 1 year, and pass as native speakers of both languages do not perceive speech like monolingual speakers in one of their languages (Cutler, Mehler, Norris, & Seguí, 1989, 1992; Dupoux, Peperkamp, & Sebastián-Gallés, 2010; Sebastián-Gallés, Echeverría, & Bosch, 2005), suggesting that there is always a dominant language for optimal processing. Likewise, early bilinguals may also be dominant in one of their languages. Performance with the non-dominant language is task-dependent: early and late bilinguals may reach native-like performance on tasks that involve pre-lexical processing (e.g., categorisation or phoneme identification), but when presented with their non-dominant language, even early bilinguals differ from native listeners in tasks that tap into lexical processing (Sebastián-Gallés & Díaz, 2012). A preference for the dominant language has been shown for different aspects of language processing. For example, Cutler et al. (1989) showed that early bilinguals used speech segmentation strategies from their dominant language in both their languages. Additionally, Hazan and Boulakia (1993) demonstrated that a language dominance effect also exists for cue-weighting. Regardless of proficiency, French- and English-dominant bilinguals tended to use the acoustic cues present in their dominant language when categorising a consonant contrast (i.e., /p/-/b/) in both their languages.

A preference for the dominant language prevails even when bilinguals live in a context where they have continuous exposure to both languages, e.g., Catalonia in Spain. For example, Pallier et al. (1997) tested highly proficient early bilinguals who had learned either Spanish or Catalan from birth. Catalan has a phonemic contrast between the mid vowels /ɛ/-/e/, while Spanish has only one front mid-vowel /e/. Results from identification and discrimination tasks showed that participants who had learnt Catalan from birth had two distinct phonemic categories. In the identification task, Catalan-dominant listeners showed categorical perception of the mid vowels, whereas the Spanish-

dominant group had a flat response curve. Similarly, only Catalan-dominant bilinguals showed a peak in their discrimination performance. Moreover, when participants were asked to rate the typicality of different vowels in two Catalan and one Spanish word, Catalan-dominant listeners produced the expected responses for the Catalan vowels, but conflated Spanish and Catalan /e/ for the Spanish word. Spanish-dominant listeners, despite behaving differently from Catalan-dominants, showed some awareness of the existence of the two different Catalan vowels, with a flat response for the close-mid vowel /e/ and a trend towards preferring a higher first formant (F1) for the open-mid vowel /ɛ/. Further research (e.g., Bosch, Costa, & Sebastián-Gallés, 2000; Sebastián-Gallés & Soto-Faraco, 1999) has shown that Spanish-dominant bilinguals perform more poorly than Catalan-dominant bilinguals in perception tasks with contrasts that only exist in Catalan and not in Spanish (e.g., front and back mid-vowels /ɛ/-/e/, /ɔ/-/o/ and fricative contrasts /s/-/z/, /ʃ/-/ʒ/), and that lack of sensitivity to the non-dominant language contrast extends to lexical representations. For instance, in a lexical decision task, Spanish-dominants performed as well as Catalan-dominants, but they processed some Catalan minimal pairs as homophones (Pallier, Colomé, & Sebastián-Gallés, 2001). These differences become evident in childhood (Ramon-Casas, Swingley, Sebastián-Gallés, & Bosch, 2009), such that acquiring phonetic contrasts in the non-dominant language appears extremely difficult, and the malleability of L1 phonetic categories severely limited, even with early and extensive exposure to the language (Sebastián-Gallés & Soto-Faraco, 1999).

Work by Flege and colleagues on sequential bilinguals who moved countries and became dominant in their L2 challenged this view. Flege, MacKay, and Meador (1999) compared different groups of Italian learners of English and found that early learners who moved to Canada around 7 years old, did not differ significantly from English native monolinguals in their discrimination of English vowels. They interpreted this as indicating that early bilinguals were able to create new phonetic categories in their L2 (see also Flege & MacKay,

2004). Research on the Catalan population provided further support for the idea that L2 use could be a crucial factor in achieving native-like perception of L2 contrasts. Mora, Keidel, and Flege (2011, 2015b) tested Catalan-Spanish bilinguals in their discrimination of mid-vowel contrasts and found that the frequency of Catalan use influenced how categorical the listeners' perception of the contrast was. This work seems to indicate that Spanish-dominant bilinguals' lack of success in acquiring Catalan-specific phonetic contrasts in the studies (Bosch et al., 2000; Pallier et al., 1997, 2001; Sebastián-Gallés & Soto-Faraco, 1999) could be related to their continued use of Spanish and infrequent use of Catalan. Taken together, these findings suggest that attunement to the L1 does not prevent early bilinguals from performing like native monolinguals in terms of perception of their L2, and instead suggests that variation in accuracy in perception may be largely determined by patterns of L2 language use.

Research on speech production has likewise shown conflicting results. Some studies support the idea that dominant bilinguals have language-specific phonetic categories in production; however, they may not have monolingual-like realisations in their non-dominant language (e.g., Hazan & Boulakia, 1993). For example, Amengual (2014, 2016) showed that Spanish-dominant bilinguals in Majorca were able to maintain a contrast between the Catalan front /ɛ/-/e/ and back /ɔ/-/o/ mid vowels, although the contrasts were smaller than those of Catalan-dominant bilinguals. Similarly, in production of the alveolar lateral approximant /l/, which differs in the degree of velarisation in Spanish and Catalan, most Catalan- and Spanish-dominant bilinguals had language-specific realisations, which were different from those used by the corresponding non-dominant group who had not learned Catalan or Spanish, respectively, from birth (Simonet, 2010). That is, production of the Catalan and Spanish variants differed according to the language being tested (i.e., Catalan or Spanish), and whether or not this was the speaker's dominant language. However, Simonet (2011) found that Spanish-dominant speakers in Majorca

(i.e., Spanish-Catalan bilinguals) had a merged contrast for /ɔ/-/o/.

Similarly, for Galician, Spanish-dominant speakers have difficulty maintaining a phonetic contrast between the front and back mid-vowels (Amengual & Chamorro, 2015). Like Catalan, Galician contrasts open-mid and close-mid front /ɛ/-/e/ and back /ɔ/-/o/ vowels in stressed position. Amengual and Chamorro (2015) tested Galician-dominant and Spanish-dominant speakers in their perception and production of the front and back mid-vowels. The results showed that Spanish-dominant listeners had greater difficulty identifying and discriminating the mid-vowels, while Galician-dominants had robust categorical perception of the contrasts, as expected. In production, Spanish-dominants also had difficulty maintaining this contrast and had a merged category for front vowels, though they appeared to have a small contrast for back vowels. Conversely, Galician-dominant speakers had a distinct contrast for both front and back vowel pairs.

Galician bilinguals in the current thesis are similar to those in the Amengual and Chamorro (2015) and Pallier et al. (1997) studies in that they are also early bilinguals who have been exposed to both languages (Galician and Spanish) in early childhood. *Neofalantes* in particular, have similar experience with Galician in childhood to Spanish-dominants in the studies mentioned above; even though they had early exposure to Galician, they were raised in Spanish in the home. However, *neofalantes* undergo a long-term conscious language dominance switch in adolescence motivated by ideological reasons. Chapter 2 will examine whether this change in language dominance has an impact on *neofalantes*' processing of Galician-specific phonetic contrasts.

1.1.2 Language learning in its social context

One factor that has not received much attention in speech learning research is the role of social factors such as identity, though one could imagine this is an important factor in the acquisition and use of phonetic categories which do not exist in the native inventory (see recent work on the acquisition of variation by

L2 learners, Drummond, 2012a, 2012b; Meyerhoff & Schleef, 2012; Schleef, Meyerhoff, & Clark, 2011). Language use in minority language communities, such as Galicia, is likely further complicated by the influence of the speaker's attitudes towards the languages they choose to use. *Neofalantes* often switch dominance to the minority language for ideological reasons; thus, it is possible that their speech production might not only be accounted for in terms of language learning constraints, but may also be influenced by social factors such as identity.

Research in sociophonetics has shown that these social factors affect the use of phonetic variables within one language (e.g., Eckert, 2000, 2008; Foulkes & Docherty, 2006; Stuart-Smith, Timmins, & Tweedie, 2007) and that speakers may alter the phonetic features they use in order to show belonging or identification with a particular group (Evans & Iverson, 2004, 2007). For example, Evans and Iverson (2007) examined speech perception and production in a group of students who moved from a small community in the Midlands (in the centre of England) to study at university, where they came into contact with speakers of different accents, in particular the standard variety. Although these students retained certain variants, e.g. to show belonging to their home community, they changed their production of other phonetic variants to better fit their new multidialectal community. In particular, some, but not all, changed their production of the STRUT vowel /ʌ/ (which in their native accent is merged with the FOOT vowel /ʊ/) to make it more centralised. However, their realisation of this phoneme was not the same as that of native speakers of the standard accent, nor were these shifts accompanied by changes in perception. This suggests that whilst speakers might be able to change certain aspects of their speech production at a relatively late stage in their language development, late adolescence, there are limits to this flexibility.

Less is known about how bilinguals encode identity through the use of their languages. Recent work with L2 learners has highlighted the importance of identity in acquiring regional features in an L2; Polish migrants in

Manchester were less likely to produce the local variant of (ing) if they were planning on returning to Poland, and more likely to adopt the local variant if they were planning on remaining in Manchester (Drummond, 2012a). Likewise, the more positive the speaker's attitude towards Manchester, the more likely they were to merge the STRUT and FOOT vowels, producing both with /ʊ/ (i.e., the local variant) rather than with the standard Southern British English /ʌ/-/ʊ/ split that they had typically been taught in school (Drummond, 2012b). Given that those who planned to stay in Manchester were more likely to identify positively with the city, one possibility is that they used these variables to signal belonging to their host community.

For *neofalantes*, the switch in language dominance is not a result of external factors such as moving countries. In this case the switch cannot be disentangled from or understood without the context of the community to which they belong. New speakers have been documented in other minority language communities in Europe: Ireland (O'Rourke & Ramallo, 2010; Walsh & O'Rourke, 2014), Wales (Robert, 2009), Scotland (McLeod & O'Rourke, 2015; Nance, McLeod, O'Rourke, & Dunmore, 2016; O'Rourke & Walsh, 2015), Isle of Man (Ó hIfearnáin, 2015), Provence (Costa, 2015), Brittany (Hornsby, 2005, 2009, 2015), Corsica (Jaffe, 2015), Galicia (O'Rourke & Ramallo, 2010, 2013a, 2013b, 2015; Ramallo, 2013; Ramallo & O'Rourke, 2014; Tomé Lourido & Evans, 2015, 2017), Catalonia (Pujolar & Puigdevall, 2015; Woolard, 2011) and the Basque Country (Ortega, Amorrortu, Goirigolzarri, Urla, & Uranga, 2014; Ortega, Urla, & Amorrortu, 2015). In the context of minority language communities, new speakers have been defined as "individuals with little or no home or community exposure to a minority language but who instead acquire it through immersion or bilingual educational programs, revitalization projects or as adult language learners" (O'Rourke, Pujolar, & Ramallo, 2015, p.1), though this definition of new speaker covers very different types of individuals; ranging from low or high proficiency L2 adult learners (e.g., Nance et al., 2016) to bilinguals in immersion schooling (e.g., Jaffe,

2015; Nance, 2015). In contrast, Galician new speakers constitute a more homogeneous group compared to other European communities; most Galician new speakers are early bilinguals who learn Spanish as their home language and Galician outside the home. This is possible because most of the Galician population is bilingual and has a high competence in both Spanish and Galician. Thus, their early exposure to Galician and high competence in the language does not necessarily come from schooling; it may also come from acquiring the language from the environment (Ramallo & O'Rourke, 2014), e.g., through grandparents, friends, the wider community.

The *neofalantes* phenomenon has been very well described in O'Rourke and Ramallo's work (cf. O'Rourke & Ramallo, 2010, 2011, 2013a, 2013b, 2015; Ramallo, 2010, 2013; Ramallo & O'Rourke, 2014). These authors define *neofalantes* as "individuals for whom Spanish was their language of primary socialization, but who at some stage in their lives (usually early to late-adolescence) have adopted Galician language practices and on occasions displaced Spanish all together" (2015, p. 148). Additionally, this language displacement is often motivated by ideological, political or socio-cultural factors. Indeed, (Ramallo, 2013) situates the origin of this group of speakers in the 1980s, after Spain's transition to democracy, which had strong implications for the sociolinguistic situation in Galicia (see Section 1.2.1, for a more detailed overview). At the beginning of the 20th century Galician was the language spoken by the majority of the population, but there has been a process of language shift, by which the use of Galician is decreasing in favour of Spanish, which was the only language allowed in formal contexts. The transition to democracy however, brought about important changes for the Galician language, which included gaining co-official status, its recognition as a symbol of Galician identity, and the start of the standardisation process, through which a standard Galician language variety was developed (Ramallo, 2013). This standard variety was then incorporated into spaces that had been exclusive to Spanish, such as education, the media and public administration, which facil-

itated access to Galician by non-traditional speakers (i.e., those who had not learned Galician from birth). However, despite the fact that *neofalantes* are often characterised as being urban middle class speakers (O'Rourke & Ramallo, 2013b), there are also *neofalantes* in rural environments and from different social classes.

Although several classifications for *neofalantes* have been proposed, in this thesis, a *neofalante* is defined in terms of language background, according to the following three characteristics:

1) Early experience with the minority language: although speakers only used Spanish with their parent(s) and vice versa, they learned Galician as children, either through school, friends, the extended family or the wider community.
2) There is a long-term switch in language dominance: speakers changed from being dominant in Spanish to displace this language either predominantly or totally to speak Galician (almost) exclusively.
3) Motivations for language switch: this switch takes place due to ideological, political or socio-cultural motivations. These speakers are normally committed to the revitalisation of the Galician language.

This definition is more restrictive than those used for new speakers in other European minority communities, e.g., Scotland (Nance, 2015; Nance et al., 2016), Corsica (Jaffe, 2015), or Catalonia (Pujolar & Puigdevall, 2015), but matches the majority use of this label in the Galician case (Ramallo, 2013; Ramallo & O'Rourke, 2014).

Neofalantes represent a small proportion of the total population[1], and it is likely that a considerable part of the Galician population might not be

[1] In 2008, 24,216 people whose initial language was Spanish switched to speak only Galician or more Galician than Spanish by personal decision (Instituto Galego de Estatística, 2008). If we understand that this figure represents *neofalantes*, they would form around 2% of the Spanish-dominant population (1,105,486) and a little less of the Galician-dominant population (1,466,915 people).

aware of the existence of *neofalantes* as a social group, particularly in environments that are unrelated to Galician culture or language. However, the *neofalante* label is not exclusively used by academics; it is also employed within the community. *Neofalantes* are salient in other spheres, such as contexts related to Galician language revitalisation and planning, Galician linguistics, culture and language teaching, especially in urban environments. Nevertheless, speaking Galician in urban environments, in particular in predominately Spanish-speaking contexts and social groups, makes *neofalantes*' social behaviour marked (O'Rourke & Ramallo, 2011, 2013a), and is sometimes associated with the political ideology of Galician nationalism (O'Rourke & Ramallo, 2013a). Additionally, this group of speakers are sometimes stigmatised for speaking a Spanish-accented variety of Galician, which is perceived as inauthentic and is often contested, depriving *neofalantes* of the anonymity of being a Galician speaker (O'Rourke & Ramallo, 2013a).

These circumstances make the process of transitioning from being a Spanish speaker to a Galician speaker in the community a complex one. O'Rourke and Ramallo (2015) have argued that this transition is driven by an awareness of the sociolinguistic situation in Galicia and a commitment to ensuring the survival of the Galician language, though, in some cases, it may also be motivated by political reasons (O'Rourke & Ramallo, 2013a; Ramallo, 2010). Indeed, these authors suggest that *neofalantes*' linguistic behaviour can contribute to the transformation of the sociolinguistic reality and characterise these speakers as proponents of social change, arguing for '*neofalantismo*' as a social movement, with *neofalantes* an active minority. An active minority is one in which "individuals or groups [...] through their behaviour attempt to influence both the attitudes and practices of the majority and in doing so, bring about social change" (p. 151). Consequently, these authors suggest that becoming a new speaker "requires innovative action through an appropriation of a new linguistic space as well as commitment to the transformation of society from below" (p. 153).

Previous work suggests that the *neofalantes*' variety is perceived to be influenced by Spanish (e.g., O'Rourke & Ramallo, 2013a), however, to my knowledge, no experimental work has examined the implications of the language dominance switch for their production or perception of Galician. Moreover, it is unclear whether Galician listeners can identify this variety as a distinctive one, or whether they can reliably identify *neofalantes*' Spanish background.

1.1.3 The *neofalantes*' accent as an emergent variety

As mentioned in the previous Section, the *neofalantes* group has become socially salient within certain spheres of the Galician society, and the *neofalantes* label has been used beyond academia to designate the social group (O'Rourke & Ramallo, 2011, 2015; Ramallo, 2013; Tomé Lourido & Evans, 2017). However, what is yet to be established is whether this label is known within the wider community, and, if so, whether a particular set of linguistic features have become associated with the label. Agha (2003, p. 231) proposed the term 'enregisterment' to describe the "processes through which a linguistic repertoire becomes differentiable within a language as a socially recognized register of forms" (see also Silverstein, 2003). Since then, this term has been also used to describe the emergence of new accents. For example, Johnstone, Andrus, and Danielson (2006) and Johnstone and Kiesling (2008) investigated how a set of linguistic features that used to be linked to socio-economic class came to be associated with a region, and 'enregistered' as a dialect called 'Pittsburghese', spoken in the United States. In this case, the linguistic features associated with 'Pittsburghese' were highly enregistered, as they were overtly linked to specific sociolinguistic spaces and discussed in metalinguistic commentary. In the Galician context, what is yet to be discovered is to what extent the *neofalantes*' accent has become enregistered and whether it is recognised as a distinctive variety in the community.

Indeed, sociolinguistic research has confirmed our intuition that listen-

ers are sensitive to accent variation and has provided evidence showing that listeners use accent variation in speech processing. Language attitude studies have investigated how listeners use the indexical information embedded in the speech signal to draw inferences about speakers' regional or social background (Giles, 1970, 1971a, 1971b; Giles & Powesland, 1975; Lambert, Hodgson, Gardner, & Fillenbaum, 1960). A well-established method to investigate listeners' attitudes towards a particular dialect is the matched-guise technique (Lambert, 1967; Lambert et al., 1960). In a prototypical task, participants are made to believe that they are listening to different speakers and are typically asked to evaluate them across a variety of traits, such as leadership, intelligence, friendliness, etc. The recordings are, in actual fact, made by a single speaker producing the same stimulus in different accent guises, so that, arguably, the differences in listeners' judgements can only be attributed to differences in the accents, and not talker-specific traits such as voice quality. The attitudes listeners express about the different guises are based on stereotypes related to the speaker's characteristics, and thus it can be inferred that listeners are sensitive to such characteristics, e.g., sex, age, language background, regional background and social class (Lambert, 1967; Lambert et al., 1960).

Using a matched-guise technique, Purnell, Idsardi, and Baugh (1999) demonstrated that listeners are also sensitive to variation that signals ethnicity. This study showed that landlords discriminated against prospective tenants based on the inferences they made about the speaker's ethnicity from hearing their accent on the phone. Baugh referred to this as 'linguistic profiling', and defined it as a process "based upon auditory cues that may be used to identify an individual or individuals as belonging to a linguistic subgroup within a given speech community, including a racial subgroup" (Baugh, 2000, p. 363).

In a MEG study, the sentence-initial 'hello' tokens from Purnell et al. (1999) were used to investigate the MMN response to accent changes. Results showed that the extraction of accent features occurs very rapidly and is pre-attentive, categorical and speaker-independent (Scharinger, Monahan, &

Idsardi, 2011). The authors propose that, given the stimuli presented were acoustically variable, accent extraction involves a process of abstraction by which low-level acoustic information is mapped to a memory trace associated with a phonetic feature which is linked to a social category, in this case, accent background. Another important finding from this study is that accent information appears to be processed in the same way as speaker voice information. A recent study has provided further evidence that appears to indicate that indexical information is processed at a relatively early stage. Although research that presented listeners with synthetic speech had suggested that non linguistic information is ignored at early stages of processing, Tuninetti, Chládková, Peter, Schiller, and Escudero (2017) found that when presented with natural speech, listeners are sensitive to indexical information (gender and regional background) at an unattended low level of processing.

Another area of sociolinguistics that has shown that listeners are sensitive to regional variation is perceptual dialectology, which is concerned with naive listeners' perception of dialect boundaries. In a seminal study, Preston (1986; 1989) gave American English speakers maps of the United States and asked them to label the places where they judged people to speak differently. This technique also enabled elicitation of attitudes about the accents spoken in the areas the participants had selected (see also Preston, 1996, 1999). Crucially, this work found that, in general terms, listeners agreed on the attitudes and stereotypes associated with the accents. More recent research has focussed specifically on whether listeners can group speakers into different regional accents. In a series of studies, Clopper and colleagues presented American listeners with sentences read by talkers from six different American English dialects in a forced-choice categorisation task (Clopper & Pisoni, 2004a, 2006). Results showed that listeners were able to distinguish broad dialect categories (New England, South and South Midland and North Midland and West). Performance in these tasks appears to be modulated by participants' background: listeners who had lived in different areas performed better than those who had

only lived in one area and, additionally, listeners who lived in a particular region performed better with the accent from that region. These results were taken to mean that greater exposure to linguistic variation and specific experience with one variety benefit accent categorisation. Similar results have been found using free classification tasks (Clopper, 2008; Clopper & Pisoni, 2007).

Two interesting questions that emerge from this research are concerned with when in development listeners start to acquire this sociolinguistic competence and when social categories are learnt with reference to phonological categories. Studies using similar tasks have shown that non-native listeners (Clopper, 2008), and children, some as early as the age of 4-5 years old (Jones, Yan, Wagner, & Clopper, 2017), are also able to group speakers into broader accent categories, although their accuracy is worse than that of adult native-listeners. These results suggests that indexical categories are acquired, together with phonological categories, in L1 and L2 acquisition (Clopper, 2008).

One category that listeners learn to discriminate very early on is that of their native language. Nazzi, Jusczyk, and Johnson (2000) used a head-turn preference procedure to investigate language discrimination by 5-month-old American listeners. The results demonstrated that infants could always discriminate the languages when their native language was one of the two languages presented or when the two foreign languages belonged to different rhythmic classes (e.g., Japanese vs. Italian), but not when the two foreign languages belonged to the same rhythmic class (e.g., Italian vs. Spanish). In a similar study, Butler, Floccia, Goslin, and Panneton (2011) showed that 5-month-old infants were able to discriminate between their native (South-West English) accent and an unfamiliar accent (Welsh English). However, they were unable to differentiate two unfamiliar accents (Welsh English and Scottish English).

Indeed, other research on this topic has suggested that young children still find discriminating unfamiliar regional accents difficult. Girard, Floccia, and Goslin (2008) showed that 5-6-year-old French-speaking children could not

discriminate between different regional varieties of French, but could distinguish their own accent from a foreign accent, indicating that, at this age, young children have different representations for regional and foreign accents. However, they have not yet developed fine-grained representations that enable them to distinguish different regional varieties from each other, at least based on the varieties tested here. Floccia, Butler, Girard, and Goslin (2009) replicated this result in a similar study with British children and suggested that the acoustic distance between the accents could have played a role in the children's discrimination patterns. They demonstrated that vowel differences between the three accents presented (native, regional and foreign) were similar, whereas Voice Onset Time (VOT) differences between the native and the foreign accent were larger. They interpreted this finding to mean that foreign accents introduce greater distortions to the signal than regional accents, in particular in terms of consonant variation, further disrupting word recognition and making the accent itself more distinctive. Similar results were found for American children, aged 5-6 years old, who were able to discriminate their native accent from an L2 accent (Indian English), but were not able to discriminate between their native and a regional accent, or regional vs. L2 accent (Wagner, Clopper, & Pate, 2014). Based on these findings, it is possible that children have a gradient representation of dialect variation with representations organised relative to the native accent, such that those a greater distance apart are easier to discriminate (cf. Wagner et al., 2014).

In addition to being able to group speakers into regional accent categories, adult listeners can identify the language background of L2 speakers above chance in forced choice tasks (Derwing & Munro, 1997; Vieru, De Mareüil, & Adda-Decker, 2011), and reported familiarity with the particular L2 accent predicts language identification accuracy (Derwing & Munro, 1997). Results from a study using a free classification task provide further evidence for the relevance of listeners' linguistic experience for accent categorisation. In this study, English, Korean, and Spanish listeners exhibited

heightened perceptual sensitivity to talkers with a matching native language when classifying native and non-native talkers by native language (Atagi & Bent, 2016). Thus, it appears that linguistic experience, in particular, familiarity with or awareness of an accent, plays a role in a listener's ability to categorise talkers according to both their regional origin and their native language background.

How might listeners store and consequently access indexical information during speech processing to enable them to group talkers in this way? As mentioned above, recent work has proposed that accent background information is processed in the same way as speaker voice information (Scharinger et al., 2011). Such work has highlighted the likely contribution of episodic memory in models of speech processing (e.g., Nygaard & Pisoni, 1998) and led to recent interest in episodic models of lexical access, which propose that phonetic variation in the speech signal, such as indexical or talker information, is not discarded in speech perception, but instead is retained and stored in memory (cf. Goldinger, 1998). Indeed, it has been shown that listeners can use fine-grained phonetic information, such as (VOT), to identify talkers (Allen & Miller, 2004). Additionally, work on talker identification has consistently shown a Language Familiarity Effect (LFE), i.e., listeners are better at identifying talkers in their native language (e.g., Fleming, Giordano, Caldara, & Belin, 2014; Goggin, Thompson, Strube, & Simental, 1991; Perrachione, Pierrehumbert, & Wong, 2009; Thompson, 1987). For example, Goggin et al. (1991) showed that monolingual English listeners were better at identifying English voices than German ones, and German listeners exhibited the opposite pattern. Similarly, English monolinguals were better at identifying English voices when compared to Spanish voices, but the pattern did not hold for English-Spanish bilinguals. This experiment also presented listeners with accented speech, which led to a deterioration in voice identification, but not to the extent to which unintelligible speech did. One possible interpretation of this particular finding is that language familiarity is beneficial for voice

recognition. However, whether this familiarity effect is related to language comprehension or familiarity with the phonological structure of the language is unclear.

This question was tested by Perrachione, Del Tufo, and Gabrieli (2011) who examined whether knowledge of phonology played a role in voice recognition. In this experiment, dyslexic listeners, who have impaired phonological processing, identified voices in English (native language) and Chinese (unfamiliar language). A control group of monolingual English listeners showed a language familiarity effect; they were more accurate with the English voices. However, dyslexic listeners were no better able to identify English talkers than Chinese talkers. These results led the authors to suggest that phonological representations are indeed important for recognising speakers and that the process of voice recognition functions by comparing the segments in the input voice with the listener's own phonological representations. Thus, voice recognition is more difficult when listeners cannot relate the speaker's segments to their own representations because they are either missing (when they hear an unfamiliar language) or impaired (in the case of aphasic listeners).

On the other hand, Fleming et al. (2014) argued that as the language familiarity effect is already apparent in 7–8 month old infants (cf. Johnson, Westrek, Nazzi, & Cutler, 2011; Nazzi et al., 2000), who cannot understand speech, the effect could also be driven by experience with the native phonological categories. Fleming et al. (2014) presented English and Chinese adult listeners with unintelligible time-reversed sentences in English and Mandarin, that they argued preserved phonological information but meant that the speech was unintelligible. Both listener groups rated pairs of native-language speakers as more dissimilar than foreign-language speakers, suggesting that the language familiarity effect is based not on comprehension, but on familiarity with the native language phonological system (Fleming et al., 2014).

In sum, though this skill is not fully developed until relatively late in life, listeners use the indexical information embedded in the speech signal to draw

inferences about speakers' regional or social background. As such, in the case of the Galician population, it would seem sensible to hypothesise that listeners in the community would be able to categorise talkers from a Galician-dominant and Spanish-dominant background. A question that remains though, is whether Galician listeners are able to recognise the *neofalantes*' accent. If they were, this could be interpreted as indicating that it has become an enregistered variety, one that has become associated with a set of linguistic features and is recognisable as a distinctive variety in the community. Nevertheless, if listeners were not able to link the *neofalantes*' accent with the sociolinguistic label, whether they classified *neofalantes* as Spanish-dominant or Galician-dominant speakers would be informative of whether *neofalantes*' speech production patterns have changed after the language dominance switch. Furthermore, from the listeners' point of view, given that both language ability and language familiarity have been shown to be beneficial for talker identification (Fleming et al., 2014; Goggin et al., 1991; Perrachione et al., 2009; Thompson, 1987) and experience with a particular variety appears to enhance the accuracy of identification of that variety (Clopper & Pisoni, 2004a, 2006), if language ability, or more specifically more robust phonological and phonetic representations of the language, are key for accent identification, Galician-dominant listeners should outperform Spanish-dominant listeners at classifying talkers speaking Galician. If, on the other hand, familiarity with the phonological system on its own is sufficient for accent identification, both groups should perform similarly on an accent identification task.

1.2 The Galician context

1.2.1 The sociolinguistic situation in Galicia

To better understand the context in which Galician and Spanish are spoken, this Section provides a summary of the sociolinguistic situation in Galicia. Galician is a Romance language spoken in the autonomous community of Gali-

cia, situated in the North West of the Iberian Peninsula (Figure 1.1). Other Galician-speaking territories outside the community include the bordering regions of Asturias, León and Zamora and a small territory in the North West of Cáceres (RAG, 2017). In 1981, Galician was recognised as the language of Galicia and together with Spanish, it constitutes one of the two official languages of the community. At the beginning of the 20th century, the Galician language was almost exclusively the only language spoken in the community, with more than 90% of the population monolingual in Galician (Loredo Gutiérrez, Fernández Salgado, Suárez Fernández, & Casares Berg, 2007). Considered a minority language in the context of the European Union, it is still the language spoken by around half of the population in Galicia (Figure 1.2), although this situation is rapidly changing, due to a process of language shift by which the use of Galician is decreasing in favour of Spanish.

The sociolinguistic situation in Galicia and its consequences for the Galician language have been extensively studied. Most of this work has been written in Galician (Álvarez Cáccamo, 1983, 1989; Dubert García, 2002; Fernández, 1991; Freixeiro Mato, 1997, 2006, 2009; González González,

Figure 1.1: Location of Galicia in Europe

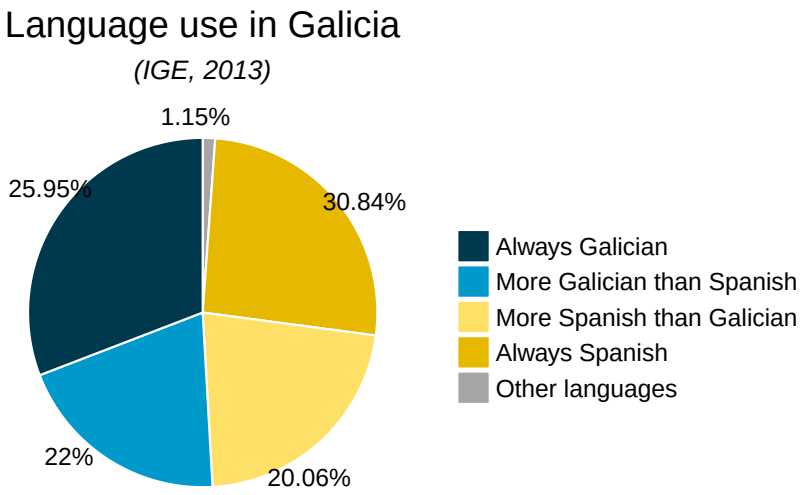

Figure 1.2: Pie chart showing the percentages of the language people spoke in Galicia in 2013 (Instituto Galego de Estatística, 2013). People who reported to speak 'always Galician' (25.95%) or 'more Galician than Spanish' (22%) on the left (dark blue and light blue, respectively) and people who reported speaking 'always Spanish' (30.84%) or 'more Spanish than Galician' (20.06%) on the right (dark yellow and light yellow, respectively). 1.15% of people reported to speak Galician and/or Spanish and other languages or only other languages (grey).

2008; González González et al., 2003; González González, Rodríguez Neira, Fernández Salgado, Loredo Gutiérrez, & Suárez Fernández, 2007, 2009; González González et al., 2011; Kabatek, 1991, 2000; Mariño Paz, 1998; Monteagudo, 1999, 2005; Regueira, 1999a, 2005, 2009; Rei-Doval, 2007), but some work has also been published in English (Beswick, 2002; Loureiro-Rodríguez, 2007, 2008; Monteagudo & Santamarina, 1993; O'Rourke, 2003; Ramallo, 2007; Ramallo & Rei-Doval, 2015), with a growing body of research on Galician new speakers in the last decade (O'Rourke & Ramallo, 2011, 2013a, 2013b, 2015; Ramallo, 2013). Some of this research has been concerned with the situation of language contact between Galician and Spanish, which has been described as one of diglossia (cf. Ferguson, 1959; Fishman,

1967) by some scholars (e.g., Beswick, 2002; Monteagudo, 2005). In a prototypical diglossic situation, there are two varieties in contact, a high variety (H) and a low variety (L), which are considered appropriate for different, non-overlapping functions in society (Ferguson, 1959). H, the prestigious variety, is typically used in formal situations, such as church, politics, media and literature, whereas L, tends to be used in informal contexts, such as personal communications or within the home. In the Galician case, the situation used to resemble a diglossic one, with Spanish as the High language variety, used in formal domains, and Galician as the Low language variety, used in informal and home domains (cf. Beswick, 2002). This scenario has changed over the last few decades and certain functions that used to be specific to each of the languages are now overlapping. For example, Galician is now used in the media and administrative and educational contexts, and Spanish is also used at home and in informal contexts.

However, it was not always the case that Galician and Spanish were used at the same time in the territory. The current situation of language contact began when Galicia became part of the Castilian crown in the XIII century and Spanish was introduced in the community. At the end of the medieval period, Spanish became the language of administration, commerce and developing urban centres, while Galician was relegated to the language of the common classes (Ramallo, 2007). Since then, there has been a slow and gradual decrease in the number of Galician speakers. This language shift process was accelerated in the 20th century under Franco's regime (1939-1975), during which, despite no official prohibition on the use of the language, the use of Spanish was favoured in all contexts and the use of Galician, Basque and Catalan was persecuted (Ramallo, 2007). Exclusion of the Galician language from education, media, administration and religion, together with massive migration from rural to urban environments (RAG, 2017), sped up the language shift process, and further contributed to the loss of prestige of the language.

In the 1980s, the Statute of Autonomy and language planning laws, were

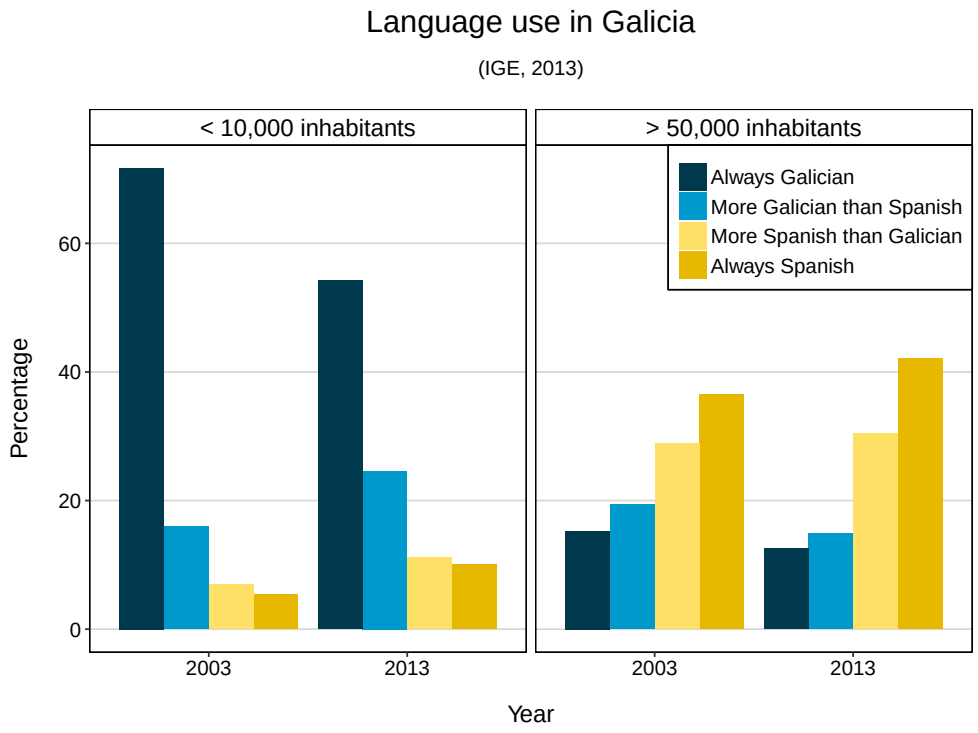

Figure 1.3: Barplot showing the percentages of the language people spoke in Galicia in 2003 and 2013 split by the number of inhabitants in the place where they live (fewer than 10,000 vs. more than 50,000) (Instituto Galego de Estatística, 2013). The left panel shows the languages spoken in places with fewer than 10,000 inhabitants and the right panels shows the languages spoken in places with more than 50,000 inhabitants. Each group of bars in each panel represents the percentage of speakers who report to speak 'always Galician' (first bar, dark blue), 'more Galician than Spanish' (second bar, light blue), 'more Spanish than Galician' (third bar, light yellow) and 'always Spanish' (fourth bar, dark yellow). Each panel shows results for 2003 (left group of bars) and 2013 (right group of bars).

passed and a process of revitalisation of the Galician language began. With the Statute of Autonomy (1981), Galician was declared Galicia's own language and gained official status, which meant that since then everyone has the right to learn it and use it. Additionally, this law states that public authorities are required to guarantee the normal and official use of both Galician and Spanish and promote the use of Galician in all spheres of public life. As a result, Galician is now used in mass media, administration and education, but, despite the apparent social recovery, the language shift process has not been reversed. On the contrary, the Sociolinguistic Map of Galicia (González González et al.,

2007, 2009, 2011), which examined the competences, uses, and attitudes towards the Galician language, showed that despite the fact that speakers seem to have more positive attitudes towards Galician and still retain a high competence in the language, the use of Galician has, in fact, continued to decrease. Spanish has become the main language spoken in the cities, where there has been a break in transmission of Galician to the next generation and, as a consequence, younger generations have predominantly been raised in Spanish in urban environments. Figure 1.3 shows the percentages of the language people spoke in Galician in 2003 and 2013, split by places with fewer than 10,000 inhabitants and places with more than 50,000 inhabitants (Instituto Galego de Estatística, 2013). The graph illustrates that considerably more people reported to speak Galician in places with fewer than 10,000 inhabitants when compared with places with more than 50,000 inhabitants. Moreover, the percentage of people who report speaking 'always Galician' has significantly decreased in rural environments during the last decade, whilst the use of Spanish has increased such that it is now the majority language in urban contexts.

Speakers' high competence in Galician and the apparently increasing positive attitudes towards the language are in contrast with the continuous decrease in the number of speakers. González González et al. (2003) hypothesised that this disparity might be due to more implicit attitudes towards the language that would have not been revealed when participants were asked explicitly about their opinions on the Galician language in the questionnaire used for the Sociolinguistic Map of Galicia (González González et al., 2007, 2009, 2011). Such attitudes could be elicited using more sophisticated experimental methods and so, to evaluate this hypothesis, an attitudinal study tested 400 participants between the ages of 14-20 years old using the matched-guise technique (cf. Lambert, 1967; Lambert et al., 1960). Participants were told they would hear sixteen different male and female voices and were asked to rate the speakers' accents using a number of scales that included, for example, how likely of social success the listener thought the speaker would be. The

stimuli were recordings of one male and one female speaker switching language and accent between Standard Galician, Galician with a Spanish accent, Spanish with a Galician accent and Standard Spanish, and then filler speakers. The results showed that speakers using Galician-accented varieties (Standard Galician and Spanish with a Galician accent) were perceived as unlikely of achieving social success, whereas speakers with Spanish-accented varieties (Standard Spanish and Galician with a Spanish accent) were characterised as innovative and socially competent. This suggests that the negative stereotypes are, in fact, associated with Galician-accented varieties, rather than with the language per se, whilst Spanish-accented varieties are considered prestigious.

Indeed, the consequences of the language contact situation have not only been limited to the decrease in Galician speakers, but have also involved interference between Spanish and Galician (Kabatek, 1991). Code-switching is a widespread phenomenon in Galicia (see Acuña Ferreira, 2017) and overall, the Galician language used nowadays, including Galician-dominant varieties, is very influenced by Spanish, in terms of its lexicon, syntax and phonology. Additionally, a Spanish-accented variety, such as the one mentioned in the study by González González et al. (2003) has emerged in urban environments. This variety has been referred to as 'New Urban Galician' (*Novo Galego Urbano*) and has been associated with urban speakers and, particularly relevant here, *neofalantes* (Dubert García, 2002; Regueira, 1999a; Vidal Figueroa, 1997). These groups, despite being a minority, are considered to have a strong social influence. The variety is often used in the media, and is now usually perceived as formal urban Galician (Dubert García, 2002; Regueira, 1999a; Vidal Figueroa, 1997), having become prestigious in certain contexts (cf. González González et al., 2003), despite being regarded as inauthentic by some Galician-dominant speakers (e.g., Kabatek, 2000).

1.2.2 The sounds of Galician

This thesis focusses on the perception and production of segmental variables that exist in Galician, but not in Spanish, by different bilingual groups. As such, it is important to understand the relationship between the Galician and Spanish phonetic repertoires and so this Section describes the sounds of Galician and specifies how these relate to those of Spanish.

The Galician inventory described here corresponds to the standard variety spoken by Galician-dominant speakers and is based on the descriptions by Regueira (1999b) and Freixeiro Mato (2006), although references to regional variants will be made. Table 1.1 shows the Galician consonant phonemic inventory (Regueira, 1999b). As well as the phonemes on the chart, it is worth mentioning that the voiced plosives /b/, /d/ and /g/ are realised as approximants [β̞], [ð̞] and [ɣ̞] in inter-sonorant position (cf. Martínez-Celdrán & Regueira, 2008). Regional dialect and accent variation has been documented, with regional dialects traditionally organised into three geographical areas: *bloque occidental* 'Western block', *bloque central* 'Central block', and *bloque oriental* 'Eastern block' (see Figure 1.4, adapted from F. Fernández Rei, 1990). In Western varieties of Galician, the phonemes [θ] and [s̻] are merged, and both sounds are typically realised as a voiceless lamino-alveolar fricative [s] (Regueira, 1999b). This process is known as *seseo* (F. Fernández Rei, 1990; Regueira, 1999b). Another salient regional consonantal feature is *gheada*, which consists of producing [g] and [ɣ] as [ɦ], [h], [x], [ɦ̞] or [ʕ] (F. Fernández Rei, 1990; Labraña Barrero & Oosterzee, 2003). Of particular interest for this thesis is the phonological contrast between the apico-alveolar [s̺] and post-alveolar [ʃ] sibilant fricatives (see Labraña Barrero, 2009, 2014; Regueira & Ginzo, in press, for an acoustic description), which does not exist in Spanish, as Spanish lacks the post-alveolar segment [ʃ]. Another distinctive characteristic of Galician is the realisation of final nasals as velar [ŋ] (e.g., *can* [kaŋ], 'dog').

In terms of vowels, Galician has a triangular system. Vowels in stressed

	Bilabial	Labio- dental	Dental	Alveolar	Post- alveolar	Palatal	Velar
Plosive	p b		t d			ɟ	k g
Affricate							
Nasal	m			n		ɲ	ŋ
Trill				r			
Tap				ɾ			
Fricative		f	θ	s̪	ʃ		
Approximant						j	w
Lateral Approximant				l			

Table 1.1: Galician consonant inventory (Regueira, 1999b).

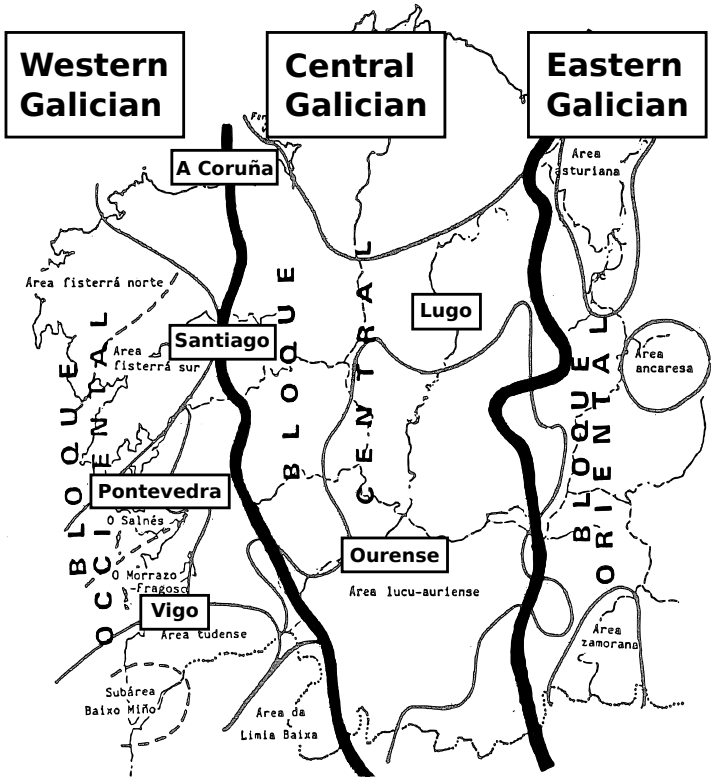

Figure 1.4: Galician regional dialects. The map shows the three main regional dialects (*bloque occidental* 'Western block', *bloque central* 'Central block', and *bloque oriental* 'Eastern block') and main cities (adapted from F. Fernández Rei, 1990).

and pre-stressed positions can have different degrees of backness and four degrees of height (open, open-mid, close-mid and close), giving seven phonemes in total /i e ɛ a ɔ o u/ (Freixeiro Mato 2006, for an acoustic description of stressed vowels see González González and Regueira Fernández 1994). In contrast, Spanish has a five vowel system /i e a o u/, lacking the distinction between open- and close-mid vowels, /ɛ/-/e/ and /ɔ/-/o/. Mid vowels are then the key difference between the vowel inventories of the two languages, as illustrated in Figure 1.5, which shows the formant frequency values of stressed vowels in Galician (data from Galician males speakers from González González & Regueira Fernández, 1994) and Spanish (data from Spanish male speakers from Madrid from Chládková, Escudero, & Boersma, 2011). As displayed in the graph, Spanish mid vowels /e/ and /o/ occupy an intermediate space in between the open-mid and close-mid Galician ones, but though note

that, the specific quality of the vowels is dependent on the Spanish variety.

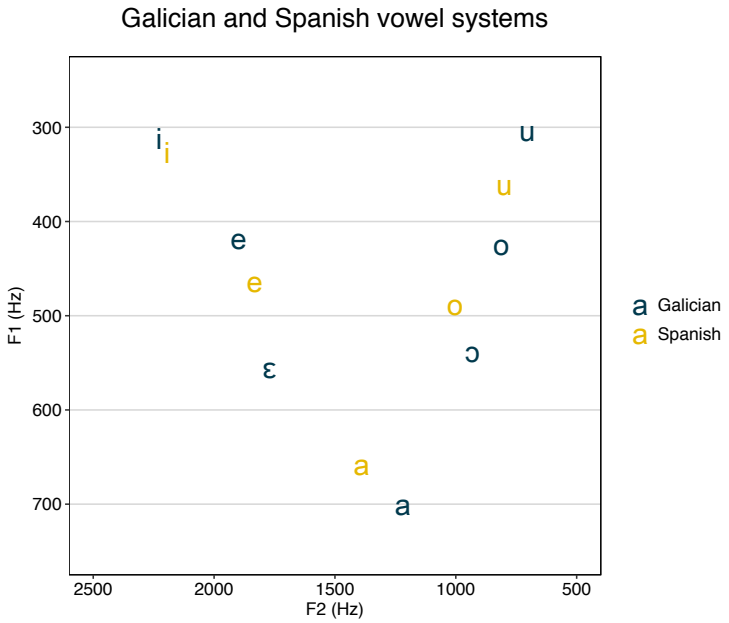

Figure 1.5: Galician and Spanish vowel systems (data from Chládková et al., 2011; González González & Regueira Fernández, 1994). The plot displays average F1 and F2 frequencies (in Hertz) of Galician vowels (in blue) and Spanish vowels (in yellow) produced by male speakers of Galician and Madrid Spanish, respectively.

The Galician contrast between open-mid and close-mid vowels only occurs in stressed and pre-stressed positions. Hence, in unstressed position, the contrast is neutralised, and the Galician vowel system is reduced to five vowels in word-internal post-stressed position, and three vowels in word-final position /e a o/, although /i/ and /u/ may occur in word-final position in loanwords (Freixeiro Mato, 2006). As illustrated in Figure 1.6, Galician unstressed word-final vowels /e a o/ (the inner, darker triangle) are raised and centralised [e̝ a̝ o̝] with respect to stressed vowels (see Molinos Castro, 2002; Regueira, 2007, for an acoustic description). This process, which is not characteristic of Standard Spanish, is one of the most easily perceptible features of the Galician 'accent' (Regueira, 2012, p. 191).

Impressionistic accounts of Galician varieties associated with Spanish-dominant speakers and *neofalantes* often describe them as merging the open and close mid-vowel contrast in stressed position (see Amengual & Chamorro,

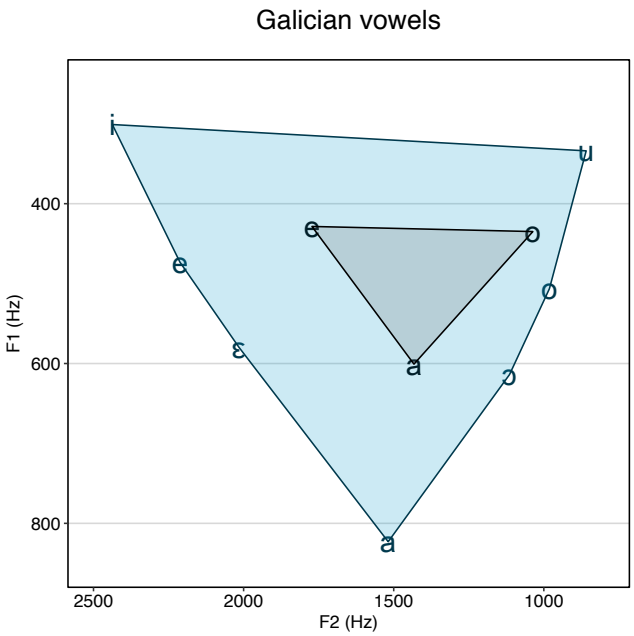

Figure 1.6: Galician stressed and unstressed vowels (data from González González & Regueira Fernández, 1994; Regueira, 2007). The plot displays average F1 and F2 frequencies (in Hertz) of Galician vowels in stressed position (outer triangle) and unstressed word-final vowels (inner triangle).

2015, for an acoustic description), and also lacking the sibilant contrast /ʃ/-/s/, having unreduced word-final vowels and producing alveolar realisations of the velar nasal [ŋ] (E. Fernández Rei, 2004; Freixeiro Mato, 2014; Hermida Gulías, 2008; Kabatek, 1991; Regueira, 1999a; Vidal Figueroa, 1997). In this thesis, the focus will be on the former three variables: open and close front /ɛ/-/e/ and back vowels /ɔ/-/o/, sibilant fricatives /ʃ/-/s/, and unstressed word-final vowels.

1.3 Chapter overview

This thesis investigates the effects of language dominance on bilingual speech processing. The findings from three different studies are reported. Study 1 (Chapter 2) examines the consequences of a language dominance switch on Galician new speakers' speech production and perception of Galician phonetic features that do not exist in Spanish, i.e., mid vowels in stressed position, sibilant fricatives and unstressed word-final vowels. *Neofalantes* are raised

in Spanish and learn Galician at an early age in a bilingual environment. In adolescence, they decide to switch language dominance permanently to use Galician predominantly or exclusively for by ideological or cultural reasons. *Neofalantes* were compared to two control groups, Galician-dominant bilinguals, who were raised in Galician and usually speak Galician, and Spanish-dominant bilinguals, who were raised in Spanish and usually speak Spanish. Study 2 (Chapter 3) examines whether the *neofalantes*' accent is an emerging variety in the community. Finally, Study 3 (Chapters 4 and 5) investigates the time course of spoken word recognition in Galician-dominant and Spanish-dominant bilinguals.

Chapter 2 presents a study on the effects of language dominance switch on speech production and perception. The aim of this study is to examine whether *neofalantes* have changed aspects of their production or perception after the switch. Change is inferred by comparing *neofalantes* to two control groups, Galician-dominant and Spanish-dominant bilinguals. If they pattern with Spanish-dominants when producing and perceiving variables that are specific to Galician, it is assumed that there has been no change, while if they pattern with Galician-dominants it is assumed that there has been a change. This study consists of two experiments. Experiment 1 investigates the production and perception of two mid-vowel contrasts in stressed position /ɛ/-/e/ and /ɔ/-/o/, a sibilant consonant contrast /ʃ/-/s/ and the production of reduced word-final vowels by *neofalantes*, Galician-dominant and Spanish-dominant speakers. Experiment 2 uses a word identification and a phoneme identification task to examine the perception of the mid-vowel and fricative contrasts by the three bilingual groups.

Chapter 3 reports the results of an accent identification study. The aim of this study was twofold: 1) to investigate whether the *neofalantes*' accent has emerged as a distinctive variety in the community and 2) to explore whether listeners' background has an effect on accent identification abilities and patterns. This task includes speakers and listeners from the three language backgrounds

of interest: *neofalantes*, Galician-dominant and Spanish-dominant bilinguals.

Chapters 4 and 5 present an eye-tracking study that investigated bilingual lexical access. The aim of Chapter 4 is to provide an introduction to the experiment by outlining previous research on the bilingual lexical acquisition and phonological processing in L1 and L2 spoken word recognition. Moreover, this Chapter describes the methodology that will be used in the study, the Visual World Paradigm. Chapter 5 presents the eye-tracking experiment, a study that examines the influence of language dominance and explores the effect of a language dominance switch on bilingual spoken word recognition. To date, no research has investigated the time course of lexical competition by dominant bilinguals. The first part of this Chapter focusses on whether Galician-dominant and Spanish-dominant bilinguals behave differently in terms of lexical access, in particular, when presented with words containing contrasts that do not exist in Spanish. The second part of this chapter explores whether *neofalantes* exhibit patterns of word recognition that are similar to those of Spanish-dominant or Galician-dominant bilinguals.

Chapter 6 presents a general discussion of the main findings of the three studies and the implications these results may have for theories of speech perception, word recognition and social cognition.

Chapter 2

Study 1: The effects of language dominance switch on speech production and perception[2]

2.1 Introduction

The current study investigates the consequences of a long-term language dominance switch for speech production and perception in *neofalantes*, Spanish-dominant bilinguals in Galicia who consciously switch in adolescence from using Spanish to Galician, predominantly or exclusively, for ideological reasons. The focus is on *neofalantes*' production and perception of two mid-vowel contrasts in stressed position /ɛ/-/e/ and /ɔ/-/o/ and a sibilant consonant contrast /ʃ/-/s/ all of which do not exist in Spanish. Additionally, the production of reduced word-final vowels will also be tested. Unstressed word-final vowels have a distinctive phonetic realisation in Galician and have been reported to contribute to the perception of the Galician accent (Regueira, 2012). study examines whether *neofalantes* have changed their production and perception of Galician after the language dominance switch, by comparing them to a group of Spanish-dominant bilinguals and a group of Galician-dominant

[2] Parts of this chapter were published in the *Proceedings of the International Congress of Phonetic Sciences* (Tomé Lourido & Evans, 2015) and included in a manuscript submitted for publication.

bilinguals. All three groups completed a series of production and perception tasks. If *neofalantes* pattern with Spanish-dominant bilinguals, it will be inferred that they have not changed their production or perception of the phonetic feature; however, if they pattern with the Galician-dominant group, it will be inferred that they have changed their production or perception of the Galician phonetic feature.

As previously mentioned, Galician has a phonemic contrast between mid-front and back vowels and this contrast does not exist in Spanish. Based on previous research on Galician (Amengual & Chamorro, 2015) and Catalan bilinguals (e.g., Pallier et al., 1997, 2001; Sebastián-Gallés & Soto-Faraco, 1999) and impressionistic descriptions of *neofalantes*' varieties (Dubert García, 2002; Regueira, 1999a), these pairs of vowels are predicted to be difficult for *neofalantes* to perceive and produce. The fricatives /ʃ/-/s/ are different phonemes in Galician, but only /s/ exists in Spanish. There are no descriptions of the production and perception of this contrast by either Spanish-dominant bilinguals or *neofalantes*, but descriptions of urban varieties often associated with these groups of speakers report apical realisations of /ʃ/ (González González, 2008; Regueira, 1999b), suggesting that for these two groups /ʃ/ may be more similar to /s/. Finally, unstressed word-final vowels are raised and centralised in Galician (Molinos Castro, 2002; Regueira, 2007), but not in standard Spanish. It has been reported that word-final vowels are also reduced in the variety of Spanish spoken in Galicia (Rojo, 2004), but others have claimed that Spanish-dominant speakers do not produce reduced vowels. For example, in the accent used in the media, which has been associated with the variety spoken by Spanish-dominant speakers, it has been claimed that word-final vowels are not reduced and the intensity and duration is similar to that of stressed vowels (Regueira, 1994). Assuming that Galician-dominant and Spanish-dominant speakers behave differently from each other, this study will also investigate where *neofalantes* lie on this continuum in terms of their production of unstressed word-final vowels.

2.2 Experiment 1: Measurement of Production

2.2.1 Method

2.2.1.1 Participants

Sixty-eight participants were tested. Participants were recruited from the University of Santiago de Compostela which has the largest and most heterogeneous student population in Galicia. This facilitated recruitment of participants with different backgrounds and therefore different accents (urban vs. rural, Eastern vs. Western). Three participants were excluded because they did not meet the criteria for the experiment. The remaining 65 participants grew up in Galicia, had not lived anywhere else for more than a year and were bilingual in Galician and Spanish. Participants were all students and at the time of recruitment were 18–30 years old (median 20 years).

After the experiment, they completed a detailed language background questionnaire which included questions about language background and exposure, language use, and social variables (see Appendix A). Other instruments for assessing language dominance, such as the Bilingual Language Profile (BLP; Birdsong, Gertken, & Amengual, 2012), were not appropriate for this experiment because the language dominance index is calculated as a weighted combination of various linguistic variables, i.e., language history, language use, language proficiency and language attitudes. As well as obtaining information about participants early exposure and language use, the aim of the questionnaire used in the current study was to identify *neofalantes* and elicit information about the reasons which motivated the language dominance switch. Thus, there were extra questions for this group of bilinguals. The questionnaire was used to classify participants into three groups, resulting in 14 *neofalantes* (7 female), 22 Galician-dominant (12 female), 20 Spanish-dominant (12 female) and 6 simultaneous bilinguals (3 female). The data from the simultaneous bilinguals will not be presented here. The criteria used to include participants in the three groups was the following:

- *Neofalantes*: they were predominantly raised in Spanish (their parent(s) used to speak to them in Spanish), but they decided to adopt Galician as their dominant language in adolescence (13-20 years old, median 17 years) for ideological or cultural reasons. After the switch, they have mainly spoken Galician (mean reported Galician use[3] = 4.65/5).
- Galician-dominant bilinguals: they were raised predominantly in Galician (their parent(s) spoke Galician to them) and have always spoken mainly Galician (mean reported Galician use = 4.64/5).
- Spanish-dominant bilinguals: they were raised predominantly in Spanish (their parent(s) spoke Spanish to them) and have always spoken mainly Spanish (mean reported Galician use = 2.36/5).

A further 3 participants who did not meet any of these criteria were also excluded, giving a final total of 56 participants. Note that all participants were raised in a bilingual community and, thus, would have been exposed to both languages from an early age. For 51 participants, both parents had been born and grown up in Galicia and in 5 cases one of the parents had been born in Spain (1 *neofalante*, 2 Galician-dominants, 2 Spanish-dominants), but all participants had at least one parent who had been born in Galicia. Therefore, the only difference between Spanish-dominants and *neofalantes* in terms of language background was that *neofalantes* made a conscious decision in adolescence to always speak Galician. The smaller sample size in the *neofalantes* group is due to various constraints related to recruitment. First, as mentioned in the Introduction (Section 1.1.2), *neofalantes* constitute a small proportion of the Galician population: less than 2%. Additionally, the label '*neofalante*', also a folk term used in the community, may have negative connotations in certain contexts and *neofalantes* themselves may or may not identify with it (see O'Rourke & Ramallo, 2011, 2013a, 2015), making its use inappropriate for recruitment purposes. Finally, it was necessary for participants to be naive

[3] Question 31 in the Language Background Questionnaire (Appendix A)

to the goals of the experiment; they were only informed that they were taking part on a study about bilingualism, but did not know it investigated their speech. Therefore, recruiting participants by enquiring about their language background would direct their attention to the Galician language, and might have made *neofalantes* feel they were being assessed. These limitations meant that participants were only asked very general questions about their language background before the experiment, and *neofalantes* were recruited by sampling the population or targeting certain groups. Note that the ages at which *neofalantes* made the switch ranged from 13 to 20 years old; however, it is difficult to predict how or whether the age of switch would affect the results and given the sample size this question will not be investigated in the current project.

Participants in the three groups came from urban and rural backgrounds (*Neofalantes*: 8 urban, 6 rural; Galician-dominant: 5 urban, 17 rural; Spanish-dominant: 11 urban, 9 rural). Investigating the effect of origin, i.e., rural or urban, is not a central aim of this study; however, this factor might have an effect on the accent of Galician acquired; bilinguals growing up in urban areas, characterised by a higher usage of Spanish (Instituto Galego de Estatística, 2013) are likely to be exposed more often to Spanish and Spanish-accented varieties of Galician than those in rural areas. The imbalance in the Galician-dominant group will not enable a reliable interpretation of the effect of origin, but the results could form the basis of future research. None of the subjects reported any speech, hearing or language disorders at the time of testing.

2.2.1.2 Materials

The stimuli consisted of a wordlist and a text that contained all three variables of interest; mid vowels, sibilant fricatives and word-final vowels. The subset of words used for the mid-vowel analysis was *pazo* [ˈpaθo̯] 'pazo[4]', *peza* [ˈpɛθa̯] 'piece', *peto* [ˈpeto̯] 'pocket', *pita* [ˈpita̯] 'hen', *pote* [ˈpɔte̯] 'pot',

[4] a type of Galician traditional house, similar to a manor house.

pozo [ˈpoθo̯] 'well (N)', *pucho* [ˈput͡ʃo̯] 'calf', *seca* [ˈseka̯] 'dry (F)', *sota* [ˈsɔta̯] 'knave (cards)', *sopa* [ˈsopa̯] 'soup' (see Appendix B, for a table). The target was the first, stressed vowel. For the fricative analysis, the words were *pase* [ˈpase̯] 'pass' and *paxe* [ˈpaʃe̯] 'page'. In this case the target sound was the fricative. The analysis for the unstressed word-final vowels included all the words for the two previous analyses, as well as *pata* [ˈpata̯] 'paw', *sapo* [ˈsapo̯] 'toad', *saco* [ˈsako̯] 'sack bag', *sito* [ˈsito̯] 'situated', *suco* [ˈsuko̯] 'furrow' and *pare* [ˈpare̯] 'stop (v)'. The target was the final, unstressed vowel. Each of these words was recorded in phrase-final position in the carrier sentence *digo a palabra* _____ (I say the word _____) and in phrase-medial position in the carrier sentence *digo a palabra* _____ *con coidado* (I say the word _____ carefully). The text was a modified version of 'The North Wind and the Sun' (*O vento do norte e o sol*). The original text contained only a small number of key variables, and so a sentence was added to increase the number of instances of these, giving 3-6 repetitions of each target variable (see Appendix C, for a full version of the text in Galician and English). All recordings were made in Praat (Boersma & Weenink, 2016), in a quiet room using a Samson C01U microphone connected to a laptop, and with a sampling rate of 44.1 kHz, 16-bit resolution.

2.2.1.3 Procedure

Participants recorded one repetition of the wordlist and the text and also completed a picture matching game to elicit spontaneous speech[5]. At the end of the session, participants completed the language background questionnaire (Appendix A) on LimeSurvey (LimeSurvey Project Team / Carsten Schmitz, 2012). To equalize any accommodation effects across participants, all testing was carried out by the first author, who was also a bilingual speaker from Galicia and the entire session was conducted in Galician. None of the participants had a close relationship with the experimenter, though they knew that she was

[5] The spontaneous speech data will not be presented in this thesis.

from Galicia; they were university students or friends of friends. Participants were asked not to discuss the study with other participants before they had taken part.

Recordings from both the wordlist and the text were segmented using a forced aligner for Galician (García-Mateo et al., 2014) and any errors hand-corrected. Three different sets of measurements were made for each of the three variables; mid vowels, fricatives and word-final vowels. For the mid-vowel analysis, the mean F1 and F2 values were extracted using Praat scripts (Boersma & Weenink, 2016) from each target word. Measurements were taken from the middle portion of the stressed vowel, with this portion centred on the midpoint (50%) of the vowel where formant values are most stable (average segment duration 85 ms). Praat's default formant tracking settings were used (maximum formant value for female speakers: 5500 Hz; male speakers: 5000 Hz). Only the mid-vowels /e ɛ o ɔ/ were included in the statistical analysis. The vowels /a i u/ were used in the normalisation procedure and are included in plots for reference. This gave between 2 and 4 measurements per mid-vowel (i.e., /e ɛ o ɔ/) for the wordlist and between 3 and 6 measurements per mid-vowel for the text. Formant measures that were 2 standard deviations outside the F1 or F2 mean per vowel were checked and hand-corrected if necessary. In order to be able to compare data from male and female talkers, measurements were normalised using the Lobanov method which has been shown to reduce the effects of anatomical and physiological variation, whilst retaining phonemic variation (Adank, Smits, & van Hout, 2004).

For the sibilant fricative analysis, the centre of gravity was calculated in the middle portion 40 ms around the midpoint of the fricative (average segment duration 98 ms) in each target word, using Praat (Boersma & Weenink, 2016). This gave 2 measurements per consonant (i.e., /s ʃ/) for the wordlist and between 5 and 9 measurements per consonant for the text. Although other acoustic variables, such as skew and kurtosis, could contribute to differences in fricative production, the centre of gravity was chosen because it has been

shown to differentiate place of articulation in fricatives for many languages, and also for Galician (Regueira & Ginzo, in press); alveolar sibilants have been shown to have a higher spectral mean than post-alveolar sibilants (Jongman, Wayland, & Wong, 2000; Regueira & Ginzo, in press). Fricatives produced by women have been shown to have higher spectral means than those produced by men (Jongman et al., 2000), perhaps due to biological differences, though note that constructed gender can also influence spectral frequency (see Levon, Maegaard, & Pharao, 2017). Galician sibilants are prototypically voiceless; however, given that the voiced counterparts do not occur in the language contrastively, some speakers may produce voiced sounds in certain contexts. Given that voicing may affect spectral moments (cf. Jongman et al., 2000), segments which had a voiced portion longer than 20% of the total length of the sound were manually checked, and fricatives that were mostly or fully voiced were excluded from further analysis (16 tokens). Fricatives shorter than 40 ms were also excluded (21 tokens). Centre of gravity measures that were 2 standard deviations outside the mean for each phoneme were checked and hand corrected if necessary. This gave a total of 944 measurements (485 alveolar and 459 post-alveolar phonemes).

Finally, word-final vowels were analysed in a similar way to mid vowels. The mean F1 and F2 values were extracted using Praat scripts (Boersma & Weenink, 2016) from the middle portion of the unstressed word-final vowel in each target word, with this portion centred on the midpoint (50%) of the vowel (average segment duration 65 ms). Only the mid unstressed vowels were included in the analysis; [a̟] was included for reference. This gave between 8 and 16 measurements per vowel [e̟ o̟] for the wordlist and 10 measurements per vowel for the text. Formant measures that were 2 standard deviations outside the F1 or F2 mean per vowel were checked and hand corrected if necessary, giving a total of 1741 tokens. As before, to enable comparison of male and female talkers, data was then normalised using the Lobanov method (Adank et al., 2004).

2.2.2 Results

2.2.2.1 Mid vowels in stressed position

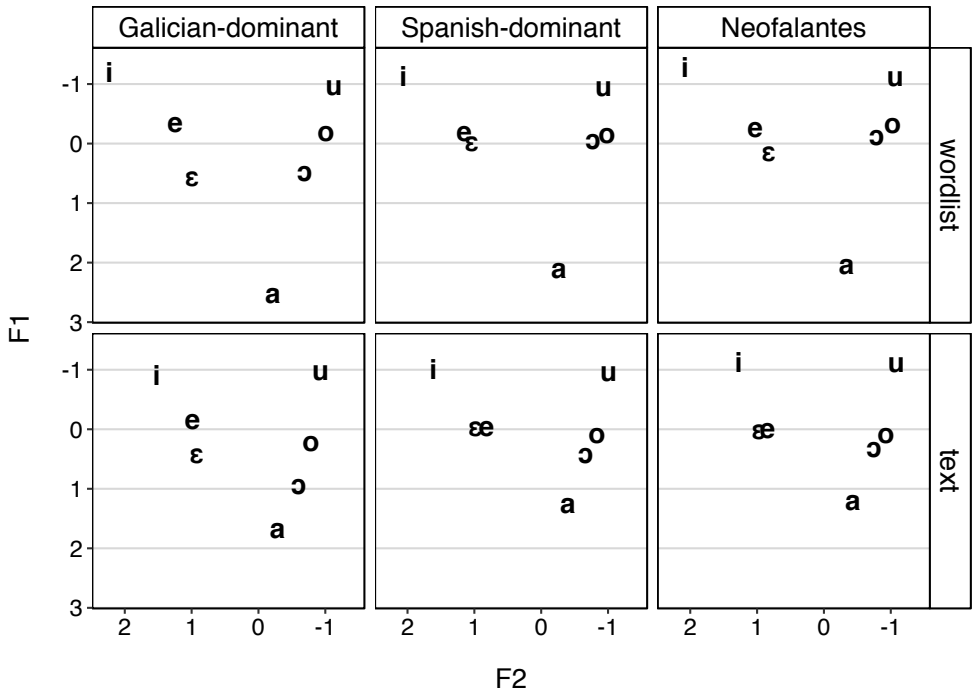

Figure 2.1: Average F1 and F2 frequencies by group (Galician-dominant, *Neofalantes*, Spanish-dominant) and speech style (wordlist, text). Plots display normalised values. Galician-dominant speakers appear to make a clear distinction between open and close front and back mid vowels both in the wordlist and text. In contrast, Spanish-dominants seem to have merged categories for both the front and back vowel contrasts. *Neofalantes* seem to behave more similarly to Spanish-dominants

Figure 2.1 displays the mean normalised F1 and F2 values of test words in the wordlist and text as produced by the three groups, Galician-dominant, Spanish-dominant and *neofalantes*. As expected, Galician-dominants appear to make a clear distinction between open and close front and back mid vowels both in the wordlist and text. In contrast, Spanish-dominants seem to have merged categories for both the front and back vowel contrasts. Although *neofalantes* largely appear not to have overlapping mid-vowels in the wordlist or text, these differences look very small and overall, they seem to behave more similarly to Spanish-dominants.

To investigate whether the groups had a split or a merged category, the

Euclidean distance was calculated separately for front and back vowels for each speaker for each speech style (wordlist, text), giving a total of 224 tokens. These values were used in all further mid-vowel analyses. Given that the Euclidean distance yields a skewed distribution, a rank-transformation to normality was applied to fit a linear mixed-effects regression model[6]. The variables of `group` (*neofalantes*, Galician-dominant, Spanish-dominant speakers), `speech style` (wordlist, text), `origin` (rural, urban), `vowel` (front, back) and `sex` (female, male) were included as fixed factors in the model up to three-level interactions. All possible by-participant random slopes were included in the model, following Barr, Levy, Scheepers, and Tily (2013).

A simple coding scheme was used for the `group` factor in this model and all others in this Chapter. In this coding scheme, each level is compared to the reference level (similar to the treatment coding scheme), but here the intercept represents the grand mean rather than the cell mean of the reference level. The *neofalantes* group was selected as the reference level (level 1) in the group factor to enable investigation of whether this group behaved differently from the Galician-dominant (level 2) and Spanish-dominant (level 3) groups. The contrasts between the reference level and each of the two groups were created manually in `R` by modifying the dummy coding scheme. For the contrast between *neofalantes* and Galician-dominant groups, the coding was 2/3 for level 2, and -1/3 for the other two levels. For the contrast between the *neofalantes* and Spanish-dominant groups, the coding was 2/3 for level 3, and -1/3 for the other two levels (see *R Library Contrast Coding Systems for Categorical Variables*, 2011, for more information on the coding scheme implemented). The remaining factors in the models (`speech style`, `origin`, `vowel`, `phoneme` and `sex`) had two levels. Deviation coding was used for these factors, with the levels represented as -0.5 and 0.5, so that the estimates did not represent the baseline level, but the mean difference between conditions.

---

[6] `lmer(euclidean ~ group*style*origin + group*style*vowel + group*style*sex + style*origin*vowel + style*origin*sex + origin*vowel*sex + (1+style+vowel | participant), data=data)`

The *p*-values and degrees of freedom for this model and all the linear mixed-effects models in this thesis were estimated using the Satterthwaite approximation from the `lmerTest` package (Kuznetsova, Bruun Brockhoff, & Haubo Bojesen Christensen, 2016) in `R` (R Core Team, 2013), unless otherwise indicated.

The regression model (Table 2.1) demonstrated that there was a significant contrast between the *neofalantes* (M_{raw} = 0.414) and Galician-dominant (M_{raw} = 0.866) groups, but no significant contrast between the *Neofalantes* and Spanish-dominant (M_{raw} = 0.377) groups. Figure 2.2 shows the Euclidean distance by group. Additionally, there was a main effect of speech style; overall, the Euclidean distance was significantly higher in the text (M_{raw} = 0.611) than in the wordlist (M_{raw} = 0.546). The interaction between group (Spanish-dominants vs. *neofalantes*) and speech style approached significance.

The contrast between the *neofalantes* and Galician-dominant group was modulated by a significant interaction with `origin`; the contrast between the *neofalantes* and Spanish-dominant group was also modulated by a significant interaction with `origin`. As illustrated in Figure 2.3, the difference between Galician-dominants and *neofalantes* is bigger for those participants who are from rural settings, and much smaller for those from urban settings, such that urban Galician-dominant and *neofalantes* are very similar. For the comparison between *neofalantes* and Spanish-dominants, the pattern is reversed: urban *neofalantes* have a higher Euclidean distance than the Spanish-dominant counterparts, but rural *neofalantes* have a lower Euclidean distance. Urban Galician-dominant speakers in this sample do not appear to produce a robust contrast between mid vowels. However, given the limited sample size for the urban Galician-dominant group (N = 5), this effect is difficult to interpret and needs replication with a larger sample.

The interaction between `vowel` and `speech style` was significant, suggesting that the difference was larger for back vowels in the text (M_{raw} = 0.646) compared to the wordlist (M_{raw} = 0.472). This could be related to the

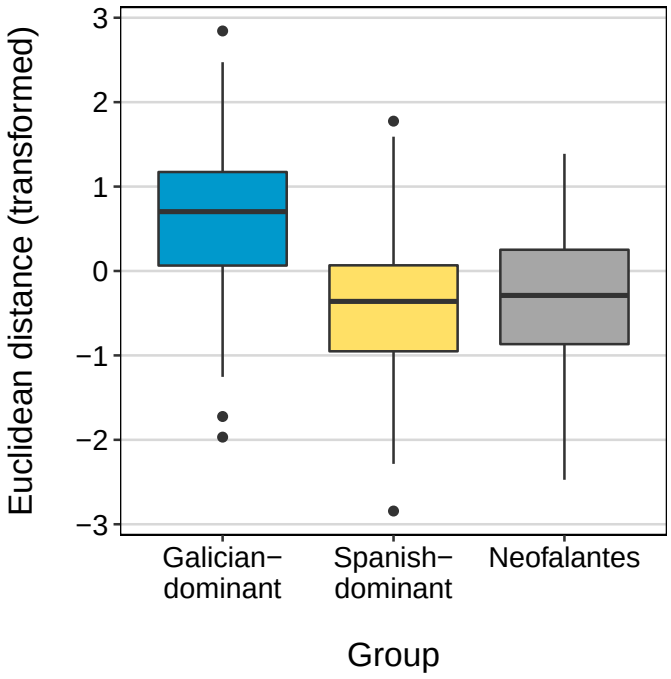

Figure 2.2: Boxplot showing the average Euclidean distance for the front and back mid-vowel contrasts by group (Galician-dominant, *Neofalantes*, Spanish-dominant), averaged over vowel and speech style. Measurements were transformed using a rank-transformation to normality to correct for a skewed distribution. *Neofalantes* behaved differently from Galician-dominants, who had a higher Euclidean distance overall, but did not differ from Spanish-dominant speakers.

fact that the vowels in the wordlist and text were not embedded in the same phonetic context. Finally, there was a three-way interaction, between `group`, `speech style` and `origin` for Galician-dominant vs. *neofalantes*. This is because the difference between urban and rural Galician-dominants and *neofalantes* becomes more pronounced in the wordlist, likely due to urban Galician-dominant and rural *neofalantes* speakers having a smaller Euclidean distance in the wordlist ($M_{rawGDurban}$ = 0.321) than in the text ($M_{rawGDurban}$ = 0.492) and urban and rural *neofalantes* being more different in the wordlist (M_{rural} = 0.297; M_{urban} = 0.526) than in the text (M_{rural} = 0.383; M_{urban} = 0.415).

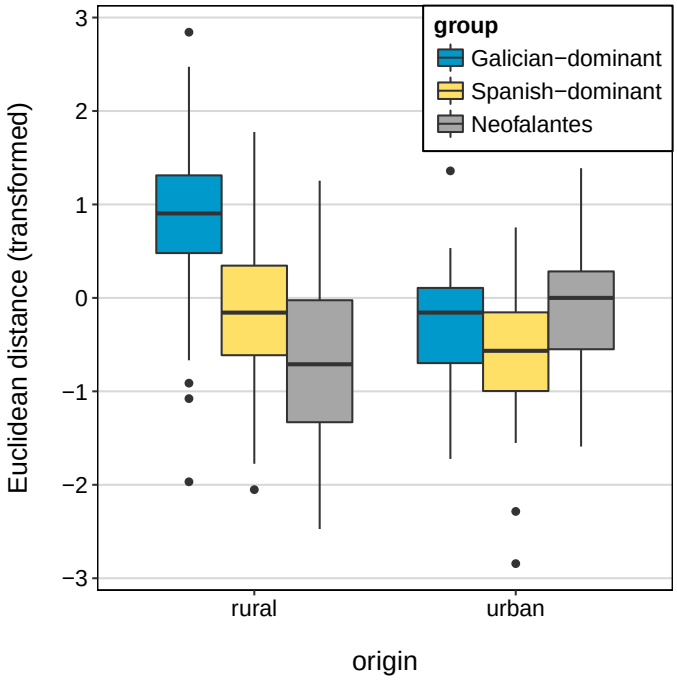

Figure 2.3: Boxplot showing average Euclidean distance for the front and back mid-vowel contrasts, averaged over vowel and speech style. Results are split by participant origin; rural participants on the left and urban participants on the right. Within each group, the left-most boxes show the Galician-dominants, the central boxes the *Neofalantes* and the right-most boxes the Spanish-dominants. Measurements were transformed using a rank-transformation to normality to correct for a skewed distribution. Rural Galician-dominant and Spanish-dominant bilinguals seemed to produce a larger contrast between the vowels than their urban counterparts, whereas urban *neofalantes* had larger contrasts than rural *neofalantes*.

	β	SE	t-value (df)	p-value
Main effects				
Intercept	−0.186	.089	−2.081(46)	.043
Group (GD)	0.663	.221	2.996(46)	.004
Group (SD)			*n.s.*	
Vowel			*n.s.*	
Speech style	0.363	.105	3.453(56)	.001
Origin			*n.s.*	
Sex			*n.s.*	
Interactions				
Group (GD): vowel			*n.s.*	
Group (SD): vowel			*n.s.*	
Group (GD): style			*n.s.*	
Group (SD): style	0.432	.246	1.758(55)	.084
Group (GD): origin	−1.645	.449	−3.666(46)	< .001
Group (SD): origin	−0.885	.416	−2.126(46)	.039
Style: origin			*n.s.*	
Style: vowel	0.396	.172	2.298(100)	.023
Group (GD): sex			*n.s.*	
Group (SD): sex			*n.s.*	
Style: sex			*n.s.*	
Origin: vowel			*n.s.*	
Origin: sex			*n.s.*	
Phoneme: sex			*n.s.*	
Group (GD): style: origin	1.433	.532	2.694(59)	.009
Group (SD): style: origin			*n.s.*	
Group (GD): style: vowel			*n.s.*	
Group (SD): style: vowel			*n.s.*	
Group (GD): style: sex			*n.s.*	
Group (SD): style: sex			*n.s.*	
Style: origin: vowel			*n.s.*	
Style: origin: sex			*n.s.*	
Origin: vowel: sex			*n.s.*	

Table 2.1: Summary of the results of the regression model for mid vowel production (Euclidean Distance). GD = Galician-dominant; SD = Spanish-dominant. Baselines for predictor variables: *neofalante* for `group`, text for `style`, rural for `origin`, front vowel for `vowel` and female for `sex`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values. Group effects in grey.

2.2.2.2 Voiceless sibilant fricatives

To investigate whether the three groups could produce the /s/-/ʃ/ contrast, centre of gravity was used as the dependent variable in the model. Given that this measurement yields a skewed distribution, a rank-transformation to normality was applied to fit a linear mixed-effects regression model[7]. The variables `group` (*neofalantes*, Galician-dominant, Spanish-dominant speakers), `phoneme` (alveolar /s/, post-alveolar /ʃ/), `speech style` (wordlist, text), `origin` (rural, urban) and `sex` (female, male) were included as fixed factors in the model up to three-level interactions. All possible by-participant and by-word random slopes were included in the model, following Barr et al. (2013). *Neofalantes* was selected as the reference level in the group factor to investigate whether they behaved differently from Galician-dominant and Spanish-dominant speakers.

As Table 2.2 shows, the regression model revealed a significant main effect of `sex`, as expected, suggesting that female speakers had a higher centre of gravity overall when compared to male speakers. Although the effect of `phoneme` on its own was not significant, it was modulated by a significant interaction with the contrast between Galician-dominant speakers and `neofalantes`, indicating that *neofalantes* behaved significantly differently from Galician-dominant but not Spanish-dominant speakers when producing /s/ and /ʃ/. Figure 2.4 shows centre of gravity by phoneme by group. Given that /ʃ/ does not exist in Spanish and is not mentioned as present in impressionistic descriptions of Spanish-dominant accents of Galician (e.g., González González, 2008; Regueira, 1999b), one possibility was that Spanish-dominants and potentially *neofalantes* might be unable to produce /ʃ/. However, there seem to be no clear differences in production between the three groups (see Table 2.3). That said, there is more variation in /s/; Galician-

[7] `lmer(cog ~ group*phoneme*origin + group*phoneme*style + group*phoneme*sex + phoneme*origin*style + phoneme*origin*sex + origin*style*sex + (1+style+phoneme | participant) + (1+group+origin+sex | word), data=data)`

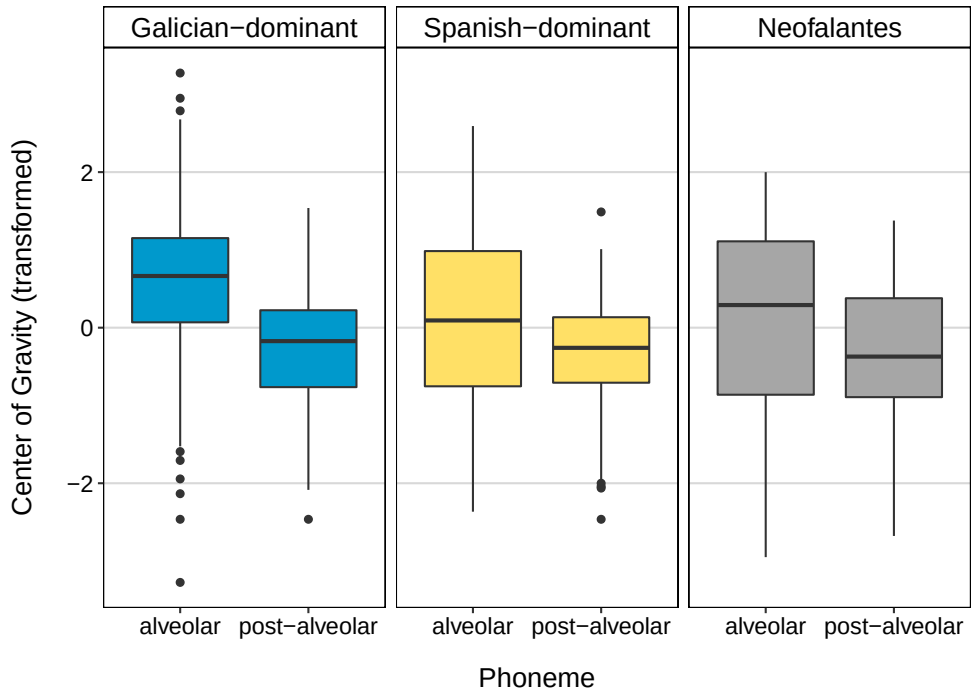

Figure 2.4: Boxplots showing transformed centre of gravity values for each phoneme (alveolar, post-alveolar) for the three groups (Galician-dominant, *Neofalantes*, Spanish-dominant) averaged over speech style. Measurements were transformed using a rank-transformation to normality to correct for a skewed distribution. *Neofalantes* behaved differently from Galician-dominant, but not Spanish-dominant speakers when producing the fricative contrast, and this difference seemed to be driven by differences in the production of /s/. Besides, the contrast was more distinct for Galician-dominant speakers than for *neofalantes* and Spanish-dominants.

dominant speakers seem to have a higher centre of gravity, when compared to *neofalantes* and Spanish-dominants who do not differ from each other.

To quantify the overlap between the two categories (i.e., /s/-/ʃ/) for each group, a logistic regression model was used as a classifier to predict the phoneme label from the transformed centre of gravity. Centre of gravity was predictor included in the model. Higher prediction accuracy corresponds to less overlap in the distributions of centre of gravity for the two fricatives. The model was scored as accurate if the probability of the true label for a given observation was above 50%. For Galician-dominants, the prediction accuracy was 71.3%, while for Spanish-dominants the accuracy was 56.2% and for *neofalantes* 58.4%. This indicates that the fricative categories were

much more distinct for Galician-dominant speakers than for *neofalantes* and Spanish-dominants.

	β	SE	t-value (df)	p-value
Main effects				
Intercept	0.030	.165	0.184(11)	*n.s.*
Group (GD)			*n.s.*	
Group (SD)			*n.s.*	
Phoneme			*n.s.*	
Speech style			*n.s.*	
Origin			*n.s.*	
Sex	0.534	.179	−2.975(31)	.006
Interactions				
Group (GD): phoneme	−0.63667	.249	−2.558(38)	.015
Group (SD): phoneme			*n.s.*	
Group (GD): style			*n.s.*	
Group (SD): style			*n.s.*	
Group (GD): origin			*n.s.*	
Group (SD): origin			*n.s.*	
Speech style: origin			*n.s.*	
Style: phoneme			*n.s.*	
Group (GD): sex			*n.s.*	
Group (SD): sex			*n.s.*	
Style: sex			*n.s.*	
Origin: phoneme			*n.s.*	
Origin: sex			*n.s.*	
Phoneme: sex	0.329	.189	1.739(28)	.093
Group (GD):			*n.s.*	
Group (SD): style: origin			*n.s.*	
Group (GD): style: phoneme			*n.s.*	
Group (SD): style: phoneme			*n.s.*	
Group (GD): style: sex			*n.s.*	
Group (SD): style: sex			*n.s.*	
Style: origin: phoneme			*n.s.*	
Style: origin: sex			*n.s.*	
Origin: phoneme: sex			*n.s.*	

Table 2.2: Summary of the results of the regression model for fricative production (centre of gravity). GD = Galician-dominant; SD = Spanish-dominant. Baselines for predictor variables: *neofalante* for `group`, text for `style`, rural for `origin`, alveolar fricative /s/ for `phoneme` and female for `sex`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values. Group effects in grey.

Phoneme	Speaker group					
	GD female	GD male	NF female	NF male	SD female	SD male
/s/	5853	4656	5283	4084	5055	4125
/ʃ/	4346	3944	4247	3802	4064	3976

Table 2.3: Mean centre of gravity values in Hertz for each phoneme (alveolar /s/, post-alveolar /ʃ/) for the three speaker groups, Galician-dominant (GD), *Neofalantes* (NF) and Spanish-dominant (SD), split by sex (female, male).

2.2.2.3 Unstressed word-final vowels

The dependent variable for this analysis was F1, which is inversely correlated with vowel height; the higher F1, the lower (i.e., more open) the vowel. To compensate for the non-normality of the distribution a rank inverse normal transform was applied. Preliminary observation of the data suggested that all groups had vowel reduction, but that although the differences were small, some had more reduction than others. A Welch two sample t-test showed that Galician-dominants' vowels were different from those of Spanish-dominants ($t(1263.8) = -2.4049$, p-value = .0163), confirming that the latter show less vowel reduction. To investigate whether *neofalantes* behaved like Galician-dominant or Spanish-dominant speakers, a linear mixed-effects regression model[8] was fitted on the transformed F1 values. The variables of `group` (*neofalantes*, Galician-dominant, Spanish-dominant), `speech style` (wordlist, text), `origin` (rural, urban), `vowel` (front, back) and `sex` (female, male) were included as fixed factors in the model up to three-level interactions. All possible by-participant and by-word random slopes were included in the model, following Barr et al. (2013). *Neofalantes* was selected as the reference level in the group factor.

Table 2.4 summarises the output of the regression model. There was a significant contrast between the *neofalantes* and Spanish-dominant groups, but no significant contrast between the *neofalantes* and Galician-dominant groups. As displayed in Figure 2.5, Galician-dominants and *neofalantes* show lower F1 values than Spanish-dominants, with *neofalantes* patterning more closely with Galician-dominants. The effect of `speech style` was significant, suggesting that vowels in the text had a lower F1 overall, that is, speakers tended to use more raised vowels overall. There was a highly significant effect of `sex`, due to male speakers having a lower F1, and therefore higher vowels. There was also

[8] `lmer(f1 ~ group*style*origin + group*style*vowel + group*style*sex + style*origin*vowel + style*origin*sex + origin*vowel*sex + (1+style+vowel | participant) + (1+group+sex+origin | word), data=data)`

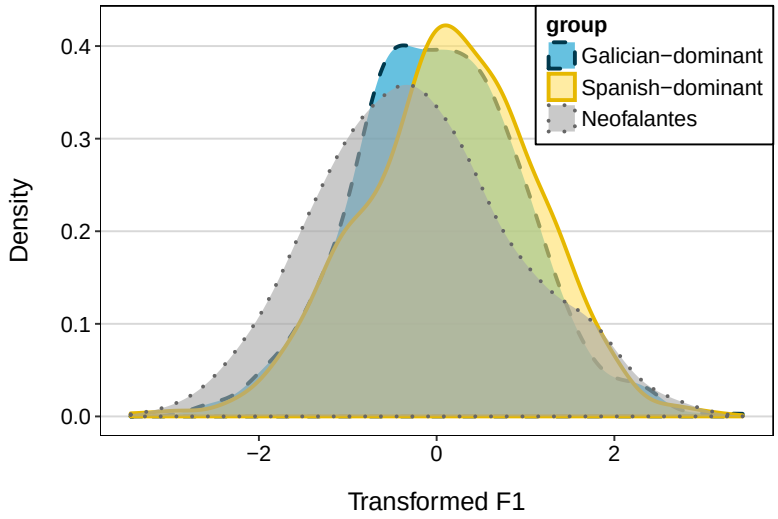

Figure 2.5: Density plot showing the transformed F1 distribution for the front and back unstressed word-final vowels, split by group (Galician-dominant, dashed line; *Neofalantes* , solid line; Spanish-dominant, dotted line), averaged over vowel and speech style. Normalised F1 measurements were transformed using a rank-transformation to normality to correct for a skewed distribution. Galician-dominants and *neofalantes* showed lower F1 values than Spanish-dominants, with *neofalantes* patterning more closely with Galician-dominants.

a significant interaction between `vowel` and `sex`, indicating that the difference between male and female speakers was more pronounced for front vowels.

	β	SE	t-value (df)	p-value
Main effects				
Intercept	−0.143	.074	−1.930(34)	.062
Group (GD)			*n.s.*	
Group (SD)	0.255	.124	2.061(47)	.045
Vowel			*n.s.*	
Speech style	−0.274	.131	−2.099(23)	.047
Origin			*n.s.*	
Sex	−0.577	.114	−5.077(39)	$< .001$
Interactions				
Group (GD): vowel			*n.s.*	
Group (SD): vowel			*n.s.*	
Group (GD): style			*n.s.*	
Group (SD): style			*n.s.*	
Group (GD): origin			*n.s.*	
Group (SD): origin			*n.s.*	
Speech style: origin			*n.s.*	
Style: vowel			*n.s.*	
Group (GD): sex			*n.s.*	
Group (SD): sex			*n.s.*	
Style: sex			*n.s.*	
Origin: vowel			*n.s.*	
Origin: sex			*n.s.*	
Vowel: sex	0.344	.163	2.109(16)	.051
Group (GD): style: origin			*n.s.*	
Group (SD): style: origin			*n.s.*	
Group (GD): style: vowel	0.488	259	1.885(73)	.063
Group (SD): style: vowel			*n.s.*	
Group (GD): style: sex			*n.s.*	
Group (SD): style: sex			*n.s.*	
Style: origin: vowel			*n.s.*	
Style: origin: sex			*n.s.*	
Origin: vowel: sex			*n.s.*	

Table 2.4: Summary of the results of the regression model for word final vowel production F1. GD = Galician-dominant; SD = Spanish-dominant. Baselines for predictor variables: *neofalante* for `group`, text for `style`, rural for `origin`, front vowel for `vowel` and female for `sex`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values. Group effects in grey.

2.2.3 Summary

There was little evidence to suggest that *neofalantes* had acquired the mid-vowel contrasts, patterning with Spanish-dominant speakers. Moreover, participants' origin appeared to play an important role in their production of the mid-vowel contrasts; rural Galician- and Spanish-dominant speakers produced a larger contrast than their urban counterparts, but the effect was reversed for *neofalantes*. Additionally urban Galician-dominant speakers did not produce a robust contrast between the vowels. However, this result is based on a small sample of urban Galician-dominant speakers (5 urban vs. 17 rural) and therefore, needs replication with larger samples.

Nevertheless, *neofalantes* were able to acquire the fricative contrast, but so were Spanish-dominants, such that all speakers produced a /s/-/ʃ/ contrast. Surprisingly, all three groups were able to produce /ʃ/, which only exists in Galician, and there were no differences between groups for this phoneme. However, there were differences in the magnitude of the contrast. Galician-dominants had a more distinct /s/-/ʃ/ contrast, while *neofalantes* and Spanish-dominants produced these phonemes with greater overlap. This difference was driven by differences in the production of the /s/. Although there are no direct comparisons in the literature, standard Castilian Spanish /s/ is often described as having an apical realisation and relatively low frequency values (cf. Martínez-Celdrán & Fernández Planas, 2007). It is likely that the Galician realisation has a higher centre of gravity, although different realisations have been found within Galician (cf. Labraña Barrero, 2009, 2014; Regueira & Ginzo, in press). It is therefore not surprising that in the current study Galician-dominants produce this phoneme differently from Spanish-dominant speakers. Overall, the results indicate that although *neofalantes* are able to produce the fricative contrast, they do not change the way in which they do this after a switch in language dominance. Finally, although all groups used reduced vowels, the word-final vowel analysis suggested that *neofalantes* produced these more like Galician-dominant speakers.

In sum, there seem to be limits to what *neofalantes* can learn in terms of production. They are unable to acquire the mid-vowel contrasts, and do not change production of /s/ to match Galician-dominants. However, their accent is not exactly like that of Spanish-dominant bilinguals either; they produce unstressed word-final vowels more like Galician-dominant than Spanish-dominant speakers.

2.3 Experiment 2: Measurement of perception

Experiment 2 investigated the consequences of a long-term language dominance switch for speech perception in *neofalantes*, by comparing them to Spanish-dominant and Galician-dominant listeners. The three groups of participants completed a word identification and a phoneme identification task. Of interest, was whether a change in language dominance would affect perception of the two mid-vowel contrasts /ɛ/-/e/ and /ɔ/-/o/ and fricative contrast /ʃ/-/s/, all of which do not exist in Spanish.

2.3.1 Method

2.3.1.1 Participants

Same as Experiment 1.

2.3.1.2 Materials

Participants completed two identification tasks. They identified naturally-produced words containing mid vowels in stressed position, and fricatives embedded in non-words on a synthetic continuum that ranged from /s/ to /ʃ/.

Word identification task

The stimuli consisted of the words *óso* [ˈɔso̪] 'bone', *oso* [ˈoso̪] 'bear', *pé* [ˈpɛ] 'foot', *pe* [ˈpe] 'p', *só* [ˈsɔ] 'alone', *so* [ˈso] 'under', *té* [ˈtɛ] 'tea', *te* [ˈte] 't' (see Appendix D, for a full table) embedded in the carrier sentence *Digo a palabra* _____ (I say the word _____). The carrier sentences were produced in two accents; (1) standard-accented Galician and (2) regionally-accented Galician. The latter included *gheada* (see subsection 1.2.2), a very salient regional

variant in which [g] and [ɣ] are produced as [ħ], [h], [x], [ɦ] or [ʕ], here giving [ˈdihoapaˈlaβɾa] instead of [ˈdiɣoapaˈlaβɾa]. This feature was included because it was hypothesised that it could act as a cue for the Galician-dominant accent. This manipulation only affected the carrier phrase. The same token of each target word was then spliced into the two carrier sentences, and thus the pronunciation of the target word did not vary between conditions. All stimuli were produced by the same male Galician-dominant speaker who was selected because he was able to produce both accents. Recordings were made in a sound attenuated room using a RODE NT1-A microphone directly connected to a PC via an Edirol processor with a sampling rate of 44.1 kHz, 16-bit resolution. The speaker recorded two repetitions and then the best was selected for use in the experiment. Stimuli were band-pass filtered at 60-20,000 Hz with a smoothing factor of 10. Finally, intensity was scaled to 70 dB SPL. All processing was carried out in Praat (Boersma & Weenink, 2016). Stimuli were played over a laptop (ASUS A55V) via a Realtek HD Audio sound card, and were presented over headphones (Sennheiser HD 25-C II).

Phoneme identification task

The stimuli were two-segment CV sequences that consisted of a fricative that varied in the place of articulation along a 22-step continuum from /s/ to /ʃ/ followed by the vowel /u/, a combination that enabled creation of non-words, giving 'su' [ˈsu] or 'xu' [ˈʃu] at the endpoints. These endpoints were based on natural tokens of /s/ and /ʃ/ recorded by the same Galician-dominant speaker as for the word identification task, with the recording procedure and processing also the same. The intermediate steps of the continuum were then created following the procedure described in (McQueen, 1991; Repp, 1981).

Briefly, the /s/ and /ʃ/ were excised from the natural recording from their onset to the zero crossing before the start of the vowel, and saved to individual wav files. The duration of each fricative was measured and the average duration calculated. The fricatives were then equalised for length in Praat

(Boersma & Weenink, 2016) using PSOLA such that both were equal to the average duration, 212ms. These were used as the endpoints of the fricative continuum. It is unclear whether duration is used as a cue to distinguish this contrast in Galician, but the duration cue was not present in the continuum. The fricative portion of the intermediate stimuli was constructed by adding the amplitudes of the two waveforms in different proportions (see McQueen, 1991), giving 22 tokens each with a duration of 212 ms. The overall amplitude envelope was kept constant for all tokens. The fricative tokens were then spliced onto a natural token of /u/, excised from the recording of 'su', creating 22 CV tokens where the fricative varied in equal steps from /s/ to /ʃ/. Lastly, intensity was scaled to 70 dB and the files downsampled to 22,050 Hz.

Four pilot participants, all Spanish-Galician bilinguals, completed the experiment to check the validity of the continuum.

2.3.1.3 Procedure

Participants completed the tasks in the same session as the production tasks (Experiment 1). Participants always completed the word identification task (vowels) first. The word identification task consisted of two blocks (standard Galician and regional Galician), so that listeners could adapt to each accent, with the order of presentation counterbalanced across participants. In each block, participants identified the word they heard by clicking on the corresponding picture. In written Galician open vowels can be signalled by an accent i.e., [ˈɔsǫ] 'bone', *oso* [ˈosǫ] 'bear', and so pictures were used to prevent orthographic cues influencing the results. Participants identified 4 repetitions of the 8 stimuli, giving a total of 32 trials per block. They heard each trial only once, with the order of presentation randomised across participants and the same stimulus never played twice in succession.

In the phoneme identification task (fricatives), participants identified whether they heard the non-word *su* [ˈsu] or *xu* [ˈʃu]. Before completing the task, participants completed a short practice session to familiarise them with

the task. The practice included 10 different stimuli from the 22-step continuum presented in a randomised order. In the test block, participants identified 4 repetitions of the 22 stimuli, giving a total of 88 trials. They heard each trial only once, with the order of presentation randomised across participants and the same stimulus never played twice in a row.

2.3.2 Results

2.3.2.1 Mid vowels in stressed position

In order to investigate the effect of group on vowel identification, a mixed-effect logistic regression model[9] was built with the binomial response (correct/incorrect) as the dependent variable, `group` (*neofalantes*, Galician-dominant, Spanish-dominant listeners), `accent` (standard, regional) and `origin` (urban, rural) as fixed factors and `participant` and `item` as crossed random effects. Since `item` was included in the model as a random factor to account for the variance introduced by the different stimuli and there were two words per vowel, vowel was not included in the model as a fixed factor. Table 2.5 summarises the results of the model. Simple contrasts were used with *neofalantes* as the baseline level for the group effect.

The model revealed a significant contrast between *neofalantes* (M_{Prop} = 0.79) and Galician-dominant listeners, who performed at ceiling (M_{Prop} = 0.92), but no significant contrast between *neofalantes* and Spanish-dominants (M_{Prop} = 0.76). To test whether *neofalantes* and Spanish-dominants could identify the vowels above chance level, the dataset was compared to a random baseline. Two separate logistic regression analyses for *neofalantes* and Spanish-dominants indicated that both groups performed significantly above chance.

In the main regression model, there was no main effect of `accent`, but the contrast between *neofalantes* and Galician-dominant listeners was modulated

[9] `glmer(result ~ group*origin*accent + (1 | participant) + (1 | stimulus), data=data, family=binomial)`

	β	SE	z-value	p-value
Main effects				
Intercept	1.965	.263	7.481	$< .001$
Group (GD)	1.043	.435	2.397	.016
Group (SD)		*n.s.*		
Origin	-0.588	.337	-1.746	.081
Accent		*n.s.*		
Interactions				
Group (GD): origin	-2.412	.871	-2.771	.006
Group (SD): origin		*n.s.*		
Group (GD): accent	0.801	.279	2.865	.004
Group (SD): accent	0.484	.231	2.088	.037
Group (GD): accent: origin		*n.s.*		
Group (SD): accent: origin		*n.s.*		

Table 2.5: Summary of the results of the regression model for mid vowel perception. GD = Galician-dominant; (SD) = Spanish-dominant. Baselines for predictor variables: neofalante for `group`, rural for `origin` and standard for `accent`. Numbers represent Estimates (β), Standard Errors (SE), Wald statistics (z-values) and p-values. Group effects in grey.

by a significant interaction with `accent`. This indicates that the difference between these two groups was smaller in standard Galician (M_{GD} = 0.90, M_{NF} = 0.82) than in the regional Galician condition (M_{GD} = 0.93, M_{NF} = 0.76). As displayed in Figure 2.6, *neofalantes* perform more poorly than the Galician-dominants overall, but do slightly better in the standard accent condition. The contrast between *neofalantes* and Spanish-dominant listeners was also modulated by a significant interaction with `accent`. Although there was no overall difference in performance between these two groups, the difference in performance between *neofalantes* and Spanish-dominants was greater in the standard condition (M_{SD} = 0.75, M_{NF} = 0.82) than the regional condition (M_{SD} = 0.76, M_{NF} = 0.76).

The main effect of `origin` approached significance and it was modulated by a significant interaction with the contrast between Galician-dominants and *neofalantes*, which indicated that the difference between these groups was

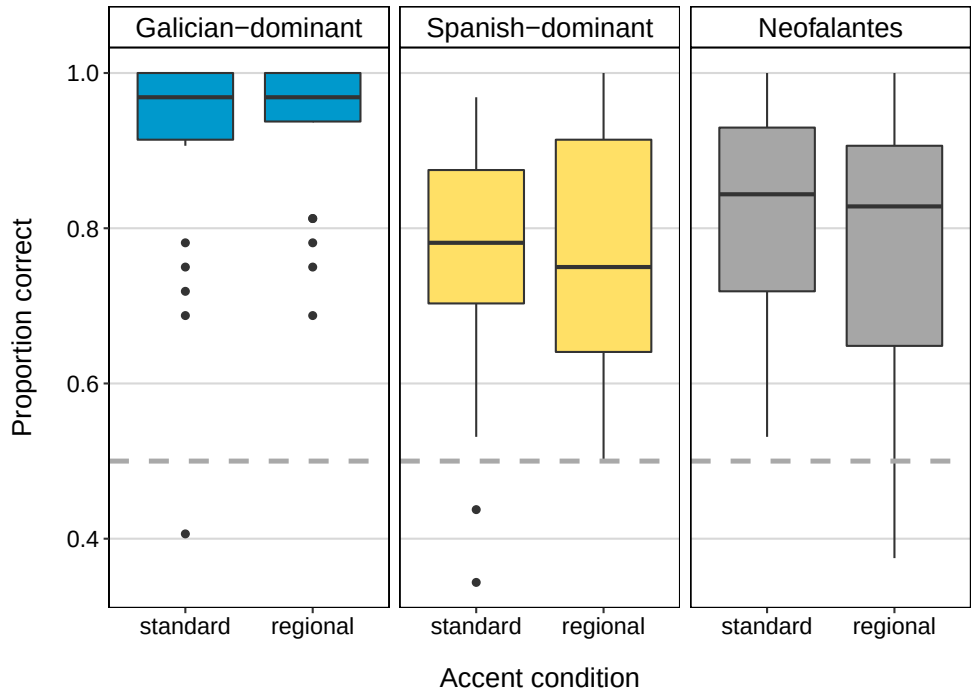

Figure 2.6: Boxplot showing vowel identification scores (proportion correct) by listener group (Galician-dominant, *Neofalantes*, Spanish-dominant) and accent (standard Galician, regional Galician). The dashed line represents chance level performance. *Neofalantes* behaved differently from Galician-dominant listeners, who performed at ceiling, but they did not differ from Spanish-dominants. However, the difference between Galician-dominants and *neofalantes* was smaller when presented with the standard Galician accent.

smaller for urban (M_{GD} = 0.79, M_{NF} = 0.81) than rural listeners (M_{GD} = 0.95, M_{NF} = 0.77). As displayed in Figure 2.7, urban Galician-dominant listeners ed more poorly than their rural counterparts; they were more similar to *neofalantes* and Spanish-dominant listeners, mirroring the production results.

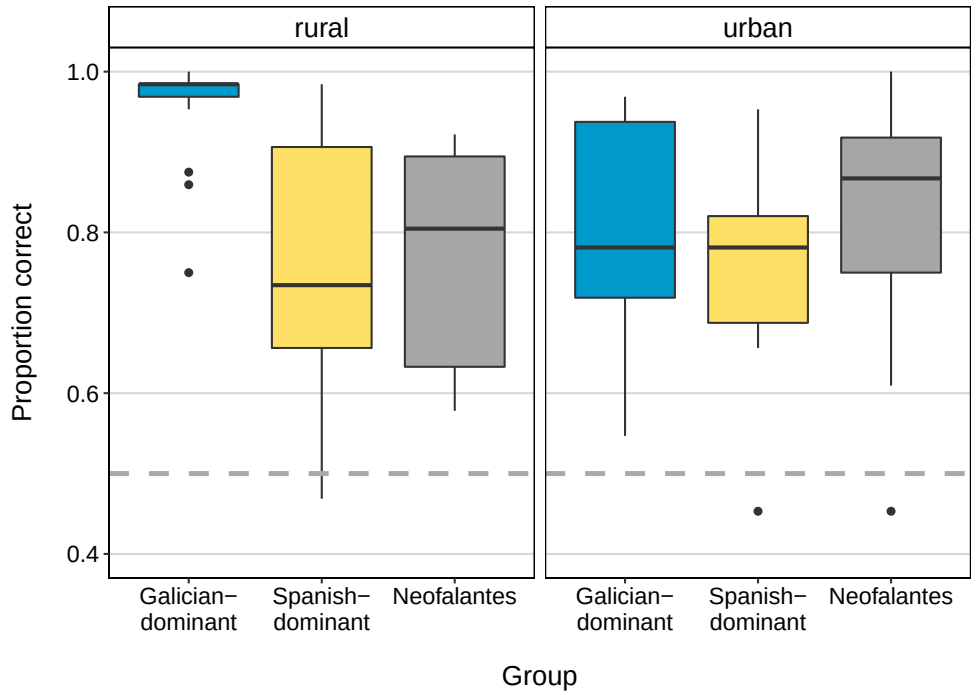

Figure 2.7: Boxplot showing vowel identification scores (proportion correct) by listener group (Galician-dominant, *Neofalantes*, Spanish-dominant) and origin (rural, urban) averaged over accent conditions. The dashed line represents chance level performance. Urban Galician-dominant listeners performed more poorly than their rural counterparts; they were more similar to *neofalantes* and Spanish-dominant listeners, mirroring the production results.

2.3.2.2 Voiceless sibilant fricatives

To investigate the effect of group on the sibilant fricative continuum categorisation, a mixed-effects logistic regression model[10] was fitted with the binomial response /s/-/ʃ/ as dependent variable. The fixed factors included in the model were `group` (*neofalantes*, Galician-dominant, Spanish-dominant listeners), `stimulus` (continuum from /s/ to /ʃ/; this variable was centred) and `origin` (urban, rural) with `participant` as a crossed random effect. **??** summarises the results of the model. Simple contrasts were used with *neofalantes* as the baseline level for the group effect.

Table 2.6 summarises the results of the model, which revealed a significant main effect of `stimulus` and a significant contrast between *neofalantes*

[10] `glmer(response ~ stimulus*group*origin + (1 | participant), data=data, family=binomial)`

	β	SE	z-value	p-value
Main effects				
Intercept	−1.266	.149	−8.500	< .001
Stimulus (c)	−0.293	.009	−30.652	< .001
Group (GD)	−1.073	.382	−2.809	.005
Group (SD)			*n.s.*	
Origin			*n.s.*	
Interactions				
Group (GD): stimulus (c)	−0.070	.025	−2.835	.004
Group (SD): stimulus (c)			*n.s.*	
Group (GD): origin			*n.s.*	
Group (SD): origin	1.490	.725	2.056	.040
Group (GD): stimulus (c): origin			*n.s.*	
Group (SD): stimulus (c): origin	0.152	.042	3.637	< .001

Table 2.6: Summary of the results of the regression model for fricative perception. GD = Galician-dominant; (SD) = Spanish-dominant; c = centred. Baselines for predictor variables: neofalante for `group` and rural for `origin`. Numbers represent Estimates (β), Standard Errors (SE), Wald statistics (z-values) and p-values. Group effects in grey.

and Galician-dominant listeners, but no significant contrast between *neofalantes* and Spanish-dominant listeners. Moreover, the effect of `origin` was not significant. As expected, as the stimulus continuum increased from /s/ to /ʃ/, the less likely it was for listeners to choose /s/. In terms of group differences, Galician-dominants chose /s/ less frequently than *neofalantes* overall. The contrast between the *neofalantes* and Galician-dominant groups was modulated by a significant interaction with `phoneme`, suggesting that *neofalantes*' categorisation of the phonemes was different than that of Galician-dominant listeners, but not different from that of Spanish-dominant listeners. Figure 2.8 shows the identification scores and the model predictions for the three groups and suggests that, although all three groups have categorical perception of this contrast, Galician-dominant listeners start categorising the stimuli as /ʃ/ earlier than the two other groups.

Additionally, the contrast between *neofalantes* and Spanish-dominant lis-

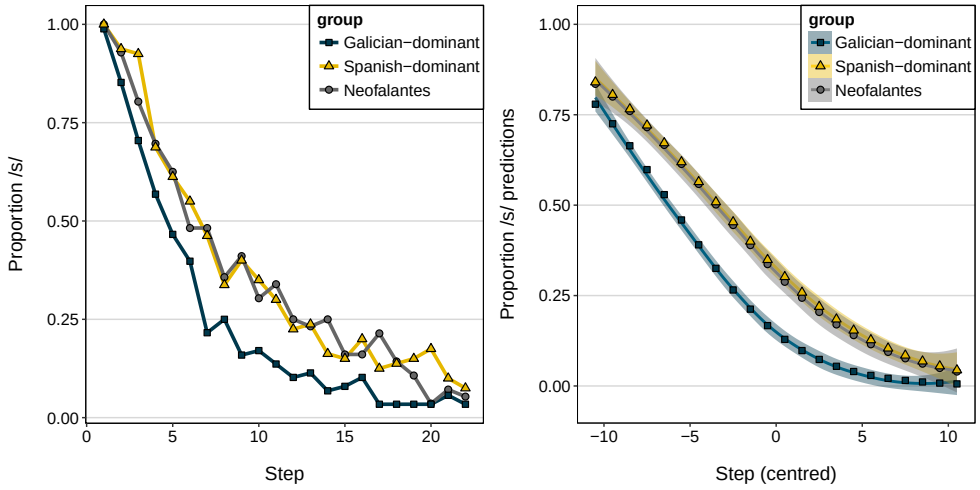

Figure 2.8: Raw proportion of /s/ response according to stimulus step (1-22) by group (Galician-dominant, squares; Spanish-dominant, triangles; *Neofalantes*, circles; left panel) and model predictions according to centred stimulus step by group (right panel). All three groups had categorical perception of the fricative contrast, but Galician-dominant listeners started categorising the stimuli as /ʃ/ earlier than the two other groups.

teners was modulated by a significant interaction with `origin`; the frequency of choosing /s/ was different for urban and rural participants in these two groups. This effect was further modulated by a significant the three-way interaction with `stimulus`, which also indicated that there were differences between these two groups in terms of origin when taking into account the stimulus; urban *neofalantes* had an earlier categorisation boundary than rural *neofalantes*, whereas Spanish-dominants showed the opposite pattern.

2.3.3 Summary

Overall, *neofalantes* did not differ in their perception from Spanish-dominants, indicating that they had not changed to behave more like Galician-dominants. Although both *neofalantes* and Spanish-dominants performed relatively well with the mid-vowel contrasts, they performed more poorly than Galician-dominants, although the performance of Galician-dominant listeners was modulated by origin. In addition, *neofalantes* behaved differently from both groups in the different accent conditions; their perception of the mid-vowels when listening to the standard accented stimuli was slightly closer to that

of Galician-dominants and better than that of Spanish-dominants. Furthermore, the effect of origin also appeared to be important, as urban Galician-dominants' identification accuracy was similar to that of urban *neofalantes*. This effect mirrors the production results, but similarly, the interpretation of this interaction is difficult given the small sample size. For fricatives, *neofalantes* likewise patterned with Spanish-dominant listeners. Both groups could perceive the /s/-/ʃ/ contrast, but they had a later phoneme categorisation boundary when compared to Galician-dominants, i.e., they still hear /s/ for tokens where Galician-dominants already hear /ʃ/. This mirrors the production results that showed that *neofalantes* and Spanish-dominants had a lower centre of gravity for /s/ than Galician-dominants. As for vowels, origin was also relevant for perception of this contrast; differences between *neofalantes* and Galician-dominants became less evident for urban participants. In this case, urban *neofalantes* seem to have an earlier boundary for /ʃ/, behaving more like Galician-dominant listeners.

2.4 Discussion

This study investigated whether *neofalantes* changed aspects of their speech production and perception after switching language dominance to Galician. Change was inferred by comparing this group to two control groups, Galician-dominant and Spanish-dominant bilinguals. If they patterned with Spanish-dominants when producing and perceiving variables that are specific to Galician, it was assumed that there was no change, while if they patterned with Galician-dominants it was assumed that there was a change. In production, there was little evidence to suggest that *neofalantes* were able to produce the two mid-vowel contrasts that do not exist in Spanish, behaving like Spanish-dominant speakers. They were able to produce a sibilant consonant contrast that does not exist in Spanish, but so were Spanish-dominants. However, both *neofalantes* and Spanish-dominants produced this contrast differently from Galician-dominants, who had a more distinct contrast. Word-final vowels, on

the other hand, which are a highly salient feature of Galician, were produced by *neofalantes* with a more Galician-like realisation, different from Spanish-dominants. In perception, *neofalantes* behaved like Spanish-dominants for both mid-vowel and the fricative contrasts. Both groups were able to identify the mid-vowel contrast, but their performance was poorer than that of Galician-dominants. Likewise, both groups were able to identify the fricative contrast, but had a different category boundary from Galician-dominants.

Previous research with Spanish-Catalan bilinguals has shown that early exposure is not enough for dominant bilinguals to acquire native-like categories in their non-dominant language, and this has been attributed to a lack of plasticity (Pallier et al., 1997, 2001; Sebastián-Gallés & Soto-Faraco, 1999). Likewise, *neofalantes* had limited success in acquiring the front and back mid-vowel contrast in production and did not perform like Galician-dominants in perception. However, it has also been argued that difficulties in L2 perception are due to continued use of the L1 (Flege & MacKay, 2004; Mora et al., 2011; Mora, Keidel, & Flege, 2015a). Given that the bilinguals in the Catalan studies continued to use their dominant language (in this case, Spanish), one could hypothesise instead that the failure to establish native-like phonetic categories was because the L1 continued to exert a strong influence on perception and therefore, the L2. Nevertheless, these results show that even with extensive use of the L2 and a high motivation to learn, dominant bilinguals are unable to form new, native-like phonetic categories in production or perception when they switch relatively late in life, i.e., late adolescence. It seems more likely then that *neofalantes* process their new, dominant language through their former dominant language categories.

Theories of cross language speech perception such as PAM/PAM-L2 (Best, 1994, 1995; Best & Tyler, 2007) and the SLM (Flege, 1992, 1995) provide support for this interpretation. Such theories have proposed that certain phonetic contrasts are more difficult to perceive than others and that this leads to difficulties in production. According to these models, the difficulty can

be predicted by the phonetic similarities of the first and second languages. The contrast between open- and close-mid vowels is a difficult one for *neofalantes* (and Spanish-dominants), because the Galician contrasts are both a good match to the single Spanish categories. However, although their category boundary was different from Galician-dominant listeners, both *neofalantes* and Spanish-dominants were able to perceive and produce the fricative contrast that does not exist in Spanish. Flege (1995) postulates that bilinguals are able to establish a new phonetic category for an L2 sound that differs phonetically from the closest L1 sound if they are able to discern at least some of the phonetic differences between the L1 and L2 sounds. One possibility then is that this contrast is more acoustically distinct than the mid-vowel contrasts, such that both Spanish-dominants and *neofalantes* are able to establish a category even though this does not match that of native speakers.

In contrast, word-final vowels seem to be more mutable. Although *neofalantes* behaved like Spanish-dominants in their production of mid vowels and fricatives, they produced word-final vowels like Galician-dominants; all speakers used reduced vowels, but *neofalantes* patterned with Galician-dominants in having a greater amount of reduction than Spanish-dominants. Word-final vowels are a highly salient characteristic of the Galician accent, and one possibility is that social factors played a role in production of this variable. *Neofalantes* switch language dominance for ideological reasons, and when they do, they are often very aware that they do not speak like Galician-dominants. They are very motivated to 'learn' the language and most of the participants reported having made a conscious effort to improve their pronunciation, i.e., to speak with a more native-like accent. One interpretation is that *neofalantes* use this feature, whether consciously or subconsciously, to fit in with their new group of Galician-dominant speakers. This is similar to findings from studies of accent change within the same language; Evans and Iverson (2007) showed that speakers who changed their accent late in life (young adulthood) acquire some, but not all the phonetic features that characterise their new accent. However,

their realisation was not like that of native speakers, and not all the speakers showed the same changes in production. These individual differences were understood as reflecting the way speakers chose to present themselves to the world. In a bilingual context, Amengual (2015) found that Spanish-dominant bilinguals did not differ from Catalan-dominant bilinguals in their production of some reduced vowels in Majorcan Catalan; both groups produced /a/ as a reduced centralised [ə] in unstressed position. This was interpreted as being a result of the "construction of socio-indexical phonological categories based on a stronger identification with the prestigious Standard Catalan variety" (2015, p. 4). In the Galician community, although the reduced vowels might not be associated with the prestigious variety, they are indeed associated with a Galician-like accent, thus meaning that they could be used to signal Galician identity.

Studies in the lab have shown that there is flexibility in production and perception in adulthood. For example, high variability phonetic laboratory training studies have shown that L2 listeners can improve in their identification of phonetic contrasts that do not exist in their L1 (Iverson & Evans, 2009; Lively, Logan, & Pisoni, 1993; Logan, Lively, & Pisoni, 1991), that this knowledge can be transferred to production (Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997) and that it is retained after a few months (Bradlow, Akahane-Yamada, Pisoni, & Tohkura, 1999). However, there appear to be limits to this such that even early exposure to an L2 in a bilingual environment is not enough to acquire native-like categories in the non-dominant language (Pallier et al., 1997). The current study is in line with these findings and provides further evidence that 'real life training' or in this case, extensive naturalistic exposure to and use of the L2, is not enough for dominant bilinguals to acquire native-like categories in their non-dominant language. Even with what could be seen as ideal circumstances for learning – early and extensive exposure, almost exclusive use of the L2 and very high motivation – L2 production and perception still seem to be filtered by L1 categories. One possibility is that underlying

categories are very difficult to change, and that although, with experience, individuals can improve at mapping new categories onto native ones, they do not create new categories (Iverson & Evans, 2009). That said, the focus of this study is group differences, and it is relevant to highlight that individual differences (e.g. learning ability or other cognitive skills) might play a role in the acquisition of such phonetic contrasts. That is, it is perhaps not the case that no *neofalante* can ever learn Galician-like contrasts, but this at least seems very difficult.

Finally, it is worth noting that the potential effect of participants' origin would also argue for a central role for early exposure in phonetic processing. In both experiments, participants' origin appears to have affected performance. However, the sample size of urban Galician-dominant speakers was limited, so these results are to be interpreted tentatively and need to be followed up. In these experiments, Spanish-dominant and Galician-dominant bilinguals performed more similarly when they came from an urban background, where the proportion of Spanish and Galician spoken by Spanish-dominant speakers is much greater than in a rural environment. Urban Galician-dominant bilinguals produced less distinct vowel contrasts and were poorer at identifying them than their rural counterparts, and they had more Spanish-like fricative categories. In some cases, rural Spanish-dominants also showed more Galician-like categories than their urban counterparts.

These results thus argue for a central role of early exposure in phonetic processing. Although studies of Korean adoptees adopted by French families and exposed exclusively to French from between the ages of 2 and 9 years old (Pallier et al., 2003; Ventureyra, Pallier, & Yoo, 2004), have indicated that all traces of attunement to the L1 sound system are lost by adulthood, new research with Chinese adoptees in Canada, also exposed exclusively to French since adoption, has shown that early experience can have lasting effects (Pierce, Chen, Delcenserie, Genesee, & Klein, 2015)). Although their performance on behavioural tasks did not differ from that of French monolin-

guals, Chinese adoptees' brain activation patterns were more similar to those of Chinese-French bilinguals. This suggests that early exposure to a language continues to influence the neural processing of a subsequently learned language sounds years later, even in highly proficient, early-exposed users.

In conclusion, these findings suggest that native-like production and perception of new phonetic contrasts is effortful. Despite early exposure, extensive use and high motivation, there was little evidence to indicate that *neofalantes* acquired the Galician mid-vowel contrasts in production and perception, and behaved more similarly to Spanish-dominants in their production and perception of the fricative contrast. However, they produced unstressed word-final vowels in the same way as Galician-dominants. Together, this results in a hybrid variety different from that used by Galician- and Spanish-dominants (cf. Harris, 2006; Stuart-Smith, Timmins, & Alam, 2011), and characterised by the effects of language dominance switch. Although underlying category representations appear hard to change, with modifications to production and perception constrained by early experience with a particular language, the resulting hybrid categories may function as opportunities to mark identity within a particular community.

The hypothesis of whether a new *neofalantes*' variety is emerging as a distinctive accent in the Galician community is tested in Study 2 in the following Chapter.

Chapter 3

Study 2: Is there an emergent *neofalantes'* accent? An accent identification task.

3.1 Introduction

The previous Chapter investigated *neofalantes*' production of Galician front /ɛ/-/e/ and back /ɔ/-/o/ mid-vowel contrasts, the reduction of unstressed word-final vowels, and the /s/-/ʃ/ fricative contrast, as compared to Galician-dominant and Spanish-dominant speakers. An acoustic analysis showed that *neofalantes*' production of mid-vowel and fricative contrasts was similar to that of Spanish-dominants, whereas their production of word-final vowels patterned with that of Galician-dominants. Overall, these findings suggest that *neofalantes* can acquire certain Galician features, but that there are limits to this flexibility, resulting in a hybrid accent. One question that arises is whether these shifts in production are perceptible to listeners in the community. If listeners can associate phonetic features in the speech of *neofalantes* with the label that defines the social group, this would indicate that this variety has become enregistered (cf. Agha, 2003). Previous research has shown that native listeners are able to reliably identify regional accents in forced-choice categorisation tasks (Clopper & Pisoni, 2004a, 2004b) and free classification task

(Clopper, 2008; Clopper & Pisoni, 2007), in some cases as early as the age of 4-5 years old (Jones et al., 2017). Moreover, accent categorisation abilities are influenced by linguistic experience (Clopper & Pisoni, 2004a, 2006). In the area of voice identification, it has been shown that listeners are better at identifying talkers in their native language (cf. LFE; Fleming et al., 2014; Goggin et al., 1991; Perrachione et al., 2009). Some authors have proposed that voice identification skills are related to listeners' language ability, with phonological processing facilitating speaker identification (Perrachione et al., 2011). Others have argued that comprehension of the message does not seem necessary for LFE to be present (Fleming et al., 2014).

In the current study, Galician listeners heard sentences produced by bilingual speakers belonging to three groups (*neofalantes*, Galician-dominant and Spanish-dominant speakers) and categorised them according to their language background. If accent categorisation ability relies on similar mechanisms to talker identification skills, it might be influenced by language ability or language familiarity. An effect of language ability would predict that Galician-dominant speakers would show an advantage in terms of speaker categorisation. In contrast, a language familiarity effect would predict similar performance for all listener groups, as they live in a bilingual environment where they listen to both Galician and Spanish on a daily basis. Thus, the present study addresses two research questions:

1) Are *neofalantes*' shifts in production sufficient for listeners in the speech community to identify their accent?
2) Does identification ability depend on listeners' language background?

3.2 Method

3.2.1 Participants

This study was deliberately set out to test the wider community and therefore, the sample is formed of a pool of varied participants from different background

and professions. The number of participants that took part in the online task was 162. Twenty participants had to be excluded because they did not meet the criteria. The remaining 142 participants grew up in Galicia, had not lived anywhere else for more than seven years and were bilingual in Galician and Spanish. Their age ranged between 18-54 years old (median = 27 years old). After the experiment, they completed the language background questionnaire used in Study 1 (Appendix A). The questionnaire was used to classify participants into the three groups of interest, following the criteria established in Study 1 (see Section 2.2.1.1 Participants), resulting in 13 *neofalantes* (6 female, 7 male), 58 Galician-dominants (34 female, 24 male) and 61 Spanish-dominants (34 female, 24 male). The remaining 10 participants did not belong to any of these three groups, but were included in the first set of analyses, as these were focussed on whether the three groups of speakers were correctly identified, regardless of listeners' language background. The second set of analyses examined specifically whether listeners' language background played a role in identification, and therefore those 10 participants were excluded. Two pilot participants had completed the experiment before collecting the data. None of the subjects reported any speech, hearing or language disorders at the time of testing.

3.2.2 Stimuli

The stimuli consisted of the first sentence of 'The north wind and the sun' passage in Galician: *O vento do norte e mais o sol porfiaban sobre cal deles era o máis forte* (The North Wind and the Sun were disputing which was the stronger). This sentence was selected because it includes all the phonetic variables that were produced differently by the three bilingual groups in Study 1 (mid vowels, unstressed word-final vowels and the voiceless alveolar fricative /s/), as well as other Galician-specific features (voiced velar nasal /ŋ/ and connected speech processes between *norte* + *e*, *mais* + *o* and *era* + *o*). The sentence was produced by the 56 participants in Study 1 (14 *neofalantes*,

22 Galician-dominant and 20 Spanish-dominant speakers). The stimuli were scaled for intensity to 65 dB and 50 ms silence was added at the beginning and end of each file. The duration of the stimuli ranged from 3.001 seconds to 5.510 seconds (M = 4.038 seconds). All processing was done using Praat (Boersma & Weenink, 2016). Stimuli were presented in a random order.

3.2.3 Procedure

Participants completed the accent identification task online, presented on Qualtrics (2015). All the instructions were written in Galician. The definitions and the illustration of the trial procedure presented below correspond to English translations (for the Galician version, see Appendix E). Before the task started, definitions for the three different groups were provided as follows:

- (she/he) Usually speaks Galician: This person speaks Galician in their daily life and has always spoken more Galician than Spanish.
- (she/he) Usually speaks Spanish: This person speaks Spanish in their daily life and has always spoken more Spanish than Galician.
- (she/he) Is a new speaker: This person used to speak more Spanish, but now she/he speaks Galician in their daily life.

It is possible that due to the diverse background of the listeners, not all of them were familiar with the *neofalantes* label, and that was the main reason for providing definitions. The trial procedure is illustrated in Figure 3.1 (for the Galician version, see Appendix F). Participants were instructed to listen to each sentence over headphones and indicate to which group the speaker belonged. The sentence was played only once. Participants were subsequently asked to comment on whether particular factors had influenced their decision. In this case, they were allowed to listen to the audio again. These comments will be considered in the Discussion section. Although the experiment was distributed online, it was only advertised through friends and acquaintances of the experimenter in order to give some control over who participated and

seek to guarantee that participants listened to the stimuli over headphones in a quiet environment. In fact, participants overall spent a considerable amount of time completing the task (mean experiment duration = 65.22 minutes), which indicates that they spent time providing detailed comments. Given that the recruitment method was through friends of friends, and that this was also the case for Study 1, from which the recordings are taken, participants were asked whether they knew the speaker. Participants indicated that they knew the talker in 114 trials (1.56% of the total number of trials), and were excluded from further analysis. Finally, they completed the language background questionnaire.

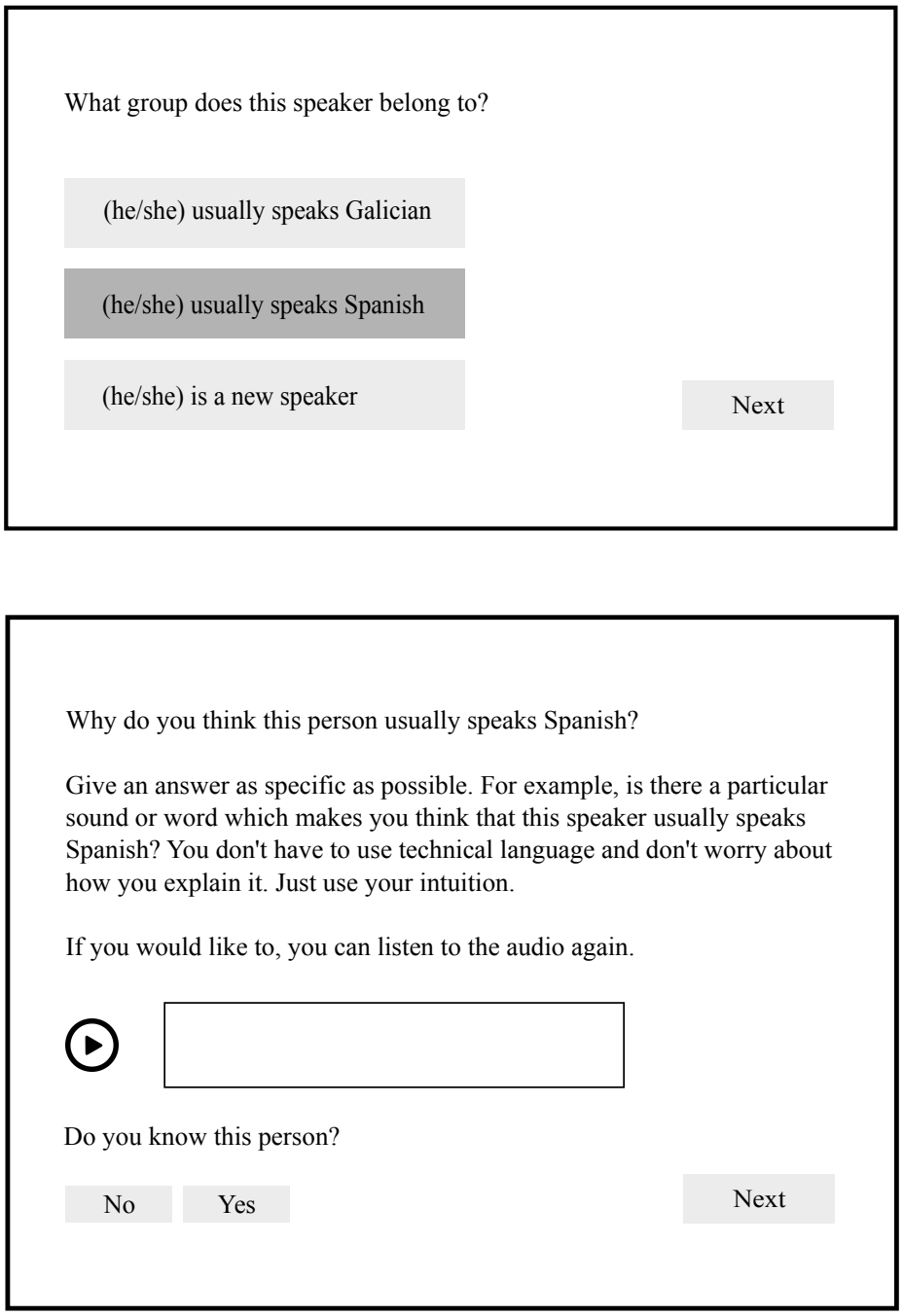

Figure 3.1: Representation of the procedure in Study 2. First, participants identified to which group they thought the speaker belonged. Then, they provided comments about what influenced their decision. They also indicated whether they thought they knew the speaker.

3.3 Results

3.3.1 Can listeners identify the *neofalantes*' accent?

Figure 3.2 shows the identification score (proportion correct) for each of the speaker groups averaged over listeners. These analyses include all 142 listeners. To investigate which accents were identified at above chance level, the real data was compared to randomly generated data of corresponding dimensions. This method was selected, instead of scoring the dependent variable as correct or incorrect and comparing the intercept to chance, because the experiment was a three-way discrimination task, and therefore the chance level was not 50%. Thus, three separate logistic regression models were fit to the real and fake data for each of the groups. The dependent variable was the binomial response (correct/incorrect) and the only predictor variable was `type of data` (fake or real). `Participant` and `item` were included as crossed random effects. Table 3.1 shows the results of each of the models. Both Galician-dominant (M_{Prop} = 0.57) and Spanish-dominant speakers (M_{Prop} = 0.41) were identified at above chance level, and *neofalantes* were identified systematically worse than chance (M_{Prop} = 0.26).

To further investigate whether there were any differences between the two groups of speakers that were identified above chance a separate regression model was fit to the binomial response (correct/incorrect) for Galician-dominant and Spanish-dominant speaker groups in the real data. `Speaker group` was included as the predictor variable, with Galician-dominant as the baseline. `Participant` and `item` were included as crossed random effects. The model revealed a significant difference in identification of Galician-dominant speakers when compared to Spanish-dominant speakers (Intercept: β = 0.343, SE = .169, z = 2.029, p = .042; Speaker group: β = −0.774, SE = .241, z = −3.210, p = .001).

It is clear from these results that listeners could not recognise the *neofalantes*' accent. Figure 3.3 displays the pattern of responses for each speaker

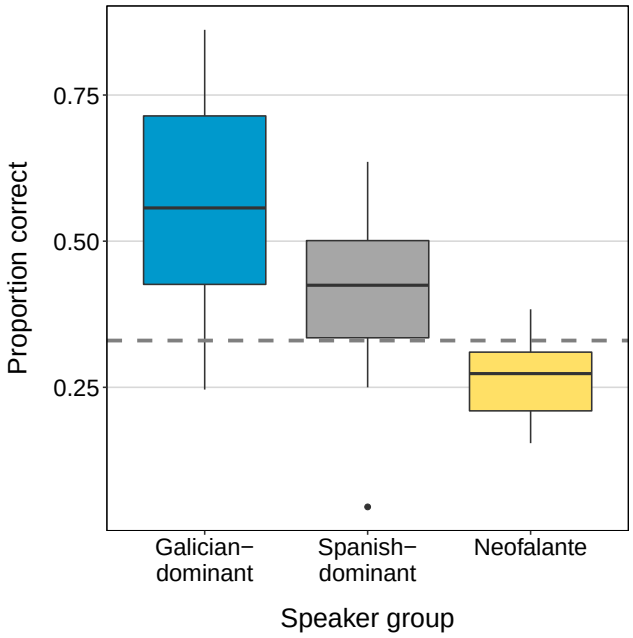

Figure 3.2: Boxplot showing accent identification scores (proportion correct) for all listeners. The three boxplots represent speaker group: Galician-dominant on the left, Spanish-dominant in the centre and *Neofalantes* on the right. The dashed line represents chance level performance. Both Galician-dominant and Spanish-dominant speakers were identified at above chance level, and *neofalantes* were identified systematically worse than chance. Listeners were better at identifying Galician-dominant than Spanish-dominant speakers.

	β	SE	z-value	p-value
Model 1: Galician-dominant speakers				
Intercept	-0.659	.096	-6.839	$< .001$
Real data	0.965	.057	17.046	$< .001$
Model 2: Spanish-dominant speakers				
Intercept	-0.704	.085	-8.307	$< .001$
Real data	0.329	.059	5.582	$< .001$
Model 3: *Neofalantes*				
Intercept	-0.608	.063	-9.617	$< .001$
Real data	-0.438	.073	-5.963	$< .001$

Table 3.1: Summary of the results of the regression models for each speaker group compared to a random baseline. The baseline for the categorical predictor variable was the fake data. Numbers represent Estimates (β), Standard Errors (SE), Wald statistics (z-values) and p-values.

group. The confusion matrix shows that *neofalantes* were not only identified as Spanish-dominant, but also as Galician-dominant speakers. To further explore this question, the responses that corresponded to when *neofalantes* were misidentified were analysed. An intercept-only logistic regression model was fitted to the categorical response (Galician-dominant vs. Spanish-dominant) when the *neofalantes* speaker group was misidentified. The model showed that the intercept is significantly different from zero ($\beta = 0.163$, SE = .055, $z = 2.945$, $p = .003$), which implies that the event probability is different from 0.5. This suggests there is a bias in classifying *neofalantes* as Galician-dominant; they were classified as Galician-dominants 54% of the time and as Spanish-dominant 46% of the time (see Figure 3.3).

One possible explanation for the consistent misidentification of *neofalantes* would be the existence of a bias against choosing the *neofalantes* label. However, it was not the case that listeners did not choose this label. The left panel on Figure 3.4 illustrates the counts for each of the speaker labels and shows that all three labels were used for classification. It also is relevant to note that there were more Galician-dominant (22) and Spanish-dominant speakers (20) than *neofalantes* (14), and that the distribution of labels reflects the distribution of speakers. Given that the *neofalantes* label was indeed used, but not for categorising the correct speakers, the question then remains as to which speakers were assigned this label. The right panel on Figure 3.4 shows counts of the use of the *neofalantes* label, and reveals that it was used to identify Spanish-dominant and Galician-dominant speakers more often than *neofalantes* themselves. A more detailed approach to the analysis of sensitivity, i.e., using Signal Detection Theory (e.g., Macmillan & Creelman, 2004), would enable further investigation of bias in the data.

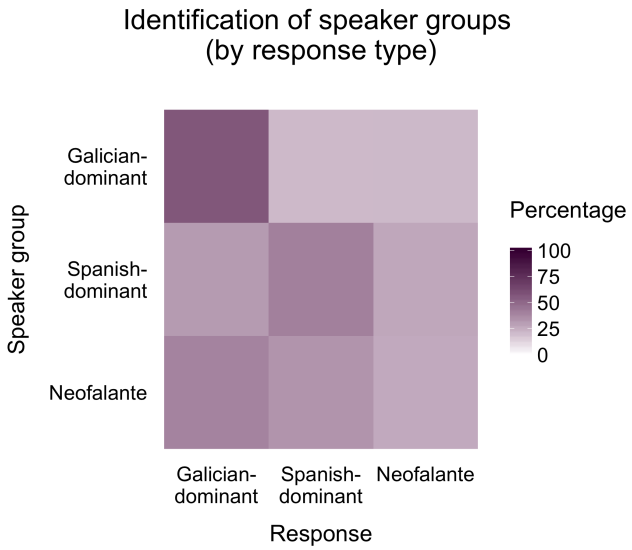

Figure 3.3: Confusion matrix showing the identification of speaker groups by response type. The y-axis represents the speaker group (Galician-dominant, Spanish-dominant, and *Neofalantes* and the x-axis represents the response all listeners gave per speaker group. The darker the colour the higher the percentage of responses in that category. *Neofalantes* were not only identified as Spanish-dominant, but also as Galician-dominant speakers.

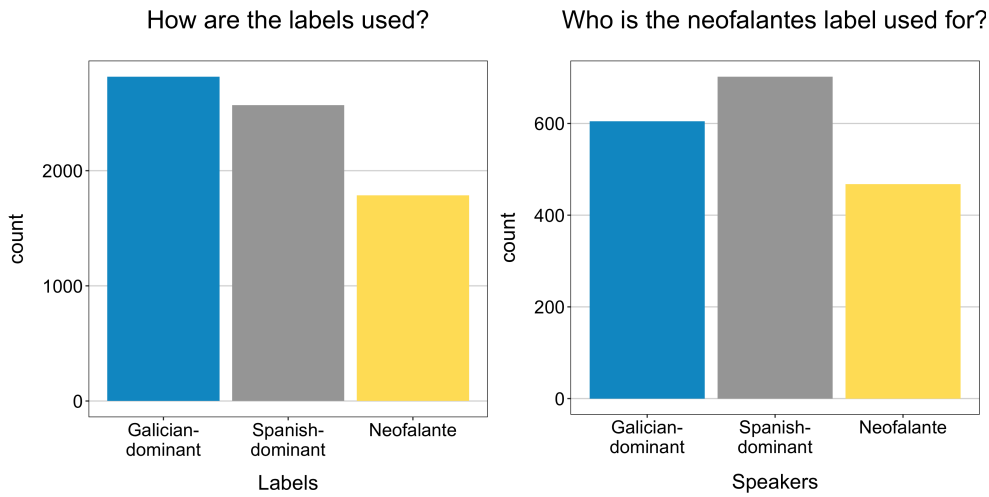

Figure 3.4: Barplots showing (a) counts for each of the three speaker labels and (b) counts for the *Neofalantes* label. The plot on the left shows how often each of the three speaker groups labels was selected, with the speaker group labels on the x-axis (Galician-dominant, Spanish-dominant and *Neofalantes* and frequency counts on the y-axis. The plot on the right shows how often each speaker group (Galician-dominant, Spanish-dominant and *Neofalantes*) was identified as *Neofalantes*. The *Neofalantes* label was used to identify Spanish-dominant and Galician-dominant speakers more often than *neofalantes*.

3.3.2 Does identification ability depend on listeners' language background?

To investigate whether identification ability depended on listeners' language background, only data from the three groups of interest was included in the analyses. A logistic mixed effect regression was fitted on the binomial response (correct/incorrect), `speaker group` and `listener group` were included as fixed factors. `Participant` and `speaker` were included as crossed random effects. The main effects from this model were interpreted using Wald χ^2 tests, as reported by the `Anova()` function in the `car` package (Fox & Weisberg, 2011) in `R` (R Core Team, 2013). The main effect of `speaker group` was highly significant (χ^2 (2) = 34.8393***[11]). As discussed in the previous Section (3.3.1), Galician-dominant speakers were identified more accurately (M = 57%) than Spanish-dominant speakers (M = 42%), and both groups were identified more accurately than *neofalantes*, whose identification was below chance (M = 27%). The effect of `listener group` was not significant (χ^2 (2) = 4.5787 *n.s.*), suggesting that language background did not affect overall identification. This can be seen in Figure 3.5, which shows the accent identification scores, and which illustrates that the pattern of identification was very similar for all three listener groups.

The analysis also showed a significant interaction between `speaker group` and `listener group` (χ^2 (4) = 12.4894*). To follow up this interaction, pairwise post-hoc tests were carried out using the `lsmeans` package (Lenth, 2016) in `R` (R Core Team, 2013), adjusting for multiple comparisons using the Tukey method. The interaction appeared to be driven by the identification of Galician-dominant speakers by *neofalantes* listeners when compared to both Galician-dominant (GD vs. NF: $\beta = -0.446$, SE = .160, $z = -2.774$, p = .015) and Spanish-dominant listeners (SD vs. NF: $\beta = -0.504$, SE = .159, $z = -3.161$, p = .004). No other interactions were significant. This indicates

[11] p-value $< .001 = ^{***}$, p-value $< .01 = ^{**}$, p-value $< .05 = ^{*}$, p-value $> .05$ = *n.s.*

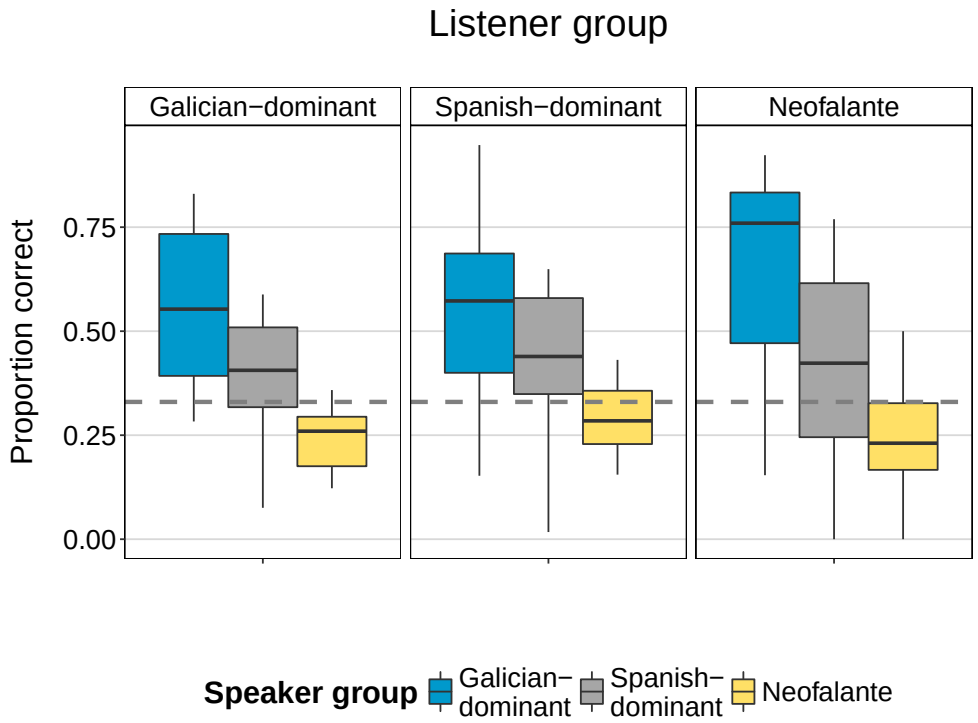

Figure 3.5: Boxplot showing accent identification scores (proportion correct) by the three listener groups: Galician-dominant (left rectangle), Spanish-dominant (middle rectangle) and *Neofalantes* (right rectangle). Boxplots represent speaker group: Galician-dominant on the left, Spanish-dominant in the centre and *Neofalantes* on the right. The dashed line represents chance level performance. The accent identification pattern was very similar for all three listener groups.

that *neofalantes* were better ($M = 66\%$) than the other two listener groups (GD: $M = 56\%$, SD: $M = 55\%$) at identifying Galician-dominant speakers.

This effect is illustrated in Figure 3.6, which displays the identification of speaker groups by response type and listener group. The graph shows that the cell with the darkest colour (i.e., highest number of accurate responses) corresponds to the identification of Galician-dominant speakers by *neofalantes* listeners (matrix on the right), indicating that *neofalantes* were more accurate than Galician-dominant and Spanish-dominant listeners at identifying Galician-dominant speakers, as revealed by the significant interaction between speaker and listener groups in the regression model.

Another apparent difference in the classification pattern concerns which listener groups classified *neofalantes* as Galician-dominant speakers. To in-

vestigate if groups differed in their classification of *neofalantes*, a mixed-effect logistic regression model was fit to the binomial response (Galician-dominant/Spanish-dominant) from the subset of data where *neofalantes* were identified incorrectly. `Listener group` was included as a fixed factor in the model, with *neofalantes* as a baseline, and `participant` was included as a crossed random effect. The model (Intercept: $\beta = 0.529$, SE = .210, $z = 2.511$, $p =$. 012) revealed that Galician-dominant listeners did not differ from *neofalantes* listeners when labelling *neofalantes* speakers as Galician-dominant ($\beta = -0.273$, SE = .233, $z = -1.176$, $p =$ *n.s.*), but Spanish-dominant listeners did differ from *neofalantes* listeners when labelling *neofalantes* speakers as Galician-dominant ($\beta = -0.533$, SE = .232, $z = -2.295$, $p = .022$). This suggests that *neofalantes* were identified as Galician-dominant more frequently by Galician-dominant listeners (56% of the time) and *neofalantes* themselves (62% of the time), than by Spanish-dominant listeners, who identified them as Galician-dominant 50% of the time and as Spanish-dominant 50% of the time.

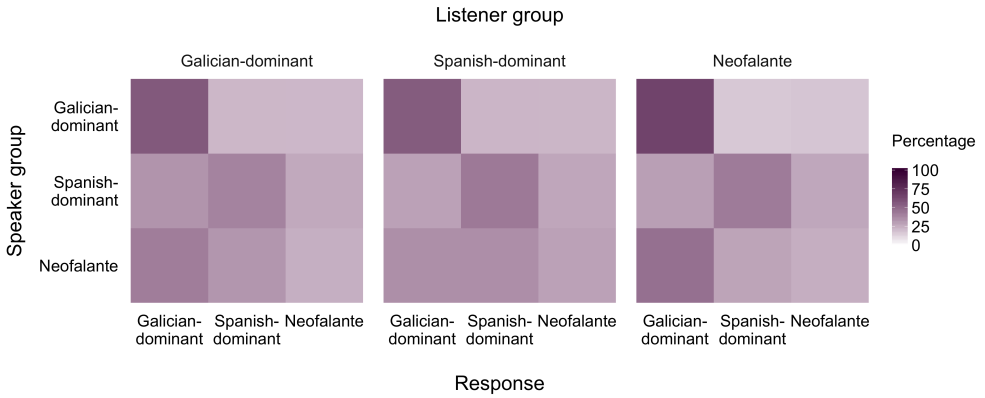

Figure 3.6: Confusion matrices showing the identification of speaker groups by response type and listener group (Galician-dominant, Spanish-dominant and *Neofalantes*). The y-axis represents the speaker group (Galician-dominant, Spanish-dominant, and *Neofalantes*) and the x-axis represents the response each listener group gave per speaker group. The matrix on the left corresponds to Galician-dominant listeners, the one in the centre to Spanish-dominant listeners and the one on the right to *Neofalantes*. The darker the colour the higher the percentage of responses in that category. *Neofalantes* listeners were better than the two other listener groups at identifying Galician-dominant speakers and *neofalantes* speakers were identified as Galician-dominant more frequently by Galician-dominant listeners and *neofalantes* themselves than by Spanish-dominant listeners.

3.4 Discussion

3.4.1 The *neofalantes*' accent

Listeners in the Galician community, regardless of language background, can identify Galician-dominant better than Spanish-dominant speakers, but cannot identify the *neofalantes*' accent. However, *neofalantes* listeners show heightened sensitivity to the Galician-dominant variety, in comparison to the other two groups. Overall, *neofalantes* speakers are not only confused with Spanish-dominants, but also with Galician-dominant speakers, suggesting that their accent has changed after the language switch.

As such, the results of this study provide no evidence for the existence of a *neofalantes* variety, despite the frequent use of this label to designate this social group (O'Rourke & Ramallo, 2011, 2015; Ramallo, 2013; Tomé Lourido & Evans, 2017). One possibility is that some participants in the experiment might not have been familiar with the existence of *neofalantes* as a

social group. This study was deliberately set out to test the wider community and selected a pool of participants from all backgrounds and professions to investigate whether this accent emerged as a new variety in the community as whole, rather than in particular areas of society (e.g., those related with language planning and revitalisation or Galician linguistics). However, it seems unlikely that participants did not understand the label, as they were provided with definitions for each group before starting the experiment and Figure 3.4 showed that participants used all three labels. Besides, even though they might not use the label themselves, Galician listeners are often aware that individual speakers may switch language dominance along their lives. In fact, some of the comments they provided to justify their choice when they identified a speaker as *neofalante* illustrate this point:

[1] *Fala galego habitualmente pero non parece que sempre fora así, como se pensara en castelán.*	[1] '(S/he) usually speaks Galician, but it doesn't seem like it has always been like this, as if (s/he) thought in Spanish.'
[2] *A entoación segue sendo lixeiramente castelá. Tenta falar galego, pero lle queda ese acento castelanfalante.*	[2] 'The intonation continues to be slightly Spanish. (S/he) tries to speak Galician, but (s/he) is left with that Spanish-speaking accent.'
[3] *Este chico non falou galego ata que chegou a universidade.*	[3] 'This guy didn't speak Galician until he got to university.'
[4] *Prosodia e pronuncia "aprendida", non soa "natural".*	[4] "'Learnt" prosody and pronunciation, it doesn't sound "natural" .'
[5] *Boa fonética, mais penso que adquirida a posteriori.*	[5] 'Good phonetics, but I think it was acquired *a posteriori*.'

These comments suggest that listeners were aware that the definition of a *neofalante* involved a long-term language switch. Therefore, it seems un-

likely that the reason why *neofalantes* were not identified as such was related to listeners not understanding the label.

A question that then arises is in what ways the '*neofalante*' label is becoming enregistered (Agha, 2003), that is, associated with a particular set of linguistic features. It is possible that listeners have not yet tuned into the phonetic forms produced by *neofalantes* to be able to link them with the social group to which they belong. However, this interpretation would assume that the changes after the *neofalantes*' language-switch are sufficiently phonetically distinct to constitute an identifiable variety. In order to evaluate whether this assumption is plausible, it is worth considering the fact that listeners were less accurate at identifying Spanish-dominant than Galician-dominant speakers. Spanish-dominant speakers are not L2 learners and thus, are likely to have a certain type of Galician accent, both in Galician and in Spanish. Therefore, variation due to language background differences could be organised along a continuum with Galician-dominant speakers at one end and L2 Galician speakers at the other end (e.g., Galician spoken by a person from Madrid). The accent of Spanish-dominant speakers then, which would fall in the middle of the continuum, but towards the L2 accent side, would not be as distinctive as the Galician-dominant one. This would also explain why the *neofalantes*' accent was not accurately identified. These speakers would be situated between Galician-dominant and Spanish-dominant bilingual speakers on the continuum, and thus, it might not be possible for this accent to emerge as a distinctive one, due to the limited phonetic repertoire. This idea is related to research regarding children's awareness of regional accent variation. For example, Wagner et al. (2014) argue that children have a gradient representation of accent variation in which the native accent forms the core set of experience and other accents are categorised in relation to that core. In this case, it is possible that a prototypical Galician-like accent and a prototypical Spanish-like accent function as anchors at both ends of a continuum, and other language backgrounds are identified relative to these. In fact, some comments that par-

ticipants made when identifying *neofalantes*' speakers provide support for this idea:

[1] *Non vexo claro se é máis galego ou máis castelán.*	[1] 'It is not clear to me if it is more Galician or more Spanish.'
[2] *Os enes e a articulación das consoantes son casteláns, pero semella polo ton e as vogais que fala galego normalmente.*	[2] 'The "n"s and the articulation of consonants are Spanish, but in terms of the tone and the vowels, it seems that (s/he) usually speaks Galician.'
[3] *Hai moita variabilidade entre rasgos de pronuncia tipicamente galegos e outros moi alleos.*	[3] 'There is a lot of variability between typically Galician pronunciation features and very alien ones.'
[4] *Ten unha mezcla de pronunciacións.*	[4] '(S/he) has a mixture of pronunciations.'
[5] *Ten un amago de sete vogais, pero non tan claras como nos galego-falantes. Transmíteme sensación de inseguridade, como se non soubese exactamente como ten que dicir cada palabra. Podería vir xusto desa condición de neo-falante.*	[5] '(S/he) has something like seven vowels, but they are not as clear as those of Galician speakers. It conveys to me a feeling of insecurity, as if (s/he) didn't know how exactly (s/he) has to say each word. It could come from precisely that condition of *neo-falante*.'
[6] *Ten un bo acento galego pero algunhas trazas son do castelán.*	[6] '(S/he) has a good Galician accent, but some features are Spanish.'

Another interesting result was that *neofalantes* were not only identified as Spanish-dominant but also as Galician-dominant, specifically by Galician-

dominant listeners and *neofalantes* themselves. This is in contrast with impressionistic descriptions of *neofalantes*' varieties that suggest that these speakers have a Spanish-accented variety of Galician (Freixeiro Mato, 2014; González González, 2008; Ramallo, 2010), such as 'New Urban Galician' (*Novo galego urbano*, Dubert García, 2002; Regueira, 1999b). Experiment 1 in Study 1 investigated the production of three segmental variables and showed that for mid-vowel and fricative contrasts *neofalantes* pattern with Spanish-dominant speakers, but that they pattern with Galician-dominant speakers for reduced word-final vowels. It is evident that these phonetic variables alone do not constitute the whole accent, and therefore, listeners are likely sensitive to other phonetic features in the *neofalantes*' variety, whether these are segmental or suprasegmental (e.g., rhythm, intonation). Nevertheless, it appears that *neofalantes* use a mixture of Galician- and Spanish-like variables, including the phonetic features examined in Study 1 and others that have not yet been explored. It is possible then, that listeners in the community are sensitive not only to the Spanish-like variables, but also to the Galician-like features that *neofalantes* acquire after their switch, and that this leads them to categorise *neofalantes* speakers as both Spanish- and Galician-dominant speakers, providing further evidence for *neofalantes* developing a hybrid variety (see Harris, 2006; Stuart-Smith et al., 2011). However, *neofalantes* were identified as Galician-dominant speakers more frequently by Galician-dominant listeners and *neofalantes* listeners, which may indicate that Spanish-dominant listeners use different phonetic cues when identifying the *neofalantes*' accent. Another possibility is that Spanish-dominant listeners have a different representation of what the *neofalantes*' accent ought to sound like, compared to the other two listener groups. Finally, it should be noted that the experiment was a forced choice task, with fixed labels, which might have affected listeners' patterns of identification.

3.4.2 Accent identification and listeners' language background

The second research question of the study examined whether identification ability depended on listeners' language background. Overall, identification accuracy was similar for the three listener groups. These results do not provide full support for the idea that language ability facilitates identification of the speakers' language background (see Perrachione et al., 2011, for effects of language ability on voice identification), as an effect of language ability would predict better performance of Galician-dominant listeners. Although all bilingual groups were familiar with the phonological system of Galician, *neofalantes* and Spanish-dominant listeners perceive the sounds of Galician through their native Spanish categories. Experiment 2 in Study 1 showed that Galician-dominant listeners' performance at identifying the mid-vowel contrasts was at ceiling, while *neofalantes* and Spanish-dominant listeners' performance was not. However, many participants from these two groups claimed to use the mid-vowel contrasts to categorise speakers:

[1] Spanish-dominant listener (SD): *Boa distinción entre vogais medias abertas e pechadas.*

[1] SD: 'Good distinction between open and close mid vowels.'

[2] SD: *Todas as vogais me sonan igual de pechadas. Creo que as non logra diferenciar con facilidade.*

[2] SD: 'All the vowels sound equally close to me. I think (s/he) can't differentiate them easily.'

[3] *Neofalante* (NF): *Véxolle seguridade na fala e non emprega as vogais abertas, que para min é algo moi característico para saber quen é galego falante e quen non.*

[3] NF: 'I see that (s/he) is confident when speaking and doesn't use the open vowels, which for me is something very characteristic to know who is a Galician speaker and who isn't.'

[4] NF: *Só lle escoito cinco vogais.* [4] NF: 'I can only hear five vowels.'

One possibility is that listeners believe they use certain phonetic features, such as mid vowels, to classify speakers according to their language background, when they might be, in fact, using different variables. This would imply that there is a mismatch between what they think they use and what they actually use. Mid-vowels could be considered a sociolinguistic stereotype, which forms part of the knowledge of members of the society, even though it may not conform to an objective fact (Labov, 1972). There is a high awareness about the fact that one of the differences between Galician and Spanish is the different vowel systems among individuals in the community. This is particularly true for younger listeners, who have been taught the Galician language at school. Besides, there is a widespread belief that a 'good speaker' of Galician must have all seven vowels. It seems rather contradictory that Spanish-dominant and *neofalantes* listeners were not always able to identify this contrast in speech perception, and yet they use it in accent categorisation. It is likely that instead, they use other phonetic features, such as unstressed word-final vowels, a feature that has been claimed to be easily perceptible and distinctive (Regueira, 2012), but that they believe they use mid vowels. Indeed, there were remarkably fewer comments highlighting the influence of word-final vowels in participants' decisions, and those comments were expressed in less explicit ways. For example, in comments [1] and [2], the participants represent in spelling the reduction of unstressed word-final vowels by writing *'norti'* instead of *norte*, *'mailu'* instead of *mailo*, and *'du'* instead of *do*. In comment [3], the listener refers to this feature by saying that the final vowel is almost not pronounced.

[1] *Clarísima galego polo acento. O vento do 'norti' e 'mailu' sol...* [1] 'Clearly Galician because of the accent. *O vento do "norti" e "mailu" sol...*'

[2] *A contracción 'do' pronúnciaa* [2] '(S/he) pronounces "do" like a

como unha persoa que fala en galego normalmente. Case pronuncia 'du'.	person who usually speaks Galician. (S/he) almost pronounces "du".'
[3] *Casi no pronuncia la <-e> final* [12].	[3] '(S/he) almost doesn't pronounce the final <-e>.'

Listeners also made references to other segmental features such as the pronunciation of /l/, /s/ and /ŋ/, and liaison processes, e.g., '*era o*' as /ˈeɾo/ and '*máis o*' as /ˈmailo̯/. The phonemes /l/ and /s/ exist in both languages, but have a different realisation in each. Additionally, the phoneme /ŋ/ and the liaison processes that occur in the sentence are characteristic of Galician and do not exist in Spanish (cf. E. Fernández Rei, 2005; Regueira, Dubert García, Parga Valiña, & Sousa Fernández, 1998, for vowel elision in Galician). Suprasegmental features, such as rhythm, intonation and prosody, which are typically different in both languages, were consistently mentioned (cf. E. Fernández Rei, 2005, 2016; E. Fernández Rei, de Castro Moutinho, & Coimbra, 2014, for Galician prosody).

The result that all listener groups showed a similar level of accuracy in identifying talkers overall is in line with the idea that language familiarity facilitates talker identification (Fleming et al., 2014; Goggin et al., 1991; Thompson, 1987). In this context, all three listener groups live in a bilingual community where they have everyday exposure to all the accents. Clopper and Pisoni (2004a, 2006) also found that performance in accent categorisation tasks appears to be modulated by participants' background: listeners who had lived in different areas performed better than those who had only lived in one area and, additionally, listeners who lived in a particular region performed better with the accent from that region. The authors proposed that greater exposure to linguistic variation and specific experience with one variety benefits accent categorisation. The results of the current study do not seem to contradict Clop-

[12] This comment was in Spanish

per and Pisoni's findings, as all listeners had been exposed to all the accents presented here, at least to Galician-dominant and Spanish-dominant varieties. Likewise, listeners did not show an advantage for their own accent, which can also be related to their frequent exposure to all accents.

However, identification accuracy was not exactly the same for all listener groups, *neofalantes* showed heightened sensitivity to one of the accents: the Galician-dominant variety. This result could be due to *neofalantes*' increased metalinguistic awareness about Galician. *Neofalantes* are typically very aware of the way they speak and the fact that their accent is different from that of Galician-dominant speakers. They are usually very motivated to learn Galician and invest time and effort to do so. O'Rourke and Ramallo (2013a, 2015) argue *neofalantes* have a heightened sense of awareness about their own sociolinguistic reality and sociolinguistic context in Galicia. Taking all these aspects into consideration, it seems reasonable to hypothesise that *neofalantes* would be more sensitive to phonetic features in the Galician variety, as that is likely the model most of them follow after they switch languages. Moreover, associations between phonetic variables and social meanings may not be the same for all listeners in the community. Eckert (2008) suggests that variables do not have fixed and static meanings, but instead they acquire that meaning in a particular context. Identifying Galician-dominant speakers or monitoring their speech might not be so important for Spanish-dominant listeners or Galician-dominant listeners themselves, whilst it might be particularly relevant for *neofalantes*. One important caveat is that the listeners' sample size was not balanced. Whilst there were 58 Galician-dominant and 61 Spanish-dominant listeners, there were only 13 *neofalantes*, due to the difficulties in recruiting this group of bilinguals (see Section 2.2.1.1). One possibility is that this result is due to variability in the *neofalantes* group, and replication of this effect is thus needed to ensure its validity.

In sum, Study 1 showed that *neofalantes* can make certain adjustments to their production of Galician to pattern with Galician-dominant speakers, but

they still retain features that are characteristic of the Spanish-dominant variety. The current study provides further support for the idea that *neofalantes* have a hybrid variety characterised by the effects of language switch. However, the findings suggests that the *neofalantes*' accent is not emerging as a distinctive variety that listeners in the Galician community can identify.

Chapter 4

Using eye-tracking to investigate bilingual spoken word recognition

Study 1 investigated the effects of a long-term language dominance switch on *neofalantes*' speech production and perception, when compared to two control groups, Galician-dominant and Spanish-dominant bilinguals. The results indicated that *neofalantes* patterned with Spanish-dominants in their production of Galician-specific phonological contrasts, such as mid vowels and sibilant fricatives, but they were able to acquire a Galician-specific allophonic feature, reduced vowels in final position. Study 2 provided further evidence to support the idea that *neofalantes* appear to develop a hybrid variety, that is different from both Spanish- and Galician-dominants, by showing that listeners in the Galician community did not only identify *neofalantes* as Spanish-dominant speakers, but that they also categorised them as Galician-dominant speakers. As well as speech production, Study 1 also examined perception and showed that *neofalantes*' performance was similar to that of Spanish-dominant listeners when identifying the Galician-specific mid-vowel contrasts, and also patterned with this group in the identification of sibilant fricatives. In this case, both groups had a contrast between /s/ and /ʃ/, but their category boundary was different when compared to that of Galician-dominant listeners. It is, therefore, possible that those differences in perception have an impact in

word recognition, causing inappropriate competitor activation (cf. Broersma, 2002; Pallier et al., 2001), which could lead to greater lexical competition for *neofalantes* and Spanish-dominant bilinguals (cf. Weber & Cutler, 2004). The current study investigates this question by using an online measure of speech processing, eye-tracking, to investigate the time course of lexical access during spoken word recognition in the three bilingual groups of interest.

Research on bilingual lexical access in spoken word recognition has mainly been concerned with parallel language activation, i.e., it has been shown that when recognising words, bilinguals simultaneously access both languages (Blumenfeld & Marian, 2007; Canseco-Gonzalez et al., 2010; Ju & Luce, 2004; Marian & Spivey, 2003; Spivey & Marian, 1999). For example, Spivey and Marian (1999) instructed Russian L2 speakers of English to pick up an object in separate monolingual Russian and English sessions. In the Russian session, participants were presented with the target object e.g., *marka* ('stamp'), an object whose English translation shares the initial sounds with the target, e.g., *flomaster* ('marker') and two unrelated fillers e.g., *lineika* ('ruler'). The English session also included a target object, a Russian competitor and fillers. On average, listeners looked more to the interlanguage competitors than to the unrelated distractors, and the effect was mainly driven by the Russian context. This study suggests that bilinguals' mental lexicons are not independent and remain active during spoken language recognition, even in a monolingual situation. Other work has compared bilingual to monolingual processing and has shown that lexical access is weaker in bilinguals, even when cross-linguistic competition is not present (Shook, Goldrick, Engstler, & Marian, 2015). These studies have mainly been focussed on late bilinguals or L2 learners (e.g., Cutler, Weber, & Otake, 2006; Spivey & Marian, 1999; Weber & Cutler, 2004; Ying, Shaw, & Best, 2013), although some studies included early bilinguals (Blumenfeld & Marian, 2007; Canseco-Gonzalez et al., 2010). To the best of my knowledge, no research has used eye-tracking to investigate the effects of language dominance on lexical access in spoken

word recognition or has focussed on a population of dominant bilinguals who are exposed to both languages on a daily basis in a bilingual environment.

Nevertheless, research on similar populations, such as Catalan-Spanish bilinguals, might be useful in making predictions regarding the Galician bilingual groups. As reviewed in the Introduction, Sebastián-Gallés and colleagues have investigated the perception of Catalan-specific contrasts (e.g., /ɛ/-/e/) by Catalan-dominant and Spanish-dominant bilinguals, and showed that highly proficient Spanish-dominant bilinguals have difficulties discriminating these contrasts (see Bosch et al., 2000; Pallier et al., 1997, 2001; Sebastián-Gallés & Soto-Faraco, 1999). These researchers have also investigated whether these difficulties in perception hinder word recognition. For example, Sebastián-Gallés et al. (2005) have shown that highly proficient Spanish-dominant bilinguals have difficulties in distinguishing between mispronounced and correctly pronounced Catalan words that differ in a Catalan-specific contrast, such as /ɛ/-/e/, on a lexical decision task. Additionally, this difficulty was found even for simultaneous bilinguals who were exposed to both languages from birth. In a different study, toddlers and pre-school children were tested on their sensitivity to Catalan words that contained the same kind of mispronunciation (Ramon-Casas et al., 2009). Word recognition was measured by coding children's looks to the target picture. The study showed that, on the one hand, bilingual toddlers, regardless of language dominance, did not show mispronunciation sensitivity for the Catalan-only contrast. On the other hand, Catalan-dominant preschoolers, but not Spanish-dominant preschoolers, showed sensitivity when the vowel was changed to another Catalan vowel, mirroring the adult results (Sebastián-Gallés et al., 2005). Sebastián-Gallés, Rodríguez-Fornells, De Diego-Balaguer, and Díaz (2006) replicated these results with adults using a similar lexical decision task.

However, ERP measurements collected along with the behavioural data showed that both Catalan- and Spanish-dominant listeners had a similar pattern for the N400 response. The N400 component is considered to be sensitive

to meaning integration and semantic processing and has been associated with degree of lexical-semantic activation, which predicts a smaller difference between words and non-words in the N400 component if a non-word is close to a real word (Sebastián-Gallés et al., 2006). Based on the behavioural data, it would be reasonable to hypothesise that Spanish-dominant listeners, due to phonetic discrimination difficulties with the mid-vowel contrasts, would show no differences in their N400 response for non-words (i.e., mispronounced words containing an altered mid-vowel) and real words, indicating a lack of mispronunciation sensitivity. In this study, however, even Catalan-dominant bilinguals did not show the predicted N400 lexicality effect for non-words that contained the altered Catalan vowel. These results were interpreted to mean that, given the bilingual environment, Catalan-dominant bilinguals who are frequently exposed to both Catalan-accented and Spanish-accented pronunciations of Catalan words might have two different acoustic representations for such words in their lexicon.

Taking into account these offline and online measurements of word recognition by Catalan-Spanish bilinguals, it is not clear how Galician-dominant and Spanish-dominant bilinguals will differ in the time course of spoken word recognition in Galician. In this study, I will first explore the differences between these two groups and then whether *neofalantes*' word recognition in Galician is more similar to that of Galician- or Spanish-dominant bilinguals. Thus, the current study has three aims:

1) to test whether there are any differences in the time course of spoken word recognition in Galician between Galician- and Spanish-dominant listeners
2) to evaluate whether the differences in discrimination of the Galician-specific phonetic contrasts lead to a delay in spoken word recognition between these two groups
3) to explore whether *neofalantes* pattern with Spanish-dominants in spo-

ken word recognition, or whether they use different strategies for word recognition and show a different pattern that that of Spanish-dominants.

To examine lexical competition in bilingual spoken word recognition, the visual world paradigm was used (Tanenhaus & Spivey-Knowlton, 1996; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Eye-tracking is a non-invasive technique that enables collection of real-time continuous data and provides information about unconscious processes, as participants do not make explicit decisions about words. Language-mediated eye movements tend to be fast, unconscious and mostly overlearned, i.e., acquired through extensive practice (Mishra, Olivers, & Huettig, 2013). The visual world paradigm, in particular, has been shown to be a powerful tool in examining how lexical activation unfolds over time, as it provides sufficient temporal resolution to measure the time course of lexical access as speech unfolds (Tanenhaus, Magnuson, Dahan, and Chambers 2000, see Huettig, Rommers, and Meyer 2011 for a review).

Cooper (1974) first showed that eye movements are closely time-locked to the acoustic input and can, therefore, be recorded and used as a method to investigate language comprehension. In this seminal study, American listeners heard a story while they were presented with a visual display that included drawings of objects that were semantically related to words in the story, e.g., the spoken words *lion*, *zebra* or *Africa* were related, directly or indirectly, to pictures of a *lion*, a *zebra* or a *snake* on the visual display. Participants spontaneously fixated on the objects that were most closely related to the meaning of the words they heard. Tanenhaus et al. (1995) further demonstrated that listeners fixate on objects after they listen to their names as the speech signal unfolds. In this study, the authors tested American English listeners on a task where they had to follow spoken instructions to select or move an object. The visual display sometimes included objects that shared the initial segments (e.g., *candy* - *candle*) and sometimes the names were phonologically unrelated.

The results showed that the mean time to initiate an eye movement to the target object was higher when the object shared the first phonemes with the target object than when it was phonologically unrelated.

Since Tanenhaus' study, the visual world paradigm has been extensively used to investigate language comprehension. Typically participants are given instructions to look at, pick up or move an object that is presented, together with other objects, in a visual field. The pattern of fixations to the objects is then used to test a hypothesis about language processing (Tanenhaus et al., 2000; Tanenhaus & Spivey-Knowlton, 1996). This type of experiment relies on the idea that spoken word recognition involves simultaneous activation of word candidates (Marslen-Wilson & Welsh, 1978; Zwitserlood, 1989). According to the Cohort model, by Marslen-Wilson and colleagues (Marslen-Wilson & Tyler, 1980; Marslen-Wilson & Welsh, 1978), acoustic input at the onset of a word activates 'a cohort' of lexical candidates that are compatible with that particular input. Candidates that become incompatible with the input are eliminated from the cohort until only one candidate remains, which may happen before the word ends, and word recognition is achieved. It is therefore assumed that word recognition takes place in a sequential order. One important shortcoming of this model is that only a perfect match from the onset is allowed.

A revised version of this model (Marslen-Wilson, 1987) addressed this issue by proposing that minor variation at the onset of the word might reduce the activation of the candidate rather than eliminating it for the cohort, but the revised model still prioritised word-initial information. The connectionist model TRACE (Elman & McClelland, 1988; McClelland & Elman, 1986), also assumes that multiple candidates are activated at the same time, but the process of lexical activation is dynamic; words that overlap phonologically at parts of the word other than the onset can also be candidates and can compete for recognition. Shortlist (Norris, 1994; Norris, McQueen, Cutler, & Butterfield, 1997) is also a connectionist model. However, whereas in other connectionist

models, such as TRACE, top-down feedback interacts with phonemic processing in spoken word recognition, Shortlist is entirely bottom-up. Additionally, in Shortlist, competition between lexical candidates takes place within a small recurrent network which considers a restricted set of lexical items at a time, i.e., a 'short-list' of candidates.

The predictions made by these models were tested by Allopenna, Magnuson, and Tanenhaus (1998) in a spoken word recognition study using the visual world paradigm. In this experiment, participants followed spoken instructions to move one of the objects on the screen (e.g., *Pick up the beaker*). The distractor objects included an onset competitor (e.g., *beetle*), a rhyme competitor (e.g., *speaker*), and an unrelated word (e.g., *carriage*). Results showed evidence of activation of both onset and rhyme competitors, providing support for the continuous mapping models, such as TRACE (Elman & McClelland, 1988; McClelland & Elman, 1986) and Shortlist (Norris, 1994; Norris et al., 1997). Dahan, Swingley, Tanenhaus, and Magnuson (2000) replicated the 'cohort' effects (activation of the onset competitor) with French listeners, whilst McQueen and Viebahn (2007) and Huettig and McQueen (2007) obtained similar results to those found in Allopenna et al. (1998) and Dahan et al. (2000), using printed words instead of pictures in the display (for printed-word displays see also Best, Shaw, & Clancy, 2013; Brouwer, Mitterer, & Huettig, 2012; Mitterer, 2011; Ying et al., 2013). In McQueen and Viebahn (2007), Dutch listeners fixated on competitors more than distractors, but the effect was stronger for onset competitors than rhyme competitors. These results also support continuous mapping models of spoken word recognition, as the mismatch of acoustic information at the word onset does not block lexical activation, which suggests that listeners update their interpretation of words as the acoustic information unfolds over time. Moreover, this study established the validity of the printed-words variant of the visual world paradigm for investigation of phonological processing, enabling the inclusion of stimuli that are not easy to depict.

Another issue to take into consideration when designing visual world

paradigm experiments is that other factors might have an effect on spoken word recognition. One well-documented factor is that of word frequency (Cleland, Gaskell, Quinlan, & Tamminen, 2006; Dahan, Magnuson, & Tanenhaus, 2001; Magnuson, Dixon, Tanenhaus, & Aslin, 2007; Magnuson et al., 2007; Marslen-Wilson, 1987, 1995; Tanenhaus et al., 2000): if the target word is of higher frequency than a competitor the rise in looks to the target will be greater. Other language-related factors that have been shown to affect word recognition are the number of words in a similarity neighbourhood (Luce & Pisoni, 1998; Magnuson et al., 2007; Vitevitch & Luce, 1999) and onset density (Magnuson et al., 2007). Regarding external factors, noise has also been shown to affect word recognition. Studies have shown that when recognising words in noise, there is a processing cost and increased competition from the rhyme competitor (Brouwer & Bradlow, 2011, 2015). Additionally, Brouwer et al. (2012) demonstrated that when listeners are presented with reduced forms of a word, instead of the canonical pronunciations, there is competition from both rhyme candidates (more similar to the reduced form) and onset candidates (more similar to the canonical word), whereas when they are presented with the canonical form only, competition of the onset candidate is stronger. Results from these three studies suggest then that when the listening conditions are poor, listeners might be more tolerant to acoustic mismatches and more flexible in adjusting to the acoustic input (Brouwer & Bradlow, 2015; Brouwer et al., 2012).

A growing body of research has also investigated non-native and bilingual word recognition. Work in this area has shown that lexical access is not language-selective, i.e., bilinguals and L2 learners seem to access both languages simultaneously when recognising words both in visual (e.g., Dijkstra & van Heuven, 1998; van Heuven, Dijkstra, & Grainger, 1998) and auditory tasks (e.g., Blumenfeld & Marian, 2007; Chambers & Cooke, 2009; Ju & Luce, 2004; Lagrou, Hartsuiker, & Duyck, 2011; Marian & Spivey, 2003; Schulpen, Dijkstra, Schriefers, & Hasper, 2003; Spivey & Marian, 1999; Vandeberg, Guadalupe, & Zwaan, 2011; Weber & Cutler, 2004). For example,

Chambers and Cooke (2009) tested non-native speakers of French listening to French sentences where the final word was the target (e.g., *poule*, *chicken*). Visual displays included the target word, and also an English interlingual homophone (e.g., *pool*). Non-native listeners' eye-movements showed consideration of the interlingual stimulus, but competition was reduced when the previous sentence was incompatible with the competitor. Although proficiency in English did not play a role in interlingual competition in this study, this factor has been shown to have an effect on interlanguage activation in others (e.g., Blumenfeld & Marian, 2007, 2013).

Other factors which may constrain parallel language activation are age of acquisition (Canseco-Gonzalez et al., 2010), language background (Marian & Spivey, 2003), language mode (Canseco-Gonzalez et al., 2010; Marian & Spivey, 2003) and the acoustic characteristics of the input signal (Schulpen et al. 2003; Ju & Luce 2004; though see Lagrou et al. 2011, for contrasting results). However, there is mixed evidence as to whether parallel language activation occurs in both directions. Some studies suggest that there is activation of the non-native competitors when listening to the native language (Lagrou et al., 2011; Marian & Spivey, 2003; Spivey & Marian, 1999), but others have shown that inter-language candidates are only present when listening to the L2 (Ju & Luce, 2004; Weber & Cutler, 2004).

Research on L2 as opposed to bilingual word recognition has also been concerned specifically with phonological processing. Weber and Cutler (2004) showed that lexical competition in spoken word recognition is greater and recognition slower for non-native than for native listeners. In this series of experiments, Dutch listeners heard English words containing vowels that are likely to be confused by Dutch listeners (e.g., /ae/-/e/). Results showed that Dutch listeners fixated longer on distractors with names containing such vowels (e.g., target *panda*, distractor *pencil*), than on distractors with vowels that were not problematic for Dutch listeners (e.g., target *beetle*, distractor *bottle*). Furthermore, this disruption was asymmetric; participants fixated longer on

pencil when it was the distractor, but not on *panda* when pencil was the target. Cutler et al. (2006) replicated this 'dominant category' effect with non-native Japanese listeners of English in a similar study. The phonemes manipulated were /ɹ/ and /l/, a contrast that is well known to be confusable for Japanese listeners (cf. Yamada, 1995). In this case, participants showed a bias towards /l/. For example, when instructed to click on a *rocket*, participants fixated on the object that represented a *locker*, but this interference did not happen in the opposite direction. Cutler et al. (2006) propose that the dominant category is based on acoustic similarity to the closest native language category. The Japanese phoneme that is closest to the English /ɹ/–/l/ contrast is a voiced alveolar flap /ɾ/, which is phonetically closer to /l/ in terms of articulation (Cutler et al., 2006), and perception; Japanese listeners assimilate /l/ into their flap category more strongly than /ɹ/ (Hattori & Iverson, 2009). Based on these results, Weber and Cutler (2004) and Cutler et al. (2006) thus argue that phonetic discrimination difficulties in the L2 may lead to activation of incorrect competitors which consequently leads to a delay in word recognition.

The visual world paradigm has also been used to investigate how listeners process phonological variation within their own language. More specifically, Best et al. (2013) examined whether vowel and consonant contrasts that do not exist in the listeners' native accent disrupt spoken word recognition when listening to an unfamiliar accent. Participants were presented with four printed words (a target word, two competitors and an unrelated distractor) and were instructed to click on the word they heard. The results showed that Australian listeners were slower at recognising the target word and considered competitor words more and for longer when listening to unfamiliar accents (Jamaican English and Cockney). These effects were stronger when the target word contained a phoneme was predicted to be assimilated to a different contrastive native phoneme (Category Shifting type) than when it was predicted to be assimilated to the same native-accent phoneme, but as a deviant variant (Category Goodness type; cf. PAM/PAM-L2: Best 1995; Best and Tyler 2007).

Ying et al. (2013) replicated this study with L2 learners of English listening to the same familiar accent (Australian English) and two unfamiliar accents (Jamaican English and Cockney). Interestingly, previous research has shown that vowels and consonants play different roles in visual word recognition (Acha & Perea, 2010; Carreiras, Duñabeitia, & Molinaro, 2009; Carreiras & Price, 2008; Lee, 2000; Lee, Rayner, & Pollatsek, 2002; New & Nazzi, 2012; Soares, Perea, & Comesaña, 2014), word identification in continuous speech (Bonatti, Peña, Nespor, & Mehler, 2005), spoken word recognition using a word reconstruction task (Cutler, Sebastián-Gallés, Soler-Vilageliu, & Van Ooijen, 2000; Van Ooijen, 1996) and sentence recognition (Cole, Yan, Mak, Fanty, & Bailey, 1996). For example, Cutler et al. (2000) showed that, in a word reconstruction experiment where participants were instructed to create real words from nonwords by changing one segment, listeners were faster and more accurate when finding a real word by altering a vowel than by altering a consonant. Based on these results and previous studies (see also Van Ooijen, 1996), these authors argued that there are differences in the information provided by vowels and consonants, with vowel information constraining lexical selection less tightly (Cutler et al., 2000). However, the results from Best et al. (2013) appear to indicate that vowels and consonants affect lexical competition in spoken word recognition in a similar manner.

In short, the visual world paradigm enables investigation of the time course of lexical access in monolingual, bilingual and L2 populations. An extensive body of research on bilingual lexical access has been focussed on whether there is cross-language lexical activation in word recognition and the factors which may influence this process. Other work has also examined whether difficulties in speech perception affect lexical competition and spoken word recognition. The next Chapter (Chapter 5) will present an eye-tracking study that used the visual world paradigm to investigate the effects of language dominance and a long-term language dominance switch on the time course of lexical access in spoken word recognition. In particular, the study will examine

how Galician-specific phonological contrasts, such as mid vowels and sibilant fricatives, influence spoken word recognition by three bilingual groups who differ in terms of language background.

Chapter 5

Study 3: The effects of language dominance and a long-term language switch on spoken word recognition

5.1 Introduction

This study investigates word recognition in Galician by dominant bilinguals using a variant of the Visual World Paradigm (McQueen & Viebahn, 2007; Tanenhaus et al., 1995; Weber & Cutler, 2004). This paradigm enables examination of the time course of lexical competition during spoken word recognition. The main adaptations to the paradigm for this study follow Best et al. (2013): 1) words were presented in isolation rather than in a carrier phrase to avoid providing information about the speaker's language background; 2) the visual stimuli consisted of printed words, instead of pictures (Brouwer et al., 2012; Huettig & McQueen, 2007; McQueen & Viebahn, 2007; Mitterer, 2011) and 3) there was a 'not there' option in the centre of the computer screen to increase task sensitivity (Brouwer, 2010; Mitterer, 2011). In this study, the choice words were the target word, a phonetically and orthographically unrelated distractor (Best et al., 2013), and two competitors. The target word and

Competitor 1 formed a Galician phonological contrast that does not exist in Spanish. Competitor 2 was phonetically related to the target, but less so than Competitor 1.

Reaction Time measurements were analysed to explore whether Spanish-dominant and *neofalantes* listeners would show a substantial delay in processing. That said, there are several reasons why the task should be easy for all three bilingual groups and reaction time differences between the groups are not necessarily expected: first, participants were put under no time pressure to complete the task (cf. Best et al., 2013; Ying et al., 2013); second, the audio stimuli presented consisted of clear speech with no noise added and third, all three bilingual groups are highly proficient in Galician.

Eye movement data was analysed to investigate whether there would be 1) overall differences in word recognition between the groups and in particular, 2) differences when presented with words containing the Galician variables that do not exist in Spanish. To my knowledge, there are no studies investigating the time course of spoken word recognition by dominant bilinguals who live in a bilingual environment, therefore, it is not clear whether Galician-dominant speakers will have an advantage over Spanish-dominant listeners overall, given that bilinguals in the latter group also have very high proficiency in Galician, as mentioned above. For the words that contain the variables of interest, however, a different pattern of results for the two groups is expected, as it has been shown that distractor pictures with names containing contrasts that do not exist in the listener's native language increase lexical competition (Cutler et al., 2006; Weber & Cutler, 2004). Study 1 demonstrated that Spanish-dominant listeners have difficulties when identifying mid vowels and have a different category boundary from that of Galician-dominants for the sibilant fricative contrast. If difficulties when perceiving these contrasts hinder word recognition, looks to the target word should start later and be less frequent for the Spanish-dominant group. Finally, a third question is whether *neofalantes*, who showed a similar pattern to Spanish-dominant bilinguals in the identification tasks, will show a

similar pattern to that of Galician- or Spanish-dominants in terms of lexical access.

The first part of the analysis will focus on the differences between Galician-dominant and Spanish-dominant listeners. Due to the difficulties associated with recruiting the *neofalantes*' population (see Section 2.2.1.1 in Study 1), only 6 participants from this group completed the task. Therefore, the second part of the analysis will present the *neofalantes*' results using descriptive statistics and graphs and discuss how these relate to the first analyses.

5.2 Method

5.2.1 Participants

A total of 66 participants were tested. Three participants were excluded due to equipment failure. The remaining participants were classified into Galician-dominant, Spanish-dominant and *neofalantes*, following the criteria established in Study 1 (see Section 2.2.1.1 Participants). Thirteen participants who did not fit the definition of these groups, as they had different profiles in terms of language background (including 5 simultaneous bilinguals), were also excluded, leaving a total of 49 participants: 22 Galician-dominant bilinguals (13 female, 9 male), 21 Spanish-dominant bilinguals (13 female, 9 male) and 6 *neofalantes* (1 female, 5 male). Participants were 19–48 years old (median 25 years) at the time of the experiment. All participants reported normal or corrected-to-normal vision and normal hearing at the time of testing. The experiment had been piloted on two participants to ensure that there were no problems with the task. All testing was carried out in the Perception Laboratory in the Faculty of Psychology at the University of Santiago de Compostela.

5.2.2 Stimuli

The materials of this experiment were designed following Best et al. (2013, 2012) and Ying et al. (2013).

Visual displays of the stimuli consisted of four printed words per trial:

a target word, Competitor 1, Competitor 2 and an unrelated distractor. All four words were displayed in four regions of the screen and there was a fifth choice in the centre (not there), following previous designs by Mitterer and McQueen (2009), Best et al. (2013) and Ying et al. (2013). All words were CVCV, CCVCV or CVCCV sequences. Half of them were test sets and the other half filler sets.

The test sets contained the variables of interest: the front /ɛ/-/e/ and back /ɔ/-/o/ mid-vowel contrasts in stressed position, and the voiceless sibilant fricative contrast /ʃ/-/s/. These contrasts, which exist in Galician, but not in Spanish, were shown to be produced and perceived in a different way by *neofalantes* and Spanish-dominant bilinguals when compared to Galician-dominant bilinguals in Study 1 (see Experiment 2). In perception, Galician-dominant listeners performed at ceiling when identifying the vowel contrasts, whereas *neofalantes* and Spanish-dominant listeners were not always able to distinguish them (Figure 2.6), and the two latter groups showed a different identification boundary to Galician-dominants for the fricative contrast (Figure 2.8).

A total of 60 test sets were used. Each target word in these sets contained either a mid vowel or a fricative and was matched with its corresponding contrast counterpart (Competitor 1) and a second competitor that was less similar phonetically (Competitor 2). The unrelated word never contained similar phonemes or letters in the same position. The words in each trial were not semantically related (for the complete list of test sets see Appendix G).

For the vowel condition, the onset of competitor words overlapped phonemically with the onset of the target word and the first vowel in the C(C)VC(C)V sequence was the target vowel. For 10 sets, the target word contained the front open vowel /ɛ/, Competitor 1 contained the front close vowel /e/ and Competitor 2 /a/ (e.g., target: *peza* [ˈpɛθa̪], Competitor 1: *peso* [ˈpeso̪], Competitor 2: *pato* [ˈpato̪], unrelated: *torre* [ˈtore̪]; see top left box in Figure 5.1). Another 10 sets included the front close mid vowel /e/ in the target and the

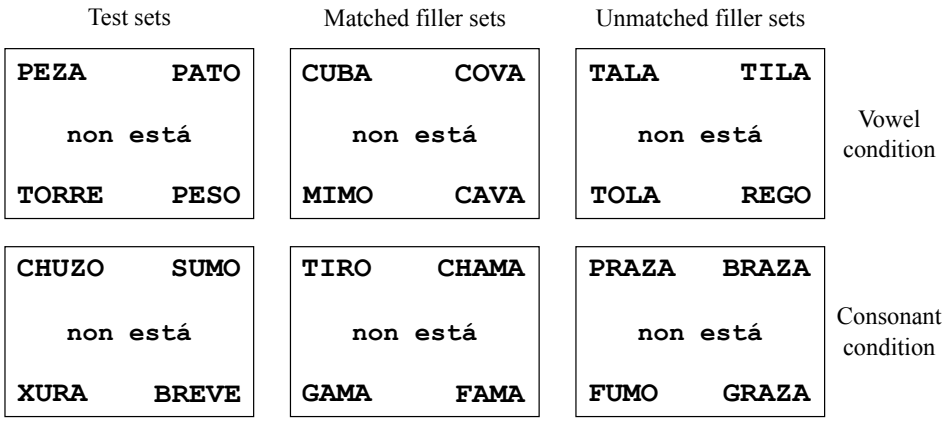

Figure 5.1: Examples of test sets (left boxes), matched filler sets (central boxes) and unmatched filler sets (right boxes). The top boxes show sets from the vowel condition and the bottom boxes show sets from the consonant condition.

corresponding open one /ɛ/ as Competitor 1. The design was the same for back mid vowels, but in this case Competitor 2 contained the vowel /u/ (e.g., target: *bote* [ˈbɔt̪e̞], Competitor 1: *boca* [ˈbok̪a̞], Competitor 2: *burra* [ˈbur̪a̞], unrelated: *galo* [ˈgalo̞]).

For the consonant condition, the target variable was the fricative contrast /ʃ/-/s/, the target consonant was the first consonant in the CVC(C)V sequence. The first vowel was the same for the target and the competitors. For 10 sets, the target word contained the alveolar fricative /s/, Competitor 1 contained the post-alveolar fricative /ʃ/ and Competitor 2 contained the voiceless post-alveolar affricate /tʃ/ (e.g., target: *sumo* [ˈsumo̞], Competitor 1: *xura* [ˈʃur̪a̞], Competitor 2: *chuzo* [ˈtʃuθo̞]; unrelated *breve* [ˈbrɛβ̞e̞]; see bottom left box in Figure 5.1). Another 10 sets included the post-alveolar fricative /ʃ/ in the target, the alveolar fricative /s/ in Competitor 1 and again, the post-alveolar affricate /tʃ/ as Competitor 2.

A total of 60 filler sets were created to match the number of test sets. All fillers were minimal triads; they differed only in one sound, either the first consonant (consonant condition) or the first vowel (vowel condition). The filler sets were designed in this manner to train participants to pay attention to the first segments in the word and discourage them from waiting and attend-

ing only to the final segment in order to identify words, following Best et al. (2012). There were two types of filler sets: matched and unmatched. Matched fillers had as targets the variables that were used as Competitor 2 in the test sets: 10 target fillers contained the post-alveolar fricative /tʃ/, 10 target fillers the front low vowel /a/ and other 10 the back high vowel /u/. Given that such Competitor 2 variables never occur as target in the test sets, including them as targets in the filler sets will make participants choose the Competitor 2 variables /tʃ a u/ as many times as the test variables /ɛ e ɔ o s ʃ/, preventing them from establishing patterns. Two examples of matched fillers are displayed in the central boxes in Figure 5.1 (e.g., vowel condition, target: *cava* [ˈkaβ̞ą], Competitor 1: *cova* [ˈkɔβ̞ą], Competitor 2: *cuba* [ˈkuβ̞ą]), unrelated word: *mimo* [ˈmim'o]; consonant block, target: *chama* [ˈtʃamą], Competitor 1: *gama* [ˈgamą], Competitor 2: *fama* [ˈfamą], unrelated word: *tiro* [ˈtiɾo̞].

The remaining 30 filler sets were unmatched and, therefore, did not contain any of the target variables in the test or matched filler sets in the target words. Two examples of unmatched filler sets are displayed in the right-most top and bottom boxes in Figure 5.1 (e.g., vowel condition, target: *tila* [ˈtilą]; consonant condition, target: *graza* [ˈgɾaθą]). In contrast to test sets, for fillers, Competitor 1 and Competitor 2 were equally confusable with the target, so there should be no differences in processing between the two. Finally, there were 8 practice sets that included four words that were unrelated to one another (e.g., target: *pita* [ˈpitą], competitors: *medio* [ˈmeðjo̞], *fraga* [ˈfraɣ̞ą] and *croio* [ˈkɾɔjo̞]). No word was repeated. This gave a total of 128 sets: 8 trials in the practice condition, 60 trials in the vowel condition and 40 trials in the consonant condition. The practice condition was always at the beginning and the order of presentation of the vowel and consonant conditions was counterbalanced across participants.

Previous research has shown that word frequency plays a role spoken word recognition, such that high frequency competitors (e.g. *bell*) are more likely to attract fixations than low frequency ones (e.g. *bell*) at early stages of

lexical access (Dahan et al., 2001). The restrictions related to the design of test and filler sets limited the range of words that could be selected for the experiment. There would not be enough high frequency words to complete the stimuli set and, as a consequence, low frequency words had to be included. However, to control for such frequency effects, as well as including as many high frequency words as possible, low frequency words were distributed across target and competitors. The Galician frequencies of the target and competitor words were calculated using the *Corpus de Referencia do Galego Actual* (CORGA, 2017). A two-factor ANOVA with word type (target and competitor) and trial type (test and filler) as between-items factors (cf. Weber & Cutler, 2004) showed no significant main effects or interactions. Lexical frequency of the unrelated distractor was not controlled, as it has been shown that if the candidate does not match the acoustic information of the target word the probability of fixating on such distractors is not influenced by lexical frequency (Dahan et al., 2001; Weber & Cutler, 2004). As Galician is closely related to Spanish, most of the stimuli used are cognates.

The audio stimuli consisted of naturally-produced words recorded by two female Galician-dominant speakers. Recordings were made in a sound attenuated room using a RODE NT1-A microphone directly connected to a PC via an Edirol processor with a sampling rate of 44.1 kHz, 16-bit resolution. The speakers recorded several repetitions and the best one was selected for use in the experiment. Stimuli were band-pass filtered at 60-20,000 Hz with a smoothing factor of 10. Finally, intensity was scaled to 65 dB SPL. The average duration of target words was 462.94 ms and 100 ms were added as a margin at each side of the word. All processing was carried out in Praat (Boersma & Weenink, 2016). Stimuli were played over headphones (Sennheiser HD 25-C II). Each participant heard all words only once produced by either one of the speakers, and the speaker that produced each word was counterbalanced.

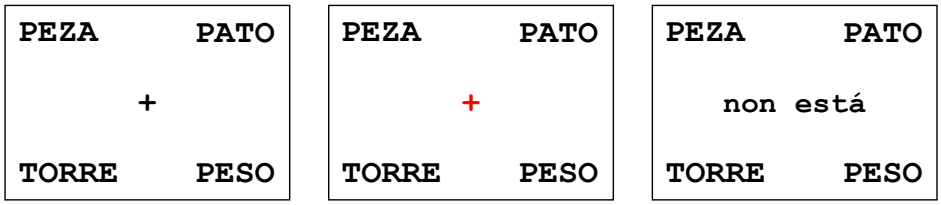

Figure 5.2: Representation of the trial procedure in Study 3. The first box shows a fixation cross in the centre of the screen. Participants clicked on the fixation cross and fixated their gaze on it. Once their gaze was detected for 200 ms the cross turn red to indicate the start of the auditory stimuli (second box) and changed into the phrase emphnon está (not there), as it can be seen on the third box.

5.2.3 Procedure

Participants completed the experiment in a quiet room 70 cm in front of a computer monitor. The screen resolution was 2048 x 1535. Their eye-movements were recorded at a sampling rate of 250 Hz with an EyeLink II eye-tracker. Participants placed their chin on a chin rest and wore a helmet, which held two cameras that provided the input to the eye-tracker. The machine recorded the spatial coordinates of the participants' fixations throughout the session. Both eyes were monitored, but data from only one eye was analysed. Mainly data from the left eye was analysed, but data from the right eye was included for trials when the left eye could not be calibrated or track was lost. Mouse clicks were recorded along the gaze data. The eye-tracker was calibrated at the participant's gaze before the start of each of the two blocks. There was a short break in-between blocks. Calibration was monitored throughout the session by the experimenter and adjusted between trials when necessary.

The trial procedure was designed to ensure that participants were fixating in the middle of the screen at the start of the trial, i.e., when the audio stimulus played (Best et al., 2013; Tanenhaus & Spivey-Knowlton, 1996). The four words were displayed in black uppercase Courier letters on a white background (luminance= 56,52 cd/m2). Each letter had a height of 2 cm, giving a visual angle (the size of the object's image on the retina) of 1.637°. All four words were equidistant from the central fixation target (Tanenhaus & Spivey-

Knowlton, 1996).

The trial procedure is represented in Figure 5.2 and followed that of Best et al. (2013), Shaw et al. (2013) and Ying et al. (2013). During the whole session the experimenter spoke Galician to the participants. Participants received verbal and printed Galician instructions explaining that they would be shown a preview of the four words with a fixation cross in the centre of the screen. They were instructed to read all four words silently and then click on the fixation cross. After the eye-tracker detected the participant's fixation (200 ms), the cross turned red to indicate that the trial was about to start. The fixation cross was replaced with the words '*non está*' ('not there') and the audio stimuli presentation was triggered. This way, the participant's gaze was always in the middle at the start of the auditory stimulus. If the eye-tracker failed to detect the participant's gaze, the trial was timed out and the eye-tracker was calibrated again. Participants were instructed to click on the word they heard and they were put under no time pressure to complete the task (Best et al., 2013; Ying et al., 2013).

The order of trial presentation was randomised throughout. All target, competitor and unrelated words were presented approximately 25% of the time in each quadrant to avoid bias. After the eye-tracking task, participants completed the language background questionnaire used in Study 1 and Study 2 (Appendix A) online and recorded a word list that consisted of the target and competitor words. The production data is not presented in this thesis. The total duration of the session ranged between 45-90 minutes and was typically an hour, including the set up, calibration and breaks.

All processing was done using `R` (R Core Team, 2013), and the `plyr` (Wickham, 2011), `dplyr` (Wickham & Francois, 2016) and `reshape2` (Wickham, 2007) packages. Overall, there were 115 timed out trials (out of 7936 trials), which were excluded from further analysis. Incorrect response trials were also excluded from further analysis. Overall, there were 57 incorrect responses trials, 0.7% of the total number of trials. This low percentage suggests

that participants had no problem completing the task. Additionally, out of the 57 incorrect responses, 50 trials were mistakes due to participants clicking on the centre of the screen after their fixation to the cross had been detected, rather actual incorrect responses.

5.3 Results

5.3.1 Galician-dominant vs. Spanish-dominant bilinguals

The first analysis will investigate whether there are differences in processing of Galician words by Galician-dominant and Spanish-dominant listeners. After excluding practice trials and participants who did not belong to the Galician-dominant or Spanish-dominant groups (see 5.2.1 Participants), there were 5053 trials left in total.

5.3.1.1 Reaction Times

First, to explore whether there were differences in how fast the two groups performed the task, reaction times were used as a dependent variable in a linear mixed-effect regression model. Although participants were put under no time pressure to complete the task, this measure was analysed to test whether there were overall large differences in processing between the two groups. Given that reaction time measurements were not normally distributed, a rank-transformation to normality was applied. Incorrect trials and observations above or below two standard deviations of the overall mean were removed.

Two linear mixed-effects regression models were fit to the transformed reaction time data, one for the consonant condition and one for the vowel condition. The variables `group` (Galician-dominant, Spanish-dominant speakers), `trial` (fillers, test sets) and their interactions were included as fixed factors. `trial` by `participant` and `group` by `item` were included as random effects. Deviation coding was used for `group` and `trial` in this model and all models in this chapter. The values of $-.5$ and .5 were chosen so that the parameter estimates would be equivalent to the mean difference between the two levels

(Barr, 2008). Other effects are averaged over all levels of each factor.

	β	SE	t-value (df)	p-value
Consonants				
Main effects				
Intercept	0.041	.106	0.386(42)	*n.s.*
Group	−0.135	.209	−0.648(40)	*n.s.*
Trial	0.150	.056	2.658(34)	.012
Interactions				
Group : trial	0.108	.086	1.246(40)	*n.s.*
Vowels				
Main effects				
Intercept	0.038	.099	0.389(43)	*n.s.*
Group	0.128	.195	0.653(41)	*n.s.*
Trial	0.129	.041	3.125(77)	.002
Interactions				
Group : trial	0.025	.064	0.389 (77)	*n.s.*

Table 5.1: Summary of the results of the reaction time regression models. Baselines for predictor variables: Galician-dominant for `group` and filler for `trial`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values.

Table 5.1 summarises the output of the regression models. The effect of `group` was not significant for either of the conditions. There was a significant main effect of `trial` for both conditions, which indicated that, overall, participants were slightly faster when presented with filler sets than test sets. The interaction between `group` and `trial` was not significant.

5.3.1.2 Eye-tracking

Consonants

Target analysis

The data processing for the figures and statistics was done using the package `eyetrackingR` (Dink & Ferguson, 2016) and the figures using `ggplot2` (Wickham, 2009), both in `R` (R Core Team, 2013). The dependent variable

for the analysis was the empirical logit transformation (elog), which enables conversion of proportion of looks to a continuous scale without upper/lower bounds. This transformation is defined as $\log \frac{y+\varepsilon}{N-y+\varepsilon}$, where y is the number of samples in the target region, N the total number of samples within each bin and $\varepsilon = 0.5$, a small value added to the logit function to correct for data that is exactly 0 or 1 the value is undefined (Barr, 2008; Dink & Ferguson, 2016). For this calculation, instead of throwing them out of the data set, fixations to the target region were coded as '1' and all other frames were coded as '0', including blinks, following Barr (2008). Figure 5.3 displays the transformed proportion of looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) as a function of time (in milliseconds). The time window spans from the stimulus onset to 1500 ms after the start of the trial in 100 ms bins. No trials had a track loss proportion that was greater than 25%, and thus no trials had to be excluded (cf. Dink & Ferguson, 2016).

To investigate fixations to target words, a time window analysis was performed using a weighted empirical logit regression, following Barr (2007, 2008) and Shaw et al. (2013). This analysis models the non-independence of observations introduced by repeated measures through random effects and enables inclusion of time as a fixed factor in the model. The start and ending points of the window selected for analysis vary in the eye-tracking literature, e.g., 0 ms to 700 ms (Allopenna et al., 1998), 200 ms to 500 ms (Dahan et al., 2001), 300 ms to 700 ms (Dahan et al., 2000), 200 ms to 800 ms (Brouwer & Bradlow, 2015), 300 ms to 800 ms (Shaw et al., 2013; Weber & Cutler, 2004), 500 ms to 1500 ms (Best et al., 2013), 600 ms to 1600 ms (Ying et al., 2013). After visually inspecting the data, the window selected for this analysis was 400 ms to 1300 ms. The selection was based on the grand mean plot (see Figure 5.4), a conservative approach to determining time-locking in that it is blind to condition (Barr, 2008, p. 466). The start point at 400 ms was determined by visual inspection of the grand mean plot and assessing the earliest rise in

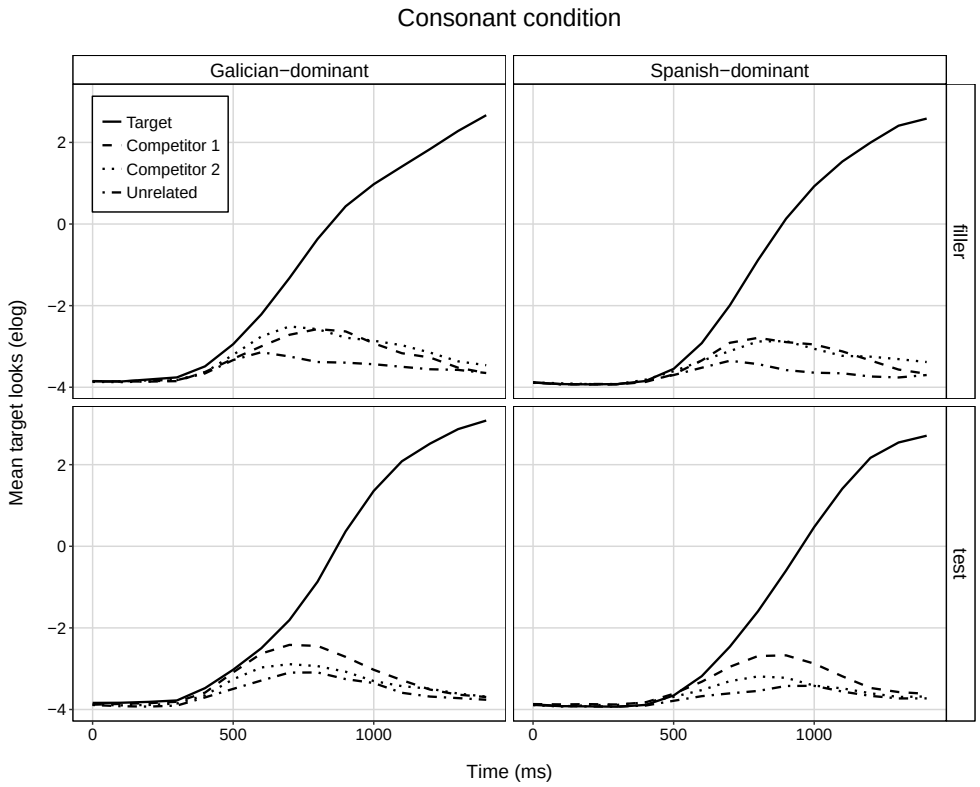

Figure 5.3: E-logit transformed mean proportion of looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) as a function of time (in milliseconds) for the consonant condition. The responses are split by type of trial (filler sets, top boxes; test sets, bottom boxes) and group (Galician-dominant, left; Spanish-dominant, right). Spanish-dominant listeners looked at the target word later and both groups looked at the target word later when presented with test sets.

fixations to the target (Barr, 2008). This coincides with the start of a drop in fixations in the centre region. Note that it is usual that the analysis window starts later, as eye movements take approximately 200 ms to be programmed before they are launched (Matin, Shao, & Boff, 1993; Saslow, 1967). As such, mapping from the acoustic signal onto lexical representations will be reflected by fixations from about 300 ms on (Weber & Cutler, 2004). In this case the audio stimuli had a 100 ms margin before the word started, so fixations driven by the acoustic information will probably be observable from 400 ms onwards. The duration of the audio stimuli in the consonant condition ranged from 387 ms to 667 ms (mean 492 ms). The end of the analysis window was determined

by the time at which the looks to the target reach a plateau (Best et al., 2013; Shaw et al., 2013; Ying et al., 2013, see Figure 5.4).

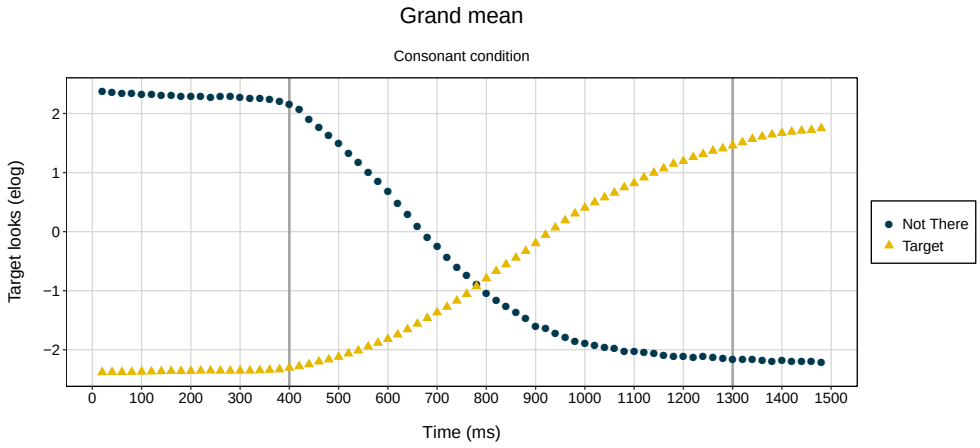

Figure 5.4: Mean fixations to the target word (triangles) and centre of the screen where the fixation cross changes to 'not there' (dots) averaged across trial type and group as a function of time (in milliseconds) for the consonant condition. Vertical lines at 400 ms and 1300 ms represent the start and end times of the analysis window, respectively.

To incorporate time as a variable in the analysis, the model has to take into account the non-independence of eye data. The eye cannot move instantaneously and freely from one region of the screen to the opposite one; rather, the eye position is dependent on the previous frame. One way to filter out these dependencies is by averaging over trials within a given condition and grouping observations within time bins. The empirical logit can be then computed for each bin (Barr, 2008). Therefore, two analyses were carried out. For the participant analysis, the data was aggregated into 20 ms bins (5 samples per interval) and was averaged over trials in each trial type (test and fillers) within each participant (43 participants). The bins were smaller than those in Barr (2007) and Shaw et al. (2013) because the sampling rate in this experiment was higher (250 Hz instead of 60 Hz). For the item analysis, the data was also aggregated into 20 ms bins and was averaged over participants in each group (Galician-dominant and Spanish-dominant) within each target (40 targets).

For the participant analysis, a mixed-effect regression model was fit to

the elogit-transformed target looks. The model included group (Galician-dominant, Spanish-dominant bilinguals), trial (fillers, test sets), time (20 ms time bins) and their interactions as fixed factors. Time by participant was included as a random effect in the model. Deviation coding was used for group and trial. The variable time was coded in seconds, from the onset of the analysis window. Given that a linear approximation was used, weights were calculated: $\frac{1}{y+\varepsilon} + \frac{1}{N-y+\varepsilon}$ (Barr, 2007, 2008).

	β	SE	t-value (df)	p-value
Main effects				
Intercept	-2.273	.075	$-30.223(41)$	$< .001$
Time	4.099	.120	33.953(41)	$< .001$
Group	-0.526	.150	$-3.502(41)$	.001
Trial	-0.289	.026	$-10.927(3781)$	$< .001$
Interactions				
Time : group	0.547	.241	2.268(41)	.029
Time : trial	0.434	.049	8.920(3781)	$< .001$
Group : trial	0.026	.053	0.493(3781)	*n.s.*
Time : group : trial	-0.494	.097	$-5.072(3781)$	$< .001$

Table 5.2: Summary of the results of the target fixations regression model for the consonant condition. Baselines for predictor variables: Galician-dominant for group and filler for trial. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values.

The regression model (Table 5.2) demonstrated that there was a significant main effect of time, group and trial. The main effect of time indicates that as time went by, participants looked more at the target word. The main effects of group and trial could be considered "whole window effects" (Shaw et al., 2013, p. 3145). Overall, Galician-dominant listeners looked at the target more than Spanish listeners, and participants looked at the target more when presented with fillers than when presented with test sets. These main effects also interacted with time, which indicates that the effects are concentrated in particular regions of the analysis window (Shaw et al., 2013), as illustrated in Figure 5.5. The first graph in Figure 5.5 shows that the delay Spanish-dominant

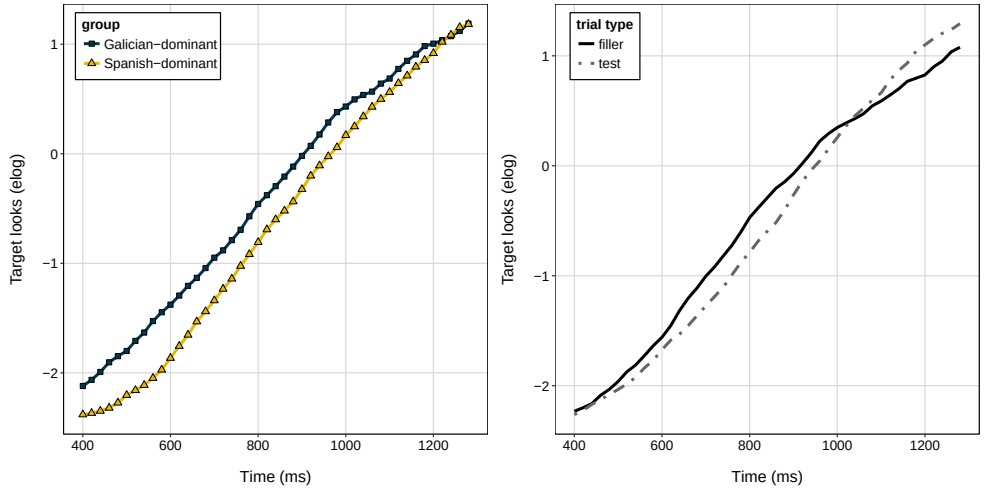

Figure 5.5: Plots showing the interaction between `time`: `group` and `time`: `trial` on target looks as a function of time (in milliseconds) for the consonant condition. The left plot shows the mean elogit-transformed looks at the target word by group (Galician-dominant, blue squares; Spanish-dominant, yellow triangles) and the right plot shows the mean elogit-transformed looks at the target word by trial (filler sets, solid line; test sets, dashed line). The first graph shows that Spanish-dominant listeners' delay in looking at the target decreases with time. The second graph shows that listeners looked more at the target when presented with fillers, but this pattern only held for 1000 ms.

listeners exhibit when looking at the target decreases with time. The second graph shows that the effect that listeners looked more at the target when presented with fillers is modulated by time, as the pattern no longer holds after 1000 ms. Moreover, there was a significant three-way interaction between `time`, `group` and `trial`, suggesting that the difference between filler and test sets that changes over time changes more significantly for Galician-dominant listeners. As illustrated in Figure 5.6, the difference in target looks for test and filler sets was only apparent until around 850 ms for Galician-dominant listeners, but remained for around 250 ms longer for Spanish-dominants. However, this interaction appears to be driven by differences between groups for filler set changes over time, rather than differences for test sets.

The participant analysis was replicated by item, and this showed the same pattern of results. Overall, Galician-dominant listeners looked at the target more than Spanish-dominant listeners and both groups looked at the target

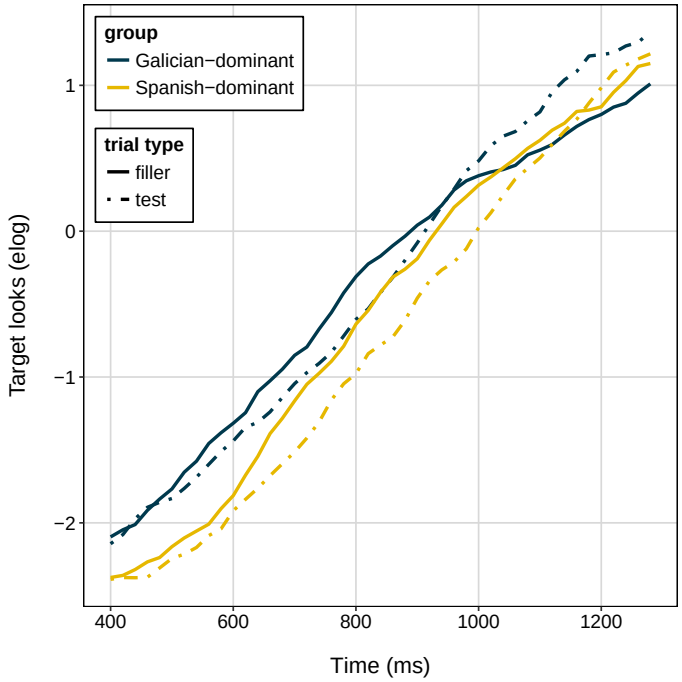

Figure 5.6: Plot showing the three-way interaction between `time`, `group` and `trial` on target looks as a function of time (in milliseconds) for the consonant condition. The plot shows the mean elogit-transformed looks at the target word by group (Galician-dominant, blue; Spanish-dominant, yellow) by trial (filler sets, solid line; test sets, dashed line). This interaction appears to be driven by differences between groups for filler set changes over time, rather than differences for test sets.

more when presented with filler sets. Contrary to what was expected, words containing the sibilant contrast did not hinder word recognition further for Spanish-dominant listeners.

Competitor analysis

A separate analysis was conducted to investigate whether there was a difference in proportion of looks to Competitor 1 (either /s/ or /ʃ/, which were more similar to the target phonetically) and Competitor 2 (/tʃ/, less similar phonetically). Figure 5.7 displays the transformed proportion of looks to Competitor 1 and Competitor 2 averaged over participants and trials and split by group (vertical boxes) and trial type (horizontal boxes). The figure suggests that Galician-dominants considered both competitors more and earlier and that the effect of trial type affected both groups in a similar fashion: whereas for

filler sets both competitors seem equally confusable, for test sets, Competitor 1 (/s/ or /ʃ/) was considered more and for longer by both listener groups. The difference in looks to both competitors when presented with test sets seems to be larger for Spanish-dominant listeners.

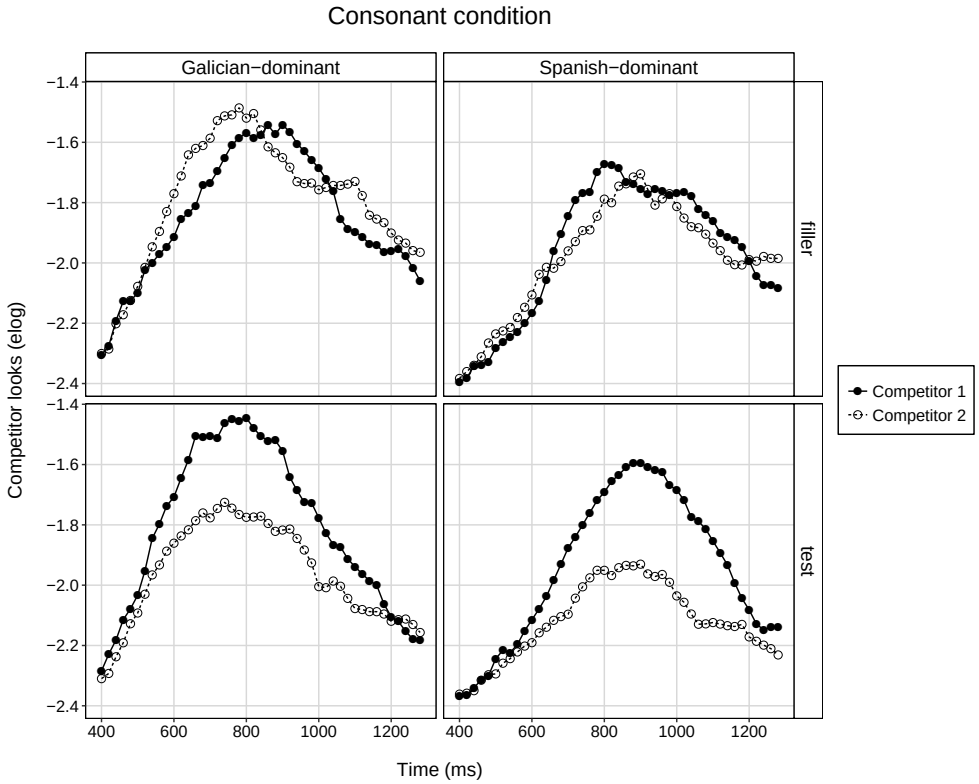

Figure 5.7: E-logit transformed mean proportion of competitor looks averaged over participants and trials for Competitor 1 (solid line) and Competitor 2 (dashed line) as a function of time (in milliseconds) for the consonant condition. The responses are split by type of trial (filler sets, top boxes; test sets, bottom boxes) and group (Galician-dominant on the left; Spanish-dominant on the right). Galician-dominants considered both competitors more and earlier and the effect of trial type appears to affect both groups in a similar fashion: whereas for filler sets both competitors seem equally confusable, for test sets, Competitor 1 (/s/ or /ʃ/) was considered more and for longer by both listener groups.

The same statistical analysis that was used for the target looks was employed to investigate the proportion of looks to the competitors. A smaller time window was selected and a linear weighted mixed effects regression was fitted to the elogit-transformed data. The window was determined by assessing the grand mean of fixations to both competitors across conditions and groups (see

Figure 5.8). Based on the grand mean, the start of the analysis window was selected to be 400 ms, as this is when fixations to both competitors start to rise. The end time was chosen to be at 800 ms, when fixations start to decrease. One trial had a track loss proportion that was greater than 25% and therefore, was excluded from further analysis (Dink & Ferguson, 2016). Restricting the time window to the start of decrease in fixations means that a considerable amount of information is lost. However, averaging over a larger window would not enable incorporation of time as a factor in the analysis, and information about the time course would be lost. Therefore, a smaller but linear portion of the data was selected to enable investigation of the effect of time on looks to the competitor.

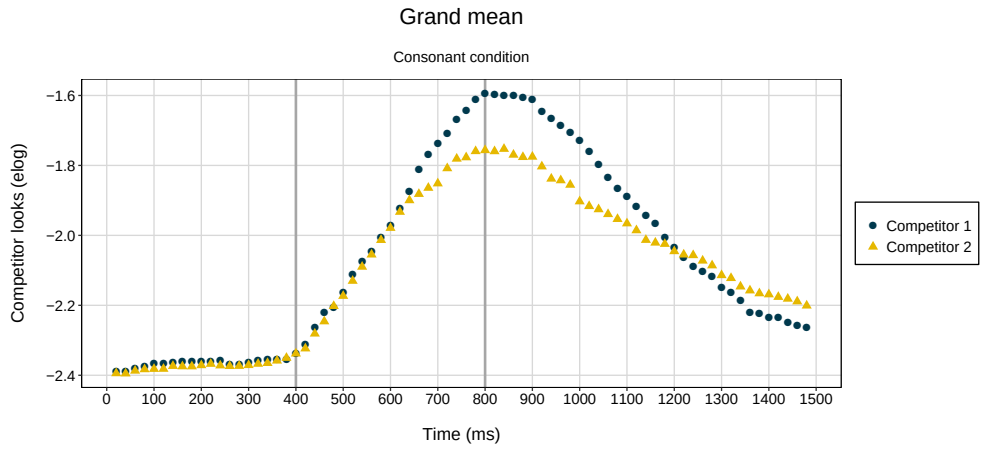

Figure 5.8: Mean fixations to Competitor 1 (triangles) and Competitor 2 (dots) averaged across trial type and group as a function of time (in milliseconds) for the consonant condition. Vertical lines at 400 ms and 800 ms represent the start and end times of the analysis window, respectively.

To investigate looks to the competitors, two separate mixed-effect regression models were fit. The first one had as a dependent variable the elogit-transformed looks to Competitor 1 and the second model had as a dependent variable the the elogit-transformed looks to Competitor 2 . Each model included `group` (Galician-dominant, Spanish-dominant bilinguals), `trial` (fillers, test sets), `time` (20 ms time bins) and their interactions as fixed factors. `Time` by `participant` was included as a random effect in the model. Devi-

ation coding was used for `group` and `trial`. The variable `time` was coded in seconds, from the onset of the analysis window. Given that a linear was used approximation, weights were again calculated: $\frac{1}{y+\varepsilon} + \frac{1}{N-y+\varepsilon}$ (Barr, 2007, 2008).

	β	SE	t-value (df)	p-value
Competitor 1				
Main effects				
Intercept	2.272	0.068	$-33.573(42)$	$< .001$
Time	2.650	0.236	$11.226(41)$	$< .001$
Group	-0.365	0.135	$-2.702(42)$	.010
Trial	0.090	0.031	$2.877(1632)$	.004
Interactions				
Time : group	0.106	0.472	$0.226(41)$	*n.s.*
Time : trial	-0.0005	0.130	$-0.004(1632)$	*n.s.*
Group : trial	-0.008	0.0626	$-0.133(1632)$	*n.s.*
Time : group : trial	-0.664	0.26	$-2.565(1632)$	.010
Competitor 2				
Main effects				
Intercept	-2.231	0.058	$-38.317(42)$	$< .001$
Time	2.197	0.194	$11.323(41)$	$< .001$
Group	-0.263	0.116	$-2.260(42)$	.029
Trial	0.007	0.028	0.259	*n.s.*
Interactions				
Time : group	-0.432	0.388	-1.114	*n.s.*
Time : trial	-0.610	0.117	$-5.206(1632)$	$< .001$
Group : trial	-0.0367	0.005	-0.657	*n.s.*
Time : group : trial	0.255	0.234	1.088	*n.s.*

Table 5.3: Summary of the results of the competitor looks regression models for Competitor 1 and Competitor 2 for the consonant condition. Baselines for predictor variables: Galician-dominant for `group` and filler for `trial`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values.

Table 5.3 shows the results of both regression models. For Competitor 1, the model showed that there were significant main effects of `time`, `group` and `trial`. The main effect of `time` indicates that as time went by, partici-

pants looked more at Competitor 1 in this time window. The main effects of `group` suggests that Galician-dominant listeners looked at Competitor 1 more than Spanish-dominant listeners in this time window and the main effect of `trial` indicates that both listener groups looked more at Competitor 1 when presented with test sets. However, the significant interaction between `time`, `group` and `trial`, suggests that the previous effect is driven by the Galician-dominant group, who seem to look more at Competitor 1 when presented with test sets. Figure 5.9 illustrates this interaction, and suggests that the effect takes place from 500 ms onwards.

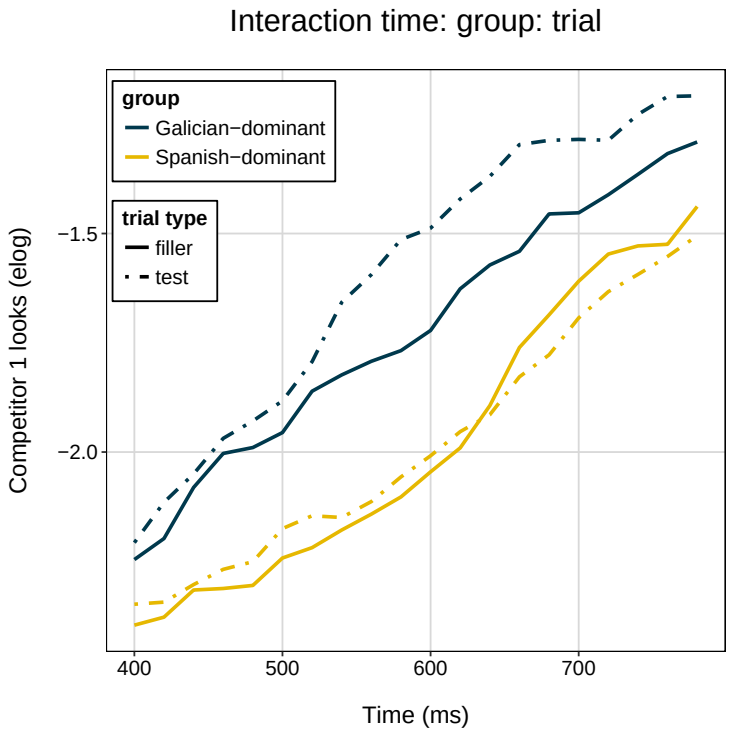

Figure 5.9: Plot showing the interaction between `time`, `group` and `trial type` on looks to Competitor 1 as a function of time (in milliseconds) for the consonant condition. The plot shows the mean elogit-transformed looks at Competitor 1 by group (Galician-dominant, blue; Spanish-dominant, yellow) by trial type (filler sets, solid line; test sets; dashed line). Galician-dominant listeners looked more at Competitor 1 when presented with test sets from 500 ms onwards.

For Competitor 2, the model showed that there were significant main effects of `time`, `group`, but not `trial`, indicating that as time went by, participants looked more at Competitor 2 in this time window and that Galician-

dominant listeners looked at Competitor 2 more than Spanish-dominant listeners. However, the significant interaction between `time` and `trial`, suggests that there was also an effect of trial, as towards the end of the analysis window, participants in both groups looked more at Competitor 2 when presented with filler sets.

These analyses showed that Galician-dominant listeners looked more at both competitors overall, and also looked more at Competitor 1 when presented with test sets, but trial type did not affect looks to Competitor 2 for either group.

Vowels

Target analysis

The same analyses were run for the vowel condition. Figure 5.10 displays the elogit-transformed looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) as a function of time (in milliseconds). The time window spans from the stimulus onset to 1500 ms after the start of the trial in 100 ms bins. Nine trials had a track loss proportion that was greater than 25% and therefore, were excluded from further analysis (Dink & Ferguson, 2016).

To investigate fixations to target words, a time window analysis was performed using a weighted empirical logit regression, following Barr (2007, 2008) and Shaw et al. (2013). The start and ending points of the window selected for analysis were 400 ms to 1300 ms, as it was for the consonant condition. The start point at 400 ms was determined by visual inspection of the grand mean plot (see Figure 5.11) and assessing the earliest rise in fixations to the target (Barr, 2008). This coincides with the start of a drop in fixations in the centre region. The duration of the audio stimuli in the vowel condition ranged from 309 ms to 582 ms (mean 450 ms). The end of the analysis window was determined by the time at which the looks to the target reach a plateau (Best et al., 2013; Shaw et al., 2013; Ying et al., 2013) (see Figure 5.11). The data was

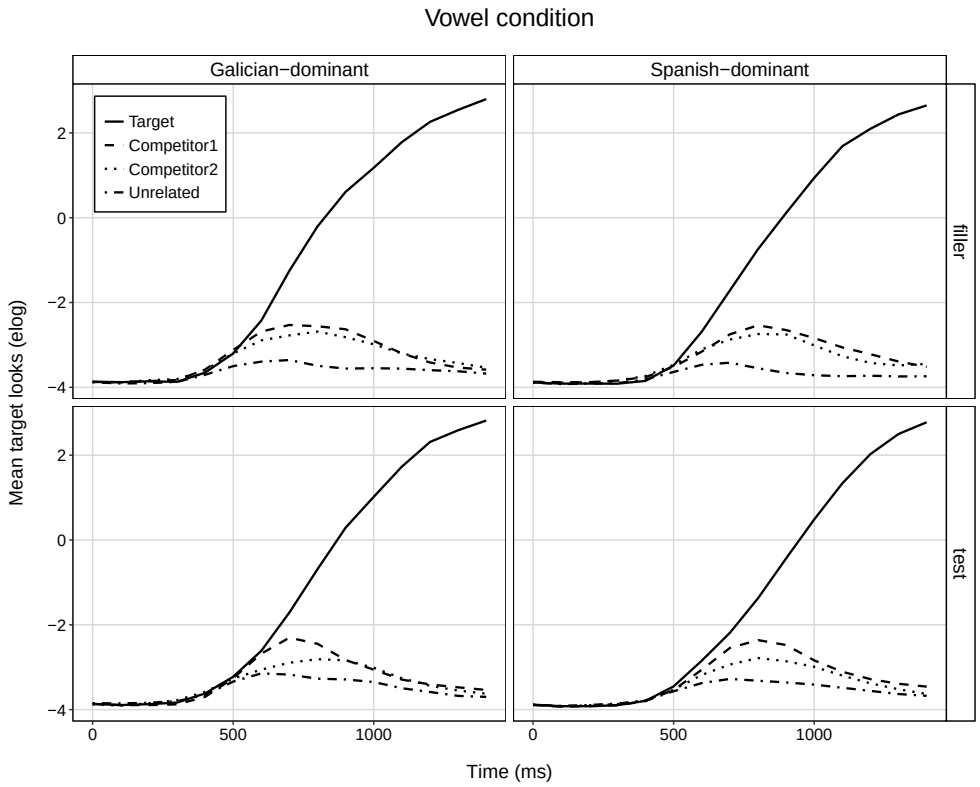

Figure 5.10: E-logit transformed mean proportion of looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) as a function of time (in milliseconds) for the vowel condition. The responses are split by type of trial (filler sets, top boxes; test sets, bottom boxes) and group (Galician-dominant, left; Spanish-dominant, right). Spanish-dominant listeners looked at the target word later and both groups looked at the target word later when presented with test sets.

aggregated into 20 ms bins and was averaged over trials in each trial type (test and fillers) within each subject. Nineteen trials had a track loss proportion that was greater than 25% and therefore, these were excluded from further analysis (Dink & Ferguson, 2016).

The dependent variable for the analysis was the empirical logit transformation (elog). The regression model included `group` (Galician-dominant, Spanish-dominant bilinguals), `trial` (fillers, test sets), `time` (20 ms time bins) and their interactions as fixed factors. `Time` by `participant` was included as a random effect in the model. Deviation coding was used for `group` and `trial`. Variable `time` was coded in seconds, from the onset of the analysis window.

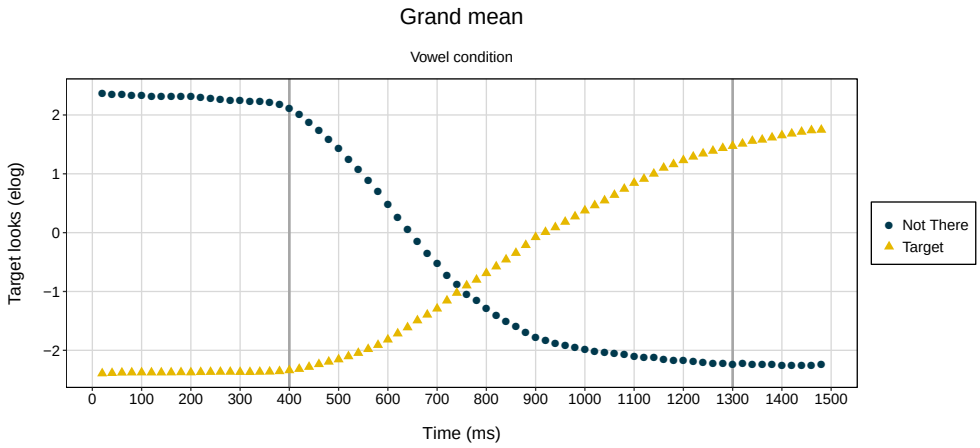

Figure 5.11: Mean fixations to the target word (triangles) and centre of the screen where the fixation cross changes to 'not there' (dots) averaged across trial type and group as a function of time (in milliseconds) for the vowel condition. Vertical lines at 400 ms and 1300 ms represent the start and end times of the analysis window, respectively.

Given that a linear approximation was used, weights were again calculated: $\frac{1}{y+\varepsilon} + \frac{1}{N-y+\varepsilon}$ (Barr, 2007, 2008).

	β	SE	t-value (df)	p-value
Main effects				
Intercept	0.065	0.038	$-34.137(41)$	$< .001$
Time	4.066	0.098	$41.529(41)$	$< .001$
Group	-0.260	0.130	$-1.884(41)$	.067
Trial	-0.118	0.020	$-5.852(3781)$	$< .001$
Interactions				
Time : group	0.097	0.19	$0.495(41)$	*n.s.*
Time : trial	-0.014	0.037	$-0.375(3781)$	*n.s.*
Group : trial	0.035	0.040	$0.875(3781)$	*n.s.*
Time : group : trial	-0.2033	0.074	$-2.739(3781)$	.006

Table 5.4: Summary of the results of the target fixations regression model by Subject for the vowel condition. Baselines for predictor variables: Galician-dominant for `group` and filler for `trial`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values.

The regression model (Table 5.4) revealed a significant main effect of `time` and `trial`. The main effect of `time` indicates that as time went by, par-

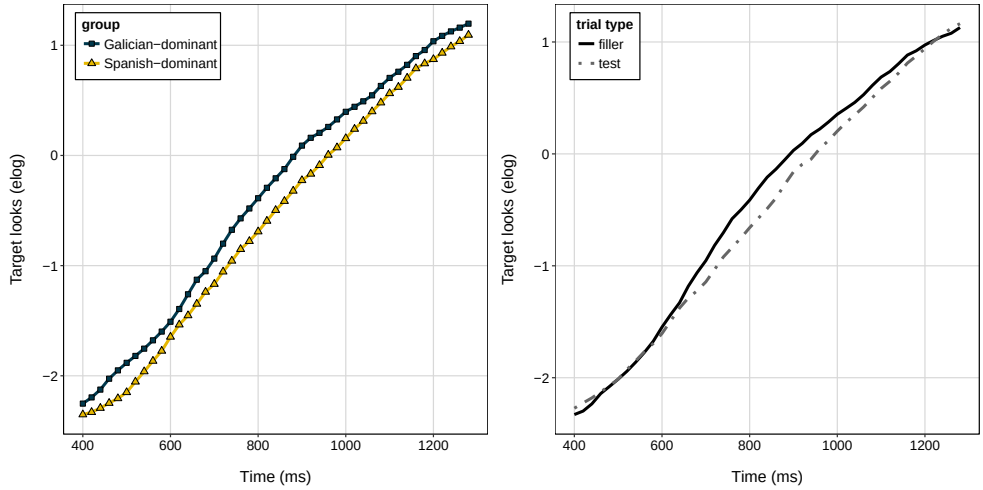

Figure 5.12: Plots showing the interaction between `time`: `group` and `time`: `trial` on target looks as a function of time (in milliseconds) for the vowel condition. The left plot shows the mean elogit-transformed looks at the target word by group (Galician-dominant and Spanish-dominant) and the right plot shows the mean elogit-transformed looks at the target word by trial (filler and test sets). Overall, Galician-dominant listeners looked at the target more than Spanish-dominant listeners and participants looked at the target more when presented with fillers than when presented with test sets, but neither effect changed significantly as a function of time in the current time window.

ticipants looked more at the target word. The main effect of `trial` suggests that participants looked at the target more when presented with fillers than when presented with test sets. The effect of `group` was marginally significant, which suggests there is a trend for Galician-dominant listeners to look at the target more overall than Spanish-dominant listeners. The analysis by item revealed a similar pattern of results, except for the main effect of `group`, which was highly significant ($t(7044) = -14.125$, $p < 0.001^{***}$). Figure 5.12 illustrates the effects of `group` and `trial` as a function of time.

In contrast to the consonant condition (see Figure 5.5), there were no significant interactions of the two effects with `time`. The three-way interaction between `time`, `group` and `trial` was statistically significant, suggesting that the difference between filler and test sets is larger for Spanish-dominant speakers for most of the window of analysis. As shown in Figure 5.13, the difference between filler and test trials was only apparent until 1000 ms

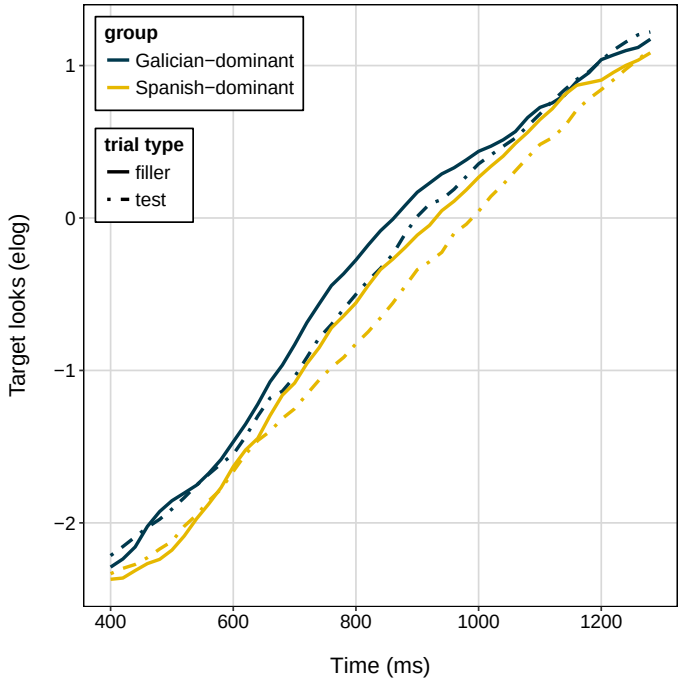

Figure 5.13: Plot showing the three-way interaction between `time`, `group` and `trial` on target looks as a function of time (in milliseconds) for the vowel condition. The plot shows the mean elogit-transformed looks at the target word by group (Galician-dominant, blue; Spanish-dominant, yellow) by trial (filler sets, solid line; test sets, dashed line). This interaction appears to be driven by differences between groups for filler set changes over time, rather than differences for test sets.

for Galician-dominants, whereas it continued for at least 200 ms longer for Spanish-dominant listeners. Similar to the consonant condition results, this interaction appears to be driven by differences between groups for filler set changes over time, rather than differences for test sets.

The target analyses showed that, overall, Galician-dominant listeners looked at the target more than Spanish-dominant listeners and both groups looked at the target more when presented with filler sets. Contrary to what was expected, words containing the vowel contrasts did not hinder word recognition further for Spanish-dominant listeners.

Competitor analysis

A separate analysis was conducted to investigate whether there was a difference in proportion of looks to Competitor 1 (/e/ or /ɛ/, /o/ or /ɔ/; more similar to the target phonetically) and Competitor 2 (/a/ or /u/ respectively;

less similar phonetically). Figure 5.14 displays the transformed proportion of looks to Competitor 1 and Competitor 2 averaged over participants and trials and split by group (vertical boxes) and trial type (horizontal boxes). Similar to consonants, the figure suggests that Galician-dominants consider both competitors earlier. However, both groups seemed to consider both competitors as often. The effect of trial type affected both groups in a similar fashion: whereas for filler sets both competitors seemed equally confusable, for test sets, Competitor 1 (/e/ or /ɛ/, /o/ or /ɔ/) was considered more by both listener groups.

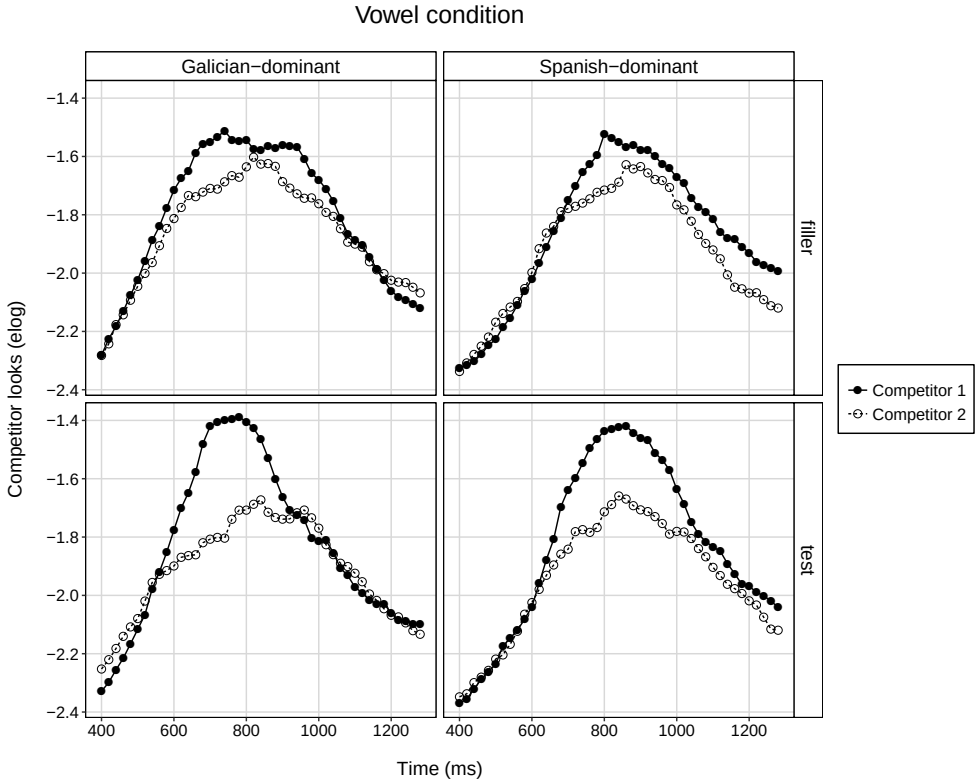

Figure 5.14: E-logit transformed mean proportion of competitor looks averaged over participants and trials for Competitor 1 (solid line) and Competitor 2 (dashed line) as a function of time (in milliseconds) for the vowel condition. The responses are split by type of trial (filler sets, top boxes; test sets, bottom boxes) and group (Galician-dominant, left; Spanish-dominant, right). Galician-dominants seemed to consider both competitors earlier, but both groups seemed to consider both competitors as often. The effect of trial type affected both groups in a similar fashion: whereas for filler sets both competitors seemed equally confusable, for test sets, Competitor 1 (/e/ or /ɛ/, /o/ or /ɔ/) was considered more by both listener groups.

The same statistical analysis that was used for the target looks was employed to investigate the proportion of looks to the competitors. A smaller time window was selected and a linear weighted mixed effects regression was fitted to the elogit-transformed data. The window was determined by assessing the grand mean of fixations to both competitors across conditions and groups (see Figure 5.15). Twenty trials had a track loss proportion that was greater than 25% and was excluded from the analysis (Dink & Ferguson, 2016). Based on the grand mean, the start of the analysis window was selected to be 400 ms as this is when the fixations to both competitors start to rise. The end time was chosen to be at 800 ms, when fixations start to decrease. As for the consonant analysis, restricting the time window to the start of decrease in fixations means that a considerable amount of information is lost. However, averaging over a larger window would not enable incorporation of time as a factor in the analysis, and information about the time course would be lost. Therefore, a smaller but linear portion of the data was selected to enable investigation of the effect of time on looks to the competitor.

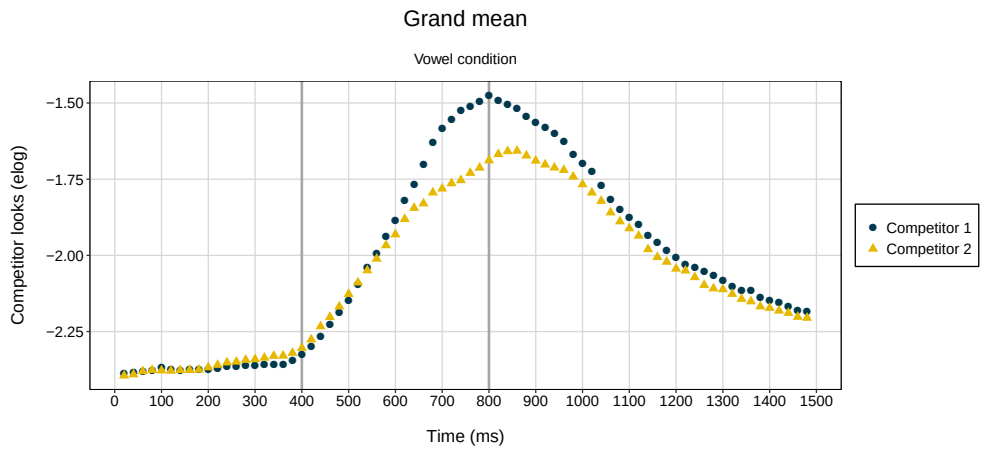

Figure 5.15: Mean fixations to Competitor 1 (triangles) and Competitor 2 (dots) averaged across trial type and group as a function of time (in milliseconds) for the vowel condition. Vertical lines at 400 ms and 800 ms represent the start and end times of the analysis window, respectively.

To investigate looks to the competitors, two separate mixed-effect regression models were fit. The first one had as a dependent variable the elogit-

transformed looks to Competitor 1 and the second model had as a dependent variable the the elogit-transformed looks to Competitor 2. Each model included `group` (Galician-dominant, Spanish-dominant bilinguals), `trial` (fillers, test sets), `time` (20 ms time bins) and their interactions as fixed factors. `Time` by `participant` was included as a random effect in the model. Deviation coding was used for `group` and `trial`. The variable `time` was coded in seconds, from the onset of the analysis window. Given that a linear approximation was used, weights were again calculated: $\frac{1}{y+\varepsilon} + \frac{1}{N-y+\varepsilon}$ (Barr, 2007, 2008).

Table 5.5 shows the results of both regression models. For Competitor 1, the model showed that there was a significant main effect of `time`, indicating that as time went by, participants looked more at Competitor 1 in this time window. The effect of `trial` was also significant, suggesting that both listener groups looked at Competitor 1 more when presented with fillers than test sets. This effect also interacted with time, which implies that the effect is concentrated in certain areas of the time window. In fact, participants look at Competitor 1 more when presented with fillers at the beginning of the time window, but this effect is reversed after 600 ms. The main effect of `group` only approached significance, indicating that there was a trend for Galician-dominant listeners to look more at Competitor 1. The effect of `group` interacted with `trial`, suggesting that the difference between the groups is less pronounced for test sets.

For Competitor 2, the model showed that there was a significant main effect of `time`, indicating that as time went by, participants looked more at Competitor 2 in this time window. The effects of `group`, `trial` and the interaction of these two with time approached significance.

The competitor analyses showed that both groups looked more at Competitor 1 when presented with fillers at the beginning of the time window, but the effect was reversed after 600 ms. The differences between groups were less pronounced for test sets.

	β	SE	t-value (df)	p-value
Competitor 1				
Main effects				
Intercept	-2.255	0.063	$-35.860(42)$	$< .001$
Time	3.039	0.225	13.490(41)	$< .001$
Group	-0.237	0.126	$-1.883(42)$	.067
Trial	-0.146	0.026	$-5.661(1631)$	$< .001$
Interactions				
Time : group	0.064	0.450	0.143(41)	*n.s.*
Time : trial	0.782	0.106	7.374(1631)	$< .001$
Group : trial	0.112	0.051	2.161(1631)	.031
Time : group : trial	-0.249	0.212	$-1.176(1631)$	*n.s.*
Competitor 2				
Main effects				
Intercept	-2.167	0.063	$-34.184(41)$	$< .001$
Time	2.182	0.180	12.088(41)	$< .001$
Group	-0.227	0.127	$-1.795(42)$	.080
Trial	-0.039	0.023	$-1.696(1631)$	.090
Interactions				
Time : group	0.367	0.361	1.018(41)	*n.s.*
Time : trial	-0.077	0.098	$-0.789(1631)$	*n.s.*
Group : trial	-0.053	0.046	$-1.133(1631)$	*n.s.*
Time : group : trial	0.369	0.195	1.890(48)	.059

Table 5.5: Summary of the results of the competitor fixations regression models for Competitor 1 and Competitor 2 for the vowel condition. Baselines for predictor variables: Competitor 1 for `object` Galician-dominant for `group` and filler for `trial`. Numbers represent Estimates (β), Standard Errors (SE), t-statistic and degrees of freedom (df; in brackets) and p-values.

5.3.2 *Neofalantes*

The data from *neofalantes* was compared to the data presented in the previous Section in order to explore whether the performance of this group was more similar to that of Spanish-dominant or Galician-dominant listeners. Given the limited sample size in the *neofalantes* group (N = 6), statistical analyses were not carried out and hence, the interpretation of results is preliminary and more

data needs to be collected to draw conclusions.

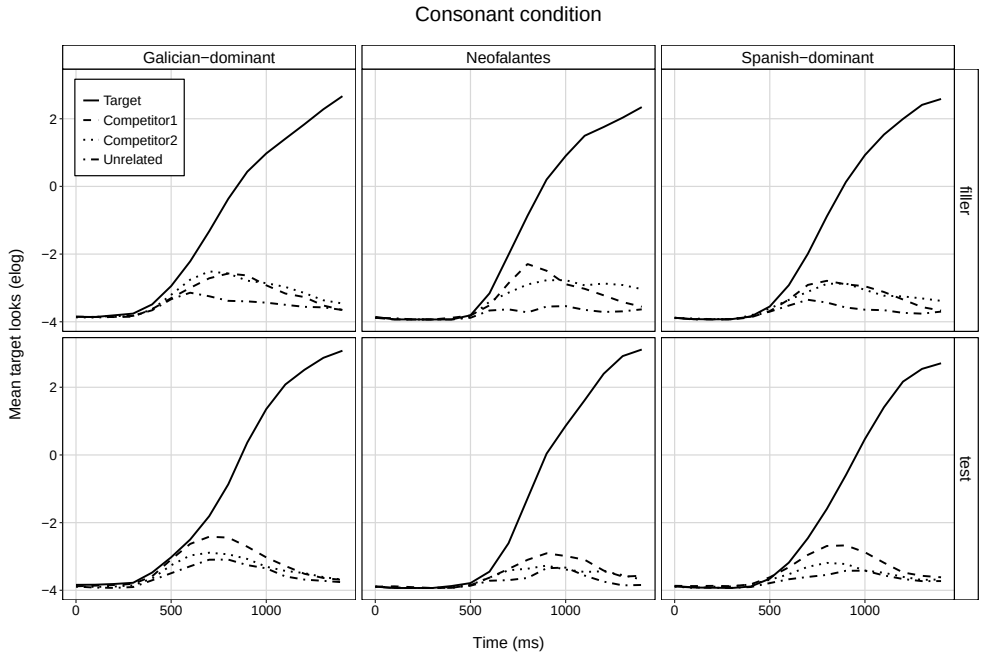

Figure 5.16: E-logit transformed mean proportion of looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) as a function of time (in milliseconds). The responses are split by type of trial (filler sets, top boxes; test sets, bottom boxes) and group (Galician-dominant, left; *Neofalantes*, centre; Spanish-dominant, right). *Neofalantes* seem to exhibit a similar pattern to that of Spanish-dominant listeners, i.e., they looked at the target word later than Galician-dominants.

Figure 5.16 displays the elogit-transformed proportion of looks averaged over participants and trials for each word type (Target, Competitor 1, Competitor 2, and Unrelated distractor) for all three groups as a function of time (in milliseconds). The time window spans from the stimulus onset to 1500 ms after the start of the trial in 100 ms bins. No trials had a track loss proportion that was greater than 25%. Visual inspection of the data indicates that *neofalantes* behaved more similarly to Spanish-dominant than to Galician-dominant listeners. Looks to target and competitor words do not start until 500 ms after the stimulus onset, as is the case for Spanish-dominants, whereas for Galician-dominants fixations to the target and the competitors start earlier. Regarding test sets in particular, the decrease in fixations to the competitors starts at around 500 ms for Galician-dominants, but slightly later for *neofalan-*

tes and Spanish-dominant speakers. The same pattern was found for the vowel condition.

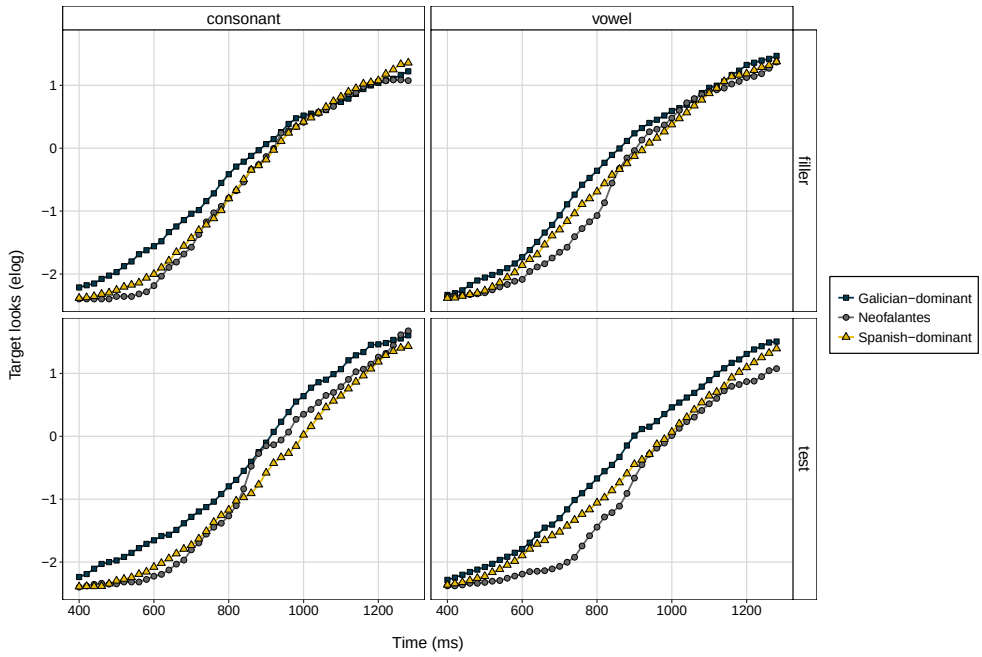

Figure 5.17: E-logit transformed mean proportion of target looks averaged over participants and trials as a function of time (in milliseconds). The responses are split by condition (consonant condition, left boxes; vowel condition, right boxes), type of trial (filler sets, boxes; test sets, bottom boxes) and group (*Neofalantes*, circles; Galician-dominants, squares; Spanish-dominants; triangles). The graph shows that the three groups look at the target to the same extent towards the end of the time window, but the rate at which they do so is slower for *neofalantes* and Spanish-dominant listeners.

To be able to compare the difference in target looks directly, Figure 5.17 displays the looks to the target for both conditions (consonant condition on the left, vowel condition on the right) for filler and test sets. The graph shows that the three groups look at the target to the same extent towards the end of the time window, but the rate at which they do so is slower for *neofalantes* and Spanish-dominant listeners. Moreover, the time when the three groups achieve the same level of performance depends on whether they are presented with filler sets (900-1000 ms) or test sets (after 1200 ms).

5.4 Discussion

This study used the visual world paradigm to investigate the time course of spoken word recognition in Galician by Galician-dominant, Spanish-dominant bilinguals and *neofalantes*. The first analysis examined the differences between Galician- and Spanish-dominant bilinguals, and revealed that 1) word recognition was slower for Spanish-dominant bilinguals, but 2) the level of lexical activation of the confusable competitors was similar for both groups.

Although large differences in processing between the two groups were not apparent in the reaction time data, the eye-tracking data did reveal overall group differences in target look proportions. In the consonant condition, Galician-dominant listeners looked at the target more and earlier than Spanish-dominant listeners. For vowels, the effect of group was less robust: marginal in the analysis by subject, but highly significant in the analysis by item. These results suggest that overall, Galician-dominant listeners were faster than Spanish-dominant listeners when recognising Galician words.

The second question addressed whether perception difficulties with Galician-specific phonological contrasts (see Study 1) hindered word recognition to a greater extent for Spanish-dominant listeners. The reaction time data showed there was a difference in terms of how fast test and filler sets were processed; listeners in both groups were faster at recognising words which did not contain Galician-specific contrasts. This effect was also found in the eye movement data. In both vowel and consonant conditions, listeners in both groups looked at the target word more when presented with filler than when presented with test sets. This result could be related to the acoustic similarity of the contrasts presented in the test sets. The fact that such contrasts are acoustically more similar than those in filler words could have as a consequence a delay in processing, even for Galician-dominant listeners. An alternative explanation would be that those contrasts create increased lexical competition for both groups (see later discussion in this Section). Contrary

to predictions, differences in processing of test sets between Galician- and Spanish-dominant listeners were not observed. In the consonant condition, the difference in target looks for test and filler sets was only apparent for Galician-dominant listeners until around 850 ms, and after that, the difference seemed to disappear. In contrast, the difference in processing the two types of sets remained for around 250 ms longer for Spanish-dominants. As for consonants, in the vowel condition, the difference between filler and test trials was only apparent until 1000 ms, whereas it continued for at least 200 ms longer for Spanish-dominant listeners. Note that this effect seems to be delayed by 200 ms overall in the vowel condition, probably due to the segment position in the word, as consonants occurred in the first segment, whereas vowels occurred in the second segment of the word. Nevertheless, this interaction seems to be driven by differences in the processing of filler sets, rather than test sets. Therefore, this result does not suggest that Galician-specific contrasts hindered word recognition for a longer period of time for Spanish-dominant listeners, as was initially predicted.

These findings are not in line with previous research in this area, which has found that words containing phonological contrasts which do not exist in the native phonetic repertoire hinder word recognition (Best et al., 2013; Cutler et al., 2006; Weber & Cutler, 2004; Ying et al., 2013). For example, Best et al. (2013) and Ying et al. (2013) demonstrated that L1 and L2 speakers of Australian English were slower overall at recognising words in an unfamiliar accent and that recognition was further impaired when words contained phones that did not exist in their native accent, especially if the contrast crossed a native category. Nonetheless, unlike Australian listeners in those studies, Spanish-dominant listeners were indeed familiar with the Galician contrasts with which they were presented and were likely to be exposed to such contrasts on a very frequent basis. However, they do have difficulties in perceiving the Galician mid-vowel contrast and their fricative category boundary is different from that of Galician-dominant listeners (Study 1). The eye-tracking results,

however, suggest that such differences at the phonetic processing level do not seem to affect word recognition for this listener group and that this is the same for both vowels and consonants.

It is not always the case that vowels and consonants have been shown to have a similar status in word recognition and phonological organisation. In fact, previous work has shown that vowels and consonants play a different role in visual word recognition (Acha & Perea, 2010; Carreiras et al., 2009; Carreiras & Price, 2008; Lee, 2000; Lee et al., 2002; New & Nazzi, 2012; Soares et al., 2014), word identification in continuous speech (Bonatti et al., 2005), spoken word recognition using a word reconstruction task (Cutler et al., 2000; Van Ooijen, 1996) and sentence recognition (Cole et al., 1996). However, in Best et al. (2013) and Ying et al. (2013), Australian listeners were presented with unfamiliar accent vowel contrasts (Jamaican English) and consonant contrasts (Cockney English) and the results showed that vowel and consonant variations affect lexical competition in spoken word recognition in a similar manner. In sum, the findings of the current study are in agreement with Best and colleagues', as both vowel and consonant contrasts appear to delay lexical processing not only for Spanish-dominants, but also for Galician-dominants and thus, affect word recognition in a similar manner.

Although the findings related to overall recognition seem to replicate the effects found in previous research, the results from the competitor analysis appear to differ. In the current experiment, Galician-dominants looked more and earlier at both competitors in an early time window. For the consonant condition, Galician-dominant listeners looked at the more confusable competitor (/s/ or /ʃ/) more when presented with test sets in comparison to filler sets, whereas this difference was not apparent for Spanish-dominants. However, looks to the less confusable competitor /tʃ/ did not depend on the type of set presented. These results suggest that the sibilant contrasts generated more lexical competition for Galician-dominant listeners. Similarly, in the vowel condition there was a trend for Galician-dominants to look at both competi-

tors more, but in this case, the pattern was different to that of consonants. Both groups looked at the most confusable competitor (/e/ or /ɛ/; /o/ or /ɔ/) more when presented with fillers, but this effect was modulated by time. Towards the end of the window of analysis, from 650 ms onwards, the pattern was reversed such that they looked more at the confusable competitor when presented with test sets. Crucially, the results indicated that test sets for vowels affected both groups similarly in terms of lexical competition.

Weber and Cutler (2004) demonstrated that L2 Dutch speakers of English fixated longer on distractor pictures with names containing contrasts that are difficult for Dutch learners of English, whereas English native listeners showed no fixation difference. The authors propose that this inappropriate activation leads to more competition, and the more competition, the slower word recognition (see also Norris, McQueen, & Cutler, 1995). However, in this study, such inappropriate activation was also found for Galician-dominant listeners. In fact, lexical activation of the competitor containing the fricative contrast was greater for Galician-dominants and activation of the competitor containing the mid vowels was similar to that of Spanish-dominant listeners. It is likely that this competition makes processing test sets slower for both groups, as was found in the reaction time and eye-tracking data analysis. Based on Weber and Cutler (2004) and Cutler et al. (2006), one might expect that Spanish-dominants, who have difficulties in perceiving the mid-vowel contrast, would exhibit increased lexical activation when presented with words containing such contrasts. For example, if a listener lacks the /ɛ/-/e/ contrast and hears the word *peza* /ˈpɛθa/, when presented with the words *peza* /ˈpɛθa/ and *peto* /ˈpeto/, they would most likely activate both, as they would not be able to distinguish between the two lexical items until information about the third segment is available. In principle though, when a Galician-dominant listener hears the word *peza* /ˈpɛθa/, the activation of *peto* /ˈpeto/ should decrease earlier, as soon as they begin to obtain information about the vowel. However, Galician bilinguals are not L2 learners: although the amount and

type of exposure to Galician and Spanish will vary from individual to individual, they are exposed to both languages from an early age, have extensive exposure to both and hear them on a daily basis. Moreover, they hear both languages produced by speakers from different language backgrounds; some speakers might have a phonological distinction between the mid vowels, but some might not. Therefore, when hearing the word *peza* /ˈpɛθa/, a Galician listener will not know if the speaker has a contrast between the mid vowels, and hence, will not be able to predict whether the first two segments are more similar to those in *peza* /ˈpɛθa/, or to those in *peto* /ˈpeto/.

A similar effect has been found for Catalan bilinguals using a different methodology. Sebastián-Gallés et al. (2006) presented Catalan- and Spanish-dominant bilinguals with words that contained mid vowels. Participants were instructed to decide whether a form was a Catalan word or not. The non-words consisted of real words with a vowel changed, including mid vowels, a contrast which has also been shown to be difficult to perceive for Spanish-dominant listeners in the Catalan context (Bosch et al., 2000; Bosch & Sebastián-Gallés, 1997; Pallier et al., 2001; Sebastián-Gallés & Soto-Faraco, 1999). ERP measurements collected during the lexical decision task showed that Catalan-dominant listeners had a similar N400 response to Spanish-dominant listeners. Even Catalan-dominant bilinguals did not show the predicted N400 lexicality effect for experimental non-words that contained the altered Catalan mid vowel. The N400 component, considered sensitive to meaning integration, has also been linked with degree of lexical-semantic activation. As such, a small N400 difference between words and non-words can be regarded as indicative of a non-word being close to a real word. These results were interpreted to mean that, given the bilingual environment, Catalan-dominant bilinguals who are frequently exposed to both Catalan-accented and Spanish-accented pronunciations of Catalan words might have two different acoustic representations for such words in their lexicon (Sebastián-Gallés et al. 2006, see also Sebastián-Gallés, Vera-Costán, Larsson, Costa, and Deco 2008, for replica-

tion).

What might this mean for phonetic representations? Sebastián-Gallés et al. (2008) investigated Catalan-dominant bilinguals' phonetic representations by measuring MMN, a component that is considered to be sensitive to phonetic differences. The results indicated that Catalan-dominant listeners had a similar MMN response for their mid-vowel discrimination when compared to the discrimination of other vowels (e.g., /i/-/e/). Consequently, the authors proposed that phoneme representations are not affected by exposure to accent variation, and instead, that adaptation occurs at the lexical level. Research from perceptual learning studies, however, presents a diverging view (e.g. Eisner & McQueen, 2005; Kraljic & Samuel, 2006; Norris, McQueen, & Cutler, 2003). In these experiments, listeners are exposed to words containing ambiguous sounds (e.g., a /f/-/s/ continuum), and this brief exposure has been shown to shift listeners' category boundaries for the corresponding contrasts. This rapid adaptation has been interpreted to mean that lexical feedback can modify phonetic categories. Nevertheless, in the case of Galician-listeners, continuous naturalistic exposure to the merged mid-vowel contrast did not have any consequences for mid-vowel identification, as demonstrated in Study 1. Rather, this exposure to the merged contrast appears to have had an impact at the lexical processing level, such that they show increased lexical competition. Therefore, the findings from this thesis are in agreement with work by Sebastián-Gallés and colleagues, and provide support for the idea that adaptation to other accents occurs at the lexical level. Furthermore, these results suggest that the flexibility in underlying L1 phonetic categories seems to be limited and modifications to these appear to be unlikely late in life, even with extensive exposure.

It is worth noting that participants in Sebastián-Gallés et al. (2006) and Sebastián-Gallés et al. (2008) were only presented with mid-vowel contrasts. In Catalan, the mid vowels /ɛ/ and /e/ are represented by one single letter 'e'. Hence, it is possible that orthography could interfere with the results.

Indeed, previous work has shown that orthography affects word recognition (e.g., Peereman, Dufour, & Burt, 2009; Ziegler, Ferrand, & Montant, 2004), and thus, it is feasible that the activation of incorrect lexical items was due to activation through orthography (Sebastián-Gallés et al., 2006). Like in Catalan, mid vowels are represented with one single letter in Galician ('e' for front mid vowels and 'o' for back mid vowels). However, the current study also found that Galician-dominant listeners had greater activation for the sibilant fricative competitors, which are represented differently in spelling ('x' for /ʃ/ and 's' for /s/). Therefore, it is likely that the role of orthography alone cannot account for the results. Nevertheless, the fricative contrast was not equally difficult to discriminate for Spanish-dominants in a phoneme identification task (Study 1). In fact, Spanish-dominant listeners showed categorical perception of this contrast, but their boundary was different from that of Galician-dominants. The phoneme identification results mirrored the production findings, which showed that Spanish-dominant speakers had a different realisation of the alveolar fricative /s/ and produced a contrast that was less distinct than that of Galician-dominant speakers. Besides, /s/ in particular can have different realisations in varieties of Galician spoken by Galician-dominant bilinguals (cf. Labraña Barrero, 2009, 2014; Regueira & Ginzo, in press). One possibility is that the variability in the production of this contrast means that it cannot be used as reliably by listeners in either of the bilingual groups in spoken word recognition.

This experiment also explored the question of whether a language dominance switch would also have an impact on lexical access. Thus, the second analysis in this study examined *neofalantes*' results in comparison to Galician- and Spanish- dominant bilinguals. Given the small sample size for this group, the comparisons were made by visualising the data. Consequently, the *neofalantes* analysis is exploratory and results should be interpreted carefully. These preliminary results suggest that *neofalantes* behaved more similarly to Spanish-dominant listeners, as they started fixating on the target later than

Galician-dominant listeners. Additionally, looks to competitors in the test sets also seemed to start and decrease later than for the Galician-dominant group. These results complement the findings from Study 1, which showed that there was little evidence to suggest that *neofalantes* had made changes to their perception after the language dominance switch. This experiment shows that there do not appear to be changes at the lexical processing level either. These findings, therefore, provide further evidence to suggest that, even with early and exposure, perceptual categories are likely difficult to modify late in life, which has an effect on lexical processing.

In short, the findings of this experiment indicate that Galician-dominant listeners looked more and earlier at the target, but also at competitors, when presented with Galician words, suggesting that their lexical processing is faster overall. However, both Galician-dominant and Spanish-dominant listeners showed increased lexical activation when presented with words that contained Galician-specific contrasts. This result is in line with previous research which proposes that the L1 mental lexicon of dominant bilinguals in a bilingual environment may include lexical entries for other varieties (cf. Sebastián-Gallés et al., 2006, 2008). Taken together, these findings indicate that language dominance plays a role in spoken word recognition, and suggest that lexical competition in dominant bilinguals is not only enhanced by difficulty with confusable phonetic contrasts, but may also be increased after extensive, long-term exposure to varieties which lack such contrasts. Overall, the results show that the visual world paradigm is an appropriate technique to investigate differences in speech processing in dominant bilinguals.

Chapter 6

General Discussion

This thesis investigated the effects of language dominance on bilingual speech processing in a naturalistic environment by focussing on Galician new speakers (*neofalantes*). *Neofalantes* are a group of unbalanced bilinguals who were raised predominantly in Spanish, but who also learn Galician at an early age, and, in adolescence, decide to switch languages to speak Galician predominantly or exclusively, for ideological reasons. These speakers, who have what could be considered ideal conditions for learning their L2/non-dominant language (i.e., Galician) phonetic categories (early exposure to the L2, high motivation to sound native-like and almost exclusive language use post-switch), offer an excellent opportunity to investigate the degree of flexibility in phonetic and lexical representations over the lifespan in a naturalistic setting.

The sections below will discuss the main findings of the studies reported in the thesis in the light of current theories of L2 and bilingual acquisition, and spoken word recognition, incorporating ideas from sociophonetic research.

6.1 The effects of a long-term language dominance switch on bilingual speech processing

Study 1 examined *neofalantes*' production and perception of Galician as compared to Galician-dominant and Spanish-dominant speakers, using a battery of speech perception and production tasks and a detailed language back-

ground questionnaire. Results showed that *neofalantes* pattern with Spanish-dominants in their perception and production two Galician contrasts that do not exist in Spanish, but with Galician-dominants in their realisation of a highly salient feature of Galician. Study 3 investigated the time course of spoken word recognition by the three bilingual groups of interest. Due to the limited sample size in the *neofalantes* group, the comparison between this group and the other two groups could only be made by visualising the time course of lexical competition and reporting descriptive statistics. However, exploratory results indicated that *neofalantes* also pattern with Spanish-dominant, rather than Galician-dominant bilinguals, in a higher level processing task, such as word recognition.

Previous work on Spanish-Catalan bilinguals has shown that early exposure is not enough for dominant bilinguals to acquire native-like categories in their non-dominant language, and this has been attributed to a lack of plasticity (Pallier et al., 1997, 2001; Sebastián-Gallés & Soto-Faraco, 1999). In contrast, Flege and MacKay (2004); Mora et al. (2011, 2015a) have argued that difficulties in L2 perception are caused by continued use of the L1 rather than a lack of plasticity *per se* (see also Iverson et al., 2003). In Pallier's study, Spanish-dominant bilinguals, who were raised in their dominant language, continue to use Spanish as their main language. It could be hypothesised then, that the lack of success in acquiring native-like categories is due to their L1 continuously influencing the perception of their L2. However, in the studies presented here, *neofalantes* use their former non-dominant language, Galician, predominantly or exclusively after the language dominance switch, and yet they still appear to process Galician categories through their Spanish ones.

Research has shown that motivation may play a role in L2 acquisition (cf. Piske, Mackay, & Flege, 2001, for a review on factors affecting the degree of foreign accent in an L2). For example, highly proficient Dutch learners of English were not differentiated from native English speakers in an accent rating task (Bongaerts, Planken, & Schils, 1995; Bongaerts, van Summeren,

Planken, & Schils, 1997). The authors suggested that one of the reasons why these exceptionally successful learners could pass as native speakers could be related to their high motivation to sound native-like. Moyer (1999) conducted a similar study with highly motivated American learners of German and attempted to quantify motivation and language input. Although in this case, L2 learners were not grouped with native speakers of German, indicating that motivation does not override the effect of age of acquisition, there was a strong relationship between motivation and the accent rating score (the higher the motivation the more native-like). However, these results show that even with extensive use of the L2 and a high motivation to learn, dominant bilinguals are unable to form new, native-like phonetic categories in production or perception when they switch late in life. It seems more likely then that *neofalantes* process their new, dominant language through their former dominant language categories.

Research on dominant bilinguals has demonstrated that performance with the non-dominant language is task-dependent: performance is better on tasks that involve pre-lexical processing (e.g., categorisation or phoneme identification), but not on tasks that tap into lexical processing (Sebastián-Gallés & Díaz, 2012). Given this finding, it was expected that if *neofalantes* patterned with Spanish-dominant in the phoneme identification tasks, the same result would be found for word recognition. Indeed, the preliminary results of the eye-tracking study (Chapters 4 & 5) showed that both *neofalantes* patterned with Spanish-dominant listeners, and were slower overall than Galician-dominants. The results from the speech perception and spoken word recognition tasks thus argue for a central role of early exposure in the formation of perceptual categories. Even with extensive exposure and motivation to learn, underlying perceptual categories are likely very difficult to change late in life.

6.2 Signalling identity in a bilingual community

As well as patterning with Spanish-dominants in perception and word recognition, *neofalantes* did not appear to produce a distinctive contrast for front and back mid vowels and did not differ from Spanish-dominant speakers in their production of the sibilant fricative contrast. However, they patterned with Galician-dominants in their production of reduced word-final vowels.

Theories of cross language speech perception such as PAM/PAM-L2 (Best, 1994, 1995; Best & Tyler, 2007) and the SLM (Flege, 1992, 1995), have proposed that certain phonetic contrasts are more difficult to perceive than others and that this leads to difficulties in production. According to these models, the difficulty can be predicted by the phonetic similarities of the first and second languages. The contrast between open- and close-mid vowels is a difficult one for *neofalantes* (and Spanish-dominants), because the Galician contrasts are both a good match to the single Spanish categories. However, Study 2 showed that listeners often claimed to use the mid-vowel contrasts to categorise speakers into accent groups and that listeners in the community are highly aware of mid-vowels as a distinctive feature of Galician. *Neofalantes* are usually conscious that it is effortful to acquire this feature, but it is often thought that it is 'necessary' to sound Galician-like. Thus, mid vowels could be considered as functioning as a stereotype (cf. Labov, 1972), though, it seems likely that, given the results of the identification tasks in Study 1, difficulties in perception determine the availability of this contrast as a phonetic resource to mark identity. In contrast, word-final vowels could be considered a feature below the level of awareness. This is supported by the qualitative data from Study 2, which showed that Galician listeners, regardless of language background, were much less aware of word-final vowels as a feature that indexes Galician. Nevertheless, word-final vowel reduction is one of the most characteristic features of the Galician accent (Regueira, 2012). For example, a speaker imitating a traditional Galician accent would reduce word-final

vowels, but they would probably not be able to express what aspect of their pronunciation they were changing. Overall then, these results support the idea that perceptual learning constraints limit what phonetic resources are available to signal social meaning in the case of dominant bilinguals.

Work by O'Rourke and Ramallo provides further support for the idea that the *neofalantes*' variety is different from that of other bilingual groups. For example, O'Rourke and Ramallo (2013a, p. 294) have shown that at least some *neofalantes* are aware that the variety they speak is not like that of Galician-dominant speakers:

'*A miña variedade é defectuosa. Eu entendo que a* persona *que o falou sempre, que tal, que a miña variedade non é nin diatópica nin diafásica, que a miña... eu falo o galego que podo. Cada día intento falar mellor, e* ahora *pois si intento máis o menos meter variedades da miña zona o intentar melloralo, facelo..., pero para min o meu galego e inauténtico*'	'My variety is imperfect. The way I see it is that a person who has always spoken Galician, and so on, that my variety is neither diatopic or diaphasic, that mine... I speak the Galician I can. Every day I try to speak better, and now well if I try to more or less include varieties from my own area or to improve it, to make it..., but for me my Galician is inauthentic.'

Some *neofalantes* are also aware that their variety is a hybrid one, as exemplified by another quote from interviews by O'Rourke and Ramallo (2015, p. 165):

'*A min* personalmente *cústome muito, muita xente se riou de min nese momento, por falar galego e dicían..."ti falas castrapo", bueno pssss..., falo castrapo e*	'For me it was very difficult, a lot of people laughed at me for speaking Galician and they would say... "you are speaking *castrapo* [12]", well pahh..., I speak *castrapo*

seguireino falando y *son neofalante hoxe en día polos motivos que sexan, non?*'	and I still speak it and I am a new speaker today for whatever reason right?'

This quote shows that at least some *neofalantes* reclaim this hybrid variety as their own, despite its stigmatisation.

Study 2 examined whether *neofalantes*' production changes post-switch were enough for listeners in the speech community to recognise this variety as an emerging one. The results showed that listeners could not identify the *neofalantes*' accent. Instead, they confused it with both Spanish-dominants' and Galician-dominants' accents, providing support for the idea that *neofalantes* have a hybrid variety which is different from that of the other two group of bilinguals. Furthermore, overall identification accuracy was similar for all listener groups, suggesting that language familiarity (cf. Clopper & Pisoni, 2004a, 2006; Fleming et al., 2014; Goggin et al., 1991; Thompson, 1987), rather than language ability (cf. Perrachione et al., 2011), facilitated accent identification. Although in this case all bilingual groups were familiar with the phonological system of Galician, the results of Study 1 suggests that *neofalantes* and Spanish-dominant listeners perceive Galician through their native Spanish categories, even though all three listener groups live in a bilingual community where they have everyday exposure to all the accents. Also noteworthy is that, in contrast to Clopper's findings (2004a; 2006), listeners did not show heightened sensitivity for their own accent, perhaps because unlike Clopper's participants, listeners in the Galician community may have a similar amount of exposure to all the accents tested here, although the exact amount of exposure to each accent for each individual will likely vary depending, for example, on their social networks.

In sum, the results of Study 1 and Study 2 indicate that *neofalantes* develop a hybrid variety characterised by the effects of language switch. In a

[12] A pejorative term used to refer to the mixture of Galician and Spanish.

bilingual environment, it could be assumed that individuals have two phonetic repertoires at their disposal to use as sociolinguistic variables. However, this does not seem to be the case for the dominant bilinguals tested here, and perceptual learning constraints appear to limit what phonetic resources are available to index social meaning.

6.3 Spoken word recognition in dominant bilinguals

Study 3 explored how these three groups of bilinguals used Galician-specific phonetic features in spoken word recognition. To date, this is the first study that has investigated the influence of particular phonetic features in spoken word recognition in dominant bilinguals that live in a bilingual environment. Consequently, differences between Galician- and Spanish-dominant listeners were examined first. The results suggested that word recognition was slower for Spanish-dominant bilinguals, but, contrary to initial predictions, Galician-specific contrasts did not further hinder word recognition for this listener group. Previous research has demonstrated that words containing phonological contrasts which do not exist in the native phonetic repertoire hinder word recognition for L2 learners (Best et al., 2013; Cutler et al., 2006; Weber & Cutler, 2004; Ying et al., 2013). One possibility is that Spanish-dominant listeners, early bilinguals exposed to Galician from an early age, behave differently from L2 language learners. Additionally, vowels and consonant contrasts had a similar effect on word recognition.

Although previous work has shown that consonants play a different role in visual word recognition (Acha & Perea, 2010; Carreiras et al., 2009; Carreiras & Price, 2008; Lee, 2000; Lee et al., 2002; New & Nazzi, 2012; Soares et al., 2014), word identification in continuous speech (Bonatti et al., 2005), and spoken word recognition (Cutler et al., 2000; Van Ooijen, 1996) and sentence recognition, other research using the visual world paradigm to investigate the

time course of lexical access has found different results. For example, Best et al. (2013) and Ying et al. (2013) presented L1 and L2 speakers of Australian English with words in two unfamiliar accents. The stimuli consisted of Jamaican English words, containing vowel contrasts which do not exist in Australian English and Cockney English words, containing consonant contrasts, which also do not exist in the native accent. The results suggested that vowel and consonant variations appear to disrupt lexical access to the same extent. Likewise, in Study 3, both consonant and vowel variations delayed word recognition for both Galician- and Spanish-dominant listeners in a similar way.

Based on previous research on lexical competition in L2 spoken word recognition (Cutler et al., 2006; Weber & Cutler, 2004), one would predict that difficulties in phonetic discrimination would increase lexical activation. Thus, the Galician-specific contrasts should have created more lexical activation for those bilinguals not dominant in Galician, i.e., Spanish-dominants, as they had difficulties in identifying the vowel contrast and had a different category boundary for the fricative contrast (Study 1). The findings, however, indicated that lexical activation was the same for both groups for candidates that contained the mid-vowel contrast, and that activation was greater for Galician-dominant listeners for candidates that contained the sibilant fricative. To understand this result, the context in which dominant bilinguals learn and use their languages should be considered. In the Galician context, bilinguals are exposed to both languages from an early age and they hear them produced by speakers of different language backgrounds. Therefore, listeners are accustomed to hearing Galician produced by speakers who have a distinctive contrast between the open- and close-mid vowels, and others who do not. These findings are supported by work with Catalan-dominant bilinguals using different methods (Sebastián-Gallés et al., 2006, 2008). For example, Sebastián-Gallés et al. (2006) instructed Catalan- and Spanish-dominant bilinguals to decide whether the form they heard was a word or not. The non-words consisted of real words with a vowel changed, including mid vowels, a contrast which

has also been shown to be difficult to perceive for Spanish-dominant listeners in Catalonia (Bosch et al., 2000; Bosch & Sebastián-Gallés, 1997; Pallier et al., 2001; Sebastián-Gallés & Soto-Faraco, 1999). ERP measurements collected during the lexical decision task showed no differences between the Catalan-dominant and Spanish-dominant listeners' N400 response. This ERP component is considered to be sensitive to meaning integration, has also been linked with degree of lexical-semantic activation. As such, a smaller N400 difference between words and non-words can be regarded as indicative of a non-word being close to a real word. The results showed that, even Catalan-dominant bilinguals did not show the predicted N400 lexicality effect for experimental non-words that contained the altered Catalan mid vowel. These findings were interpreted to mean that, given the bilingual environment, Catalan-dominant bilinguals who are frequently exposed to both Catalan-accented and Spanish-accented pronunciations of Catalan words might have two different acoustic representations for such words in their lexicons (Sebastián-Gallés et al., 2006).

Sebastián-Gallés et al. (2008) further proposed that phoneme representations are not affected by exposure to accent variation, and instead, that adaptation occurs at the lexical level. This claim is at odds with perceptual learning research, which argues that lexical feedback can make modifications to phonetic categories (cf. Eisner & McQueen, 2005; Kraljic & Samuel, 2006; Norris et al., 2003). However, naturalistic and continuous exposure to a merged contrast was shown not to have any consequences for Catalan-dominant listeners' phonetic categories, but appeared instead to have had an impact at the lexical processing level (Sebastián-Gallés et al., 2008). In the present study, Galician-dominant listeners had similar lexical activation to Spanish-dominants for candidates containing mid-vowel contrasts, but the two groups differed in phoneme identification performance, with Galician-dominant listeners performing at ceiling in the vowel identification task (Study 1). Based on the results from the Catalan study, one could hypothesise that no modifications have been made to Galician-dominants' phonetic representations, how-

ever, further research, using a different task, is needed to determine whether that is the case.

This experiment also explored the question of whether a long-term language dominance switch would have an impact on lexical access. The second analysis in this study examined *neofalantes*' results in comparison to Galician- and Spanish- dominant bilinguals. Due to the limited sample size for this group, *neofalantes*' performance was compared to the other two groups by visually inspecting the data and reporting descriptive statistics, so these results are exploratory and consequently, these findings should be interpreted carefully. However, these preliminary results suggested that *neofalantes* patterned with Spanish-dominant listeners, as word recognition was delayed for these two bilingual groups. These results complement the findings from Study 1, which showed that there was little evidence to suggest that *neofalantes* had made changes to their perception post-switch. This experiment suggests that there do not appear to be changes at the lexical processing level. Instead, these findings provide further evidence to suggest that, even with early and exposure, perceptual categories are likely difficult to modify late in life, which has an effect on lexical processing.

6.4 Limitations and future directions

The studies in this thesis contribute to our understanding of bilingual speech processing after a long-term language dominance switch. One limitation to this study is the restricted sample size in the *neofalantes* group. However, recruiting these participants is a difficult process for several reasons. First, this group of speakers is not as numerous as Spanish-dominant or Galician-dominant bilinguals, in fact, they constitute less than 2% of the Galician population (cf. Section 1.1.2). Second, it is not appropriate to recruit them by using the label due to the connotations that this label may have in the community (see section 2.2.1.1 for more details) and because all participants were naive to the goals of the experiment, and thus, drawing attention to a partic-

ipant's language background could risk undermining the data. However, the idiosyncrasy of this population from the language acquisition perspective has enabled investigation of the effects of early exposure, extensive L2 use and high motivation on speech processing. These unusual circumstances have extended our knowledge of perception and production in speech learning.

Future research will aim to recruit more *neofalantes* listeners to complete the eye-tracking task in Study 3, and obtain a clearer picture of the role a long-term language dominance switch might play in lexical competition in spoken word recognition.

6.5 Concluding remarks

The studies presented in this thesis investigated the role of a long-term language dominance switch on bilingual speech processing. The results suggest that the acquisition of new phonetic contrasts in production and perception late in life is effortful. Even with early exposure, extensive L2 use and high motivation, modifications to underlying categories seem difficult at a late stage in development. These findings argue for a central role of early exposure in the formation of perceptual categories. Additionally, this work has shed light on how bilinguals use phonetic features to signal social meaning, and provided evidence for the emergence of a hybrid variety in a 'new speaker' context. These results indicated that dominant bilinguals do not have two phonetic repertoires at their disposal, but in fact, perceptual learning constraints limit what phonetic resources are available for sociolinguistic work.

From a theoretical point of view, these findings contribute to models of L2 speech learning and bilingual speech processing. Moreover, this research has implications for combating language prejudice and prescriptive ideologies. *Neofalantes* are often stigmatised for speaking a Spanish-accented variety of Galician, and sometimes encouraged to change their accent. This research shows that there are constraints on what aspects of an accent can be changed late in life, which is not necessarily a disadvantage, but likely a mechanism for

optimal processing of the first language acquired and used.

References

Acha, J., & Perea, M. (2010). On the role of consonants and vowels in visual-word processing: Evidence with a letter search paradigm. *Language and Cognitive Processes*, *25*(3), 423–438. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01690960903411666 doi: 10.1080/01690960903411666

Acuña Ferreira, A. V. (2017). Code-switching and emotions display in Spanish/Galician bilingual conversation. *Text and Talk*, *37*(1), 47–69. Retrieved from https://www.degruyter.com/view/j/text.2017.37.issue-1/text-2016-0036/text-2016-0036.xml doi: 10.1515/text-2016-0036

Adank, P., Smits, R., & van Hout, R. (2004). A comparison of vowel normalization procedures for language variation research. *The Journal of the Acoustical Society of America*, *116*(5), 3099. Retrieved from http://scitation.aip.org/content/asa/journal/jasa/116/5/10.1121/1.1795335 doi: 10.1121/1.1795335

Agha, A. (2003). The social life of cultural value. *Language and Communication*, *23*, 231–273. Retrieved from http://www.sciencedirect.com/science/article/pii/S0271530903000120 doi: 10.1016/S0271-5309(03)00012-0

Allen, J. S., & Miller, J. L. (2004). Listener sensitivity to individual talker differences in voice-onset-time. *The Journal of the Acoustical Society of America*, *115*(6), 3171–3183. Retrieved from http://asa.scitation

.org/doi/10.1121/1.1701898 doi: 10.1121/1.1701898

Allopenna, P. D., Magnuson, J. S., & Tanenhaus, M. K. (1998). Tracking the Time Course of Spoken Word Recognition Using Eye Movements: Evidence for Continuous Mapping Models. *Journal of Memory and Language*, *38*(4), 419–439. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749596X97925584 doi: 10.1006/jmla.1997.2558

Álvarez Cáccamo, C. (1983). Cara unha caracterización da diglosia galega. *Grial*, *79*, 23–42.

Álvarez Cáccamo, C. (1989). Variaçom lingüística e o factor social na Galiza. *Hispanic Linguistics*, *2.2*, 253–98.

Amengual, M. (2014). The perception and production of language-specific mid-vowel contrasts: Shifting the focus to the bilingual individual in early language input conditions. *International Journal of Bilingualism*, 1–20. Retrieved from http://ijb.sagepub.com/cgi/doi/10.1177/1367006914544988 doi: 10.1177/1367006914544988

Amengual, M. (2015). The acoustic realization of the /a/-/ÉŹ/ alternation in Majorcan Catalan. *Proceedings of the International Congress of Phonetic Sciences*. Retrieved from https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0260.pdf

Amengual, M. (2016). Cross-Linguistic Influence in the Bilingual Mental Lexicon: Evidence of Cognate Effects in the Phonetic Production and Processing of a Vowel Contrast. *Frontiers in Psychology*, *7*, 1–17. Retrieved from http://journal.frontiersin.org/article/10.3389/fpsyg.2016.00617 doi: 10.3389/fpsyg.2016.00617

Amengual, M., & Chamorro, P. (2015). The Effects of Language Dominance in the Perception and Production of the Galician Mid Vowel Contrasts. *Phonetica*, *72*, 207–236. Retrieved from http://www.karger.com/?doi=10.1159/000439406 doi: 10.1159/000439406

Atagi, E., & Bent, T. (2016). Auditory free classification of native and nonnative speech by nonnative listeners. *Applied Psycholinguistics*, *37*(2), 241–263. Retrieved from https://www.cambridge.org/core/journals/applied-psycholinguistics/article/auditory-free-classification-of-native-and-nonnative-speech-by-nonnative-listeners/ACB155AD525D9890E7029297233C8E79 doi: 10.1017/S014271641400054X

Barr, D. J. (2007). *Walkthrough of an "empirical logit" analysis in R.* Retrieved 2017-06-01, from http://talklab.psy.gla.ac.uk/tvw/elogit-wt.html

Barr, D. J. (2008). Analyzing 'visual world' eyetracking data using multilevel logistic regression. *Journal of Memory and Language*, *59*(4), 457–474. Retrieved from http://dx.doi.org/10.1016/j.jml.2007.09.002 doi: 10.1016/j.jml.2007.09.002

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*(3), 255–278. Retrieved from http://dx.doi.org/10.1016/j.jml.2012.11.001 doi: 10.1016/j.jml.2012.11.001

Baugh, J. (2000). Racial Identification by Speech. *American Speech*, *75*(4), 362–364. Retrieved from https://muse.jhu.edu/article/2763/pdf doi: 10.1215/00031283-75-4-362

Best, C. T. (1994). The emergence of native-language phonological influences in infants: A perceptual assimilation model. *The development of speech perception: The transition from speech sounds to spoken words*, *167*(224), 233–277.

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 171–206). Timonium, MD: York Press.

Best, C. T., Shaw, J. A., & Clancy, E. (2013). Recognizing words across re-

gional accents : The role of perceptual assimilation in lexical competition. *Proceedings of the Annual Conference of the International Speech Communication Association*, 2128–2132.

Best, C. T., Shaw, J. A., Evans, B. G., Hay, J., Docherty, G., & Foulkes, P. (2012). *You came TO DIE?! Perceptual adaptation to regional accents as a new lens on the puzzle of spoken word recognition. Project ID: DP120104596.* Grant awarded by the Australian Research Council (ARC).

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In M. J. Munro & O.-S. Bohn (Eds.), *Second language speech learning: The role of language experience in speech perception and production* (pp. 13–34). Amsterdam: John Benjamins. doi: 10.1121/1.1332378

Beswick, J. (2002). Galician Language Planning and Implications for Regional Identity: Restoration or Elimination? *National Identities*, *4*(3), 257–271. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/1460894022000026123 doi: 10.1080/1460894022000026123

Birdsong, D., Gertken, L., & Amengual, M. (2012). *Bilingual Language Profile: An Easy-to-Use Instrument to Assess Bilingualism.* COERLL, University of Texas at Austin. Retrieved from https://sites.la.utexas.edu/bilingual/

Blumenfeld, H. K., & Marian, V. (2007). Constraints on parallel activation in bilingual spoken language processing: Examining proficiency and lexical status using eye-tracking. *Language and Cognitive Processes*, *22*(5), 633–660. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01690960601000746 doi: 10.1080/01690960601000746

Blumenfeld, H. K., & Marian, V. (2013). Parallel language activation and cognitive control during spoken word recognition in bilinguals. *Journal of Cognitive Psychology*, *25*(5), 547–567.

Retrieved from http://www.tandfonline.com/doi/abs/10.1080/20445911.2013.812093 doi: 10.1080/20445911.2013.812093

Boersma, P., & Weenink, D. (2016). *Praat: doing phonetics by computer*. [Computer program]. Retrieved from http://www.praat.org/

Bonatti, L. L., Peña, M., Nespor, M., & Mehler, J. (2005). Linguistic Constraints on Statistical Computations. The role of consonants and Vowels in Continuous Speech Processing. *Psychological Science*, *16*(6), 451–459. Retrieved from http://www.jstor.org/stable/40064248?seq=1{#}page{_}scan{_}tab{_}contents doi: 10.1111/j.0956-7976.2005.01556.x

Bongaerts, T., Planken, B., & Schils, E. (1995). Can late starters attain a native accent in a foreign language? A test of the critical period hypothesis. In D. Singleton & Z. Lengyel (Eds.), *The age factor in second language acquisition* (pp. 30–50). Clevedon, UK: Multilingual Matters.

Bongaerts, T., van Summeren, C., Planken, B., & Schils, E. (1997). Age and Ultimate Attainment in the Pronunciation of a Foreign Language. *Studies in Second Language Acquisition*, *19*(4), 447–465. doi: 10.1017/S0272263197004026

Bosch, L., Costa, A., & Sebastián-Gallés, N. (2000). First and second language vowel perception in early bilinguals. *European Journal of Cognitive Psychology*, *12*(2), 189–221. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/09541446.2000.10590222 doi: 10.1080/09541446.2000.10590222

Bosch, L., & Sebastián-Gallés, N. (1997). Native-language recognition abilities in 4-month-old infants from monolingual and bilingual environments. *Cognition*, *65*(1), 33–69. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/9455170 doi: 10.1016/S0010-0277(97)00040-1

Bradlow, A. R., Akahane-Yamada, R., Pisoni, D. B., & Tohkura, Y. (1999). Training Japanese listeners to identify English /r/ and /l/: long-term re-

tention of learning in perception and production. *Perception & Psychophysics*, *61*(5), 977–985. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3472521/ doi: 10.3758/BF03206911

Bradlow, A. R., Pisoni, D. B., Akahane-Yamada, R., & Tohkura, Y. (1997). Training Japanese listeners to identify English/r/and/l: IV. Some effects of perceptual learning on speech production. *The Journal of the Acoustical Society of America*, *101*(4), 2299–2310. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3507383/ doi: 10.1121/1.418276

Broersma, M. (2002). Comprehension of non-native speech: inaccurate phoneme processing and activation of lexical competitors. *Interspeech*, 261–264.

Brouwer, S. (2010). *Processing strongly reduced forms in casual speech* (Doctoral dissertation, Radboud Universiteit Nijmegen). Retrieved from http://pubman.mpdl.mpg.de/pubman/item/escidoc:576607:6/component/escidoc:1480745/Brouwer(2010){_}THESIS{_}authorVersion.pdf

Brouwer, S., & Bradlow, A. R. (2011). The influence of noise on phonological competition during spoken word recognition. *Proceedings of the International Congress of Phonetic Sciences*, 364–367. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4176825/

Brouwer, S., & Bradlow, A. R. (2015). The Temporal Dynamics of Spoken Word Recognition in Adverse Listening Conditions. *Journal of Psycholinguistic Research*, *45*(5), 1151–1160. Retrieved from https://www.semanticscholar.org/paper/The-Temporal-Dynamics-of-Spoken-Word-Recognition-i-Brouwer-Bradlow/b1b350ec755d0afec56840718b1461580efdd4f5 doi: 10.1007/s10936-015-9396-9

Brouwer, S., Mitterer, H., & Huettig, F. (2012). Speech reductions change the dynamics of competition during spoken word

recognition. *Language and Cognitive Processes*, *27*(4), 539–571. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01690965.2011.555268 doi: 10.1080/01690965.2011.555268

Butler, J., Floccia, C., Goslin, J., & Panneton, R. (2011). Infants' Discrimination of Familiar and Unfamiliar Accents in Speech. *Infancy*, *16*(4), 392–417. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1532-7078.2010.00050.x/full doi: 10.1111/j.1532-7078.2010.00050.x

Canseco-Gonzalez, E., Brehm, L., Brick, C. A., Brown-Schmidt, S., Fischer, K., & Wagner, K. (2010). Carpet or Cárcel: The effect of age of acquisition and language mode on bilingual lexical access. *Language and Cognitive Processes*, *25*(5), 669–705. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01690960903474912 doi: 10.1080/01690960903474912

Carreiras, M., Duñabeitia, J. A., & Molinaro, N. (2009). Consonants and vowels contribute differently to visual word recognition: ERPs of relative position priming. *Cerebral Cortex*, *19*(11), 2659–2670. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/19273459 doi: 10.1093/cercor/bhp019

Carreiras, M., & Price, C. J. (2008). Brain activation for consonants and vowels. *Cerebral Cortex*, *18*(7), 1727–1735. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18234690 doi: 10.1093/cercor/bhm202

Chambers, C. G., & Cooke, H. (2009). Lexical competition during second-language listening: Sentence context, but not proficiency, constrains interference from the native lexicon. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35*(4), 1029–1040. Retrieved from http://doi.apa.org/getdoi.cfm?doi=10.1037/a0015901 doi: 10.1037/a0015901

Chládková, K., Escudero, P., & Boersma, P. (2011, jul). Context-specific

acoustic differences between Peruvian and Iberian Spanish vowels. *The Journal of the Acoustical Society of America*, *130*(1), 416–428. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/21786909 doi: 10.1121/1.3592242

Cleland, A. A., Gaskell, M. G., Quinlan, P. T., & Tamminen, J. (2006). Frequency effects in spoken and visual word recognition: evidence from dual-task methodologies. *Journal of Experimental Psychology: Human Perception and Performance*, *32*(1), 104–119. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16478330 doi: 10.1037/0096-1523.32.1.104

Clopper, C. G. (2008). Auditory free classification: Methods and analysis. *Behavior Research Methods*, *40*(2), 575–581. Retrieved from http://www.springerlink.com/index/10.3758/BRM.40.2.575 doi: 10.3758/BRM.40.2.575

Clopper, C. G., & Pisoni, D. B. (2004a). Homebodies and army brats: Some effects of early linguistic experience and residential history on dialect categorization. *Language Variation and Change*, *16*(1), 31–48. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21533011 doi: 10.1016/j.biotechadv.2011.08.021.Secreted

Clopper, C. G., & Pisoni, D. B. (2004b). Some acoustic cues for the perceptual categorization of American English regional dialects. *Journal of Phonetics*, *32*(1), 111–140. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0095447003000093 doi: 10.1016/S0095-4470(03)00009-3

Clopper, C. G., & Pisoni, D. B. (2006). Effects of region of origin and geographic mobility on perceptual dialect categorization. *Language Variation and Change*, *18*(2), 193–221. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21423820 doi: 10.1017/S0954394506060091

Clopper, C. G., & Pisoni, D. B. (2007). Free classification of re-

gional dialects of American English. *Journal of Phonetics*, *35*(3), 421–438. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3059784/ doi: 10.1016/j.wocn.2009.07.004

Cole, R. A., Yan, Y., Mak, B., Fanty, M., & Bailey, T. (1996). The contribution of consonants versus vowels to word recognition in fluent speech. *Proc. ICASSP*, *2*(4), 853–856. doi: 10.1109/ICASSP.1996.543255

Cooper, R. M. (1974). The control of eye fixation by the meaning of spoken Language. *Cognitive Psychology*, *107*(1), 84–107. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0959378000000534 doi: 10.1016/0010-0285(74)90005-X

Corpus de Referencia do Galego Actual (CORGA) [1.7]. (2017). Retrieved 2017-07-14, from http://corpus.cirp.es/corga

Costa, J. (2015). New speakers, new language: on being a legitimate speaker of a minority language in Provence. *International Journal of the Sociology of Language*, *231*, 127–145. Retrieved from https://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0035/ijsl-2014-0035.xml doi: 10.1515/ijsl-2014-0035

Cutler, A., Mehler, J., Norris, D., & Seguí, J. (1989). Limits on bilingualism. *Nature*, *340*, 229–230. Retrieved from https://www.nature.com/articles/340229a0

Cutler, A., Mehler, J., Norris, D., & Seguí, J. (1992). The monolingual nature of speech segmentation by bilinguals. *Cognitive Psychology*(24), 381–410. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/1516360 doi: 10.1016/0010-0285(92)90012-Q

Cutler, A., Sebastián-Gallés, N., Soler-Vilageliu, O., & Van Ooijen, B. (2000). Constraints of vowels and consonants on lexical selection: Cross-linguistic comparison. *Memory and Cognition*, *28*(5), 746–755. Retrieved from https://link.springer.com/article/10.3758/BF03198409

Cutler, A., Weber, A., & Otake, T. (2006). Asymmetric mapping from phonetic to lexical representations in second-language listening. *Journal of Phonetics*, *34*(2), 269–284. Retrieved from http://pubman.mpdl.mpg.de/pubman/item/escidoc:58802/component/escidoc:58803/Cutler{_}2006{_}Asymmetric.pdf doi: 10.1016/j.wocn.2005.06.002

Dahan, D., Magnuson, J. S., & Tanenhaus, M. K. (2001). Time Course of Frequency Effects in Spoken-Word Recognition: Evidence from Eye Movements. *Cognitive Psychology*, *42*(4), 317–367. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0010028501907509 doi: 10.1006/cogp.2001.0750

Dahan, D., Swingley, D., Tanenhaus, M. K., & Magnuson, J. S. (2000). Linguistic Gender and Spoken-Word Recognition in French. *Journal of Memory and Language*, *42*(4), 465–480. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749596X99926888 doi: 10.1006/jmla.1999.2688

Derwing, T. M., & Munro, M. J. (1997). Accent, intelligibility, and comprehensibility: Evidence from four L1s. *Studies in Second Language Acquisition*, *19*(1), 1–16. Retrieved from https://www.cambridge.org/core/journals/studies-in-second-language-acquisition/article/div-classtitleaccent-intelligibility-and-comprehensibilitydiv/729C15F62F9EC9A51A33EAB5C2D05ED0 doi: 10.1017/S0272263197001010

Dijkstra, T., & van Heuven, W. J. (1998). The BIA Model and Bilingual Word Recognition. In J. Grainger & A. Jacobs (Eds.), *Localist Connectionist Approaches to Human Cognition* (pp. 189–225). Hillsdale, NJ: Lawrence Erlbaum Associates.

Dink, J., & Ferguson, B. (2016). *eyetrackingR*. Retrieved from http://www.eyetracking-r.com

Drummond, R. (2012a). Aspects of identity in a second lan-

guage: ING variation in the speech of Polish migrants living in Manchester, UK. *Language Variation and Change*, *24*, 107–133. Retrieved from https://www.cambridge.org/core/services/aop-cambridge-core/content/view/S0954394512000026 doi: 10.1017/S0954394512000026

Drummond, R. (2012b). The Manchester Polish STRUT: Dialect Acquisition in a Second Language. *Journal of English Linguistics*, *XX*(X), 1–29. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/0075424212449172 doi: 10.1177/0075424212449172

Dubert García, F. (2002). Os sociolectos galegos. *Cadernos de Lingua*, *24*, 5–27. Retrieved from http://webspersoais.usc.es/export9/sites/persoais/persoais/francisco.dubert/arquivos/sociolectos.pdf

Dupoux, E., Peperkamp, S., & Sebastián-Gallés, N. (2010). Limits on bilingualism revisited: Stress 'deafness' in simultaneous French-Spanish bilinguals. *Cognition*, *114*(2), 266–275. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/19896647 doi: 10.1016/j.cognition.2009.10.001

Eckert, P. (2000). *Linguistic variation as social practice*. Oxford: Blackwell.

Eckert, P. (2008). Variation and the indexical field. *Journal of Sociolinguistics*, *12*(4), 453–476. Retrieved from http://doi.wiley.com/10.1111/j.1467-9841.2008.00374.x doi: 10.1111/j.1467-9841.2008.00374.x

Eisner, F., & McQueen, J. M. (2005). The specificity of perceptual learning in speech processing. *Perception & Psychophysics*, *67*(2), 224–238. Retrieved from http://www.icn.ucl.ac.uk/feisner/dload/eisner{_}mcqueen{_}pap.pdf doi: 10.3758/BF03206487

Elman, J. L., & McClelland, J. L. (1988). Cognitive penetration of the mechanisms of perception: Compensation for coarticulation of lexically restored phonemes. *Journal of Memory and Language*, *27*(2), 143–165. Retrieved from http://www.sciencedirect.com/science/

article/pii/0749596X8890071X doi: 10.1016/0749-596X(88)90071-X

Evans, B. G., & Iverson, P. (2004). Vowel normalization for accent: An investigation of best exemplar locations in northern and southern British English sentences. *The Journal of the Acoustical Society of America*, *115*(1), 352. Retrieved from http://scitation.aip.org/content/asa/journal/jasa/115/1/10.1121/1.1635413 doi: 10.1121/1.1635413

Evans, B. G., & Iverson, P. (2007). Plasticity in vowel perception and production: a study of accent change in young adults. *The Journal of the Acoustical Society of America*, *121*(6), 3814–3826. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17552729 doi: 10.1121/1.2722209

Ferguson, C. (1959). Diglossia. *Word*, *15*, 325–340. Retrieved from http://www.mapageweb.umontreal.ca/tuitekj/cours/2611pdf/Ferguson-Diglossia.pdf

Fernández, M. (1991). Coordenadas sociais e dinámica do bilingüismo galego. *Grial*, *110*, 239–262.

Fernández Rei, E. (2004). O ensino da fonética galega a castelanfalantes: problemas e métodos. In R. Álvarez, F. Fernández Rei, & A. Santamarina (Eds.), *A lingua galega: historia e actualidade* (Vol. 2, pp. 443–453). Santiago de Compostela: Consello da Cultura Galega / Instituto da Lingua Galega. Retrieved from https://minerva.usc.es/xmlui/handle/10347/9916

Fernández Rei, E. (2005). O estándar prosódico. In R. Álvarez & H. Monteagudo (Eds.), *Norma lingüística e variación* (pp. 97–125). Santiago de Compostela: Consello da Cultura Galega / Instituto da Lingua Galega.

Fernández Rei, E. (2016). Dialectal, historical and sociolinguistic aspects of Galician intonation. *Dialectologia*, *VI*(Special Issue), 147–169. Retrieved from http://www.raco.cat/index.php/Dialectologia/article/view/316139

Fernández Rei, E., de Castro Moutinho, L., & Coimbra, R. L. (2014). As entoacións galega e portuguesa: a fronteira á luz da dialectometría e da percepción. In X. Sousa, M. Negro Romero, & R. Álvarez (Eds.), *Lingua e identidade na fronteira galego-portuguesa* (pp. 115–141). Santiago de Compostela: Consello da Cultura Galega.

Fernández Rei, F. (1990). *Dialectoloxía da lingua galega*. Vigo: Edicións Xerais.

Fishman, J. A. (1967). Bilingualism with and without diglossia; diglossia with and without bilingualism. *Journal of Social Issues*, *23*(2), 29–38. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1540-4560.1967.tb00573.x/abstract doi: 10.1111/j.1540-4560.1967.tb00573.x

Flege, J. E. (1992). Speech learning in a second language. In C. A. Ferguson, L. Menn, & C. Stoel-Gammon (Eds.), *Phonological development: Models, reserch, implications* (pp. 565–604). Maryland: Timonium. Retrieved from http://www.jimflege.com/files/Flege_in_Ferguson_1992.pdf

Flege, J. E. (1995). Second Language Speech Learning: Theory, Findings, and Problems. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 233–277). Timonium, MD: York Press. Retrieved from http://jimflege.com/files/Flege_in_Strange_1995.pdf doi: 10.1111/j.1600-0404.1995.tb01710.x

Flege, J. E., & MacKay, I. R. A. (2004). Perceiving Vowels in a Second Language. *Studies in Second Language Acquisition*, *26*(1), 1–34. Retrieved from http://jimflege.com/files/Flege_MacKay_perceiving_vowels_SSLA_2004.pdf doi: 10.1017/S0272263104261010

Flege, J. E., MacKay, I. R. A., & Meador, D. (1999). Native Italian speakers' perception and production of English vowels. *The Journal of the Acous-*

tical Society of America, *106*(5), 2973–2987. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/10573909 doi: 10.1121/1.428116

Fleming, D., Giordano, B. L., Caldara, R., & Belin, P. (2014). A language-familiarity effect for speaker discrimination without comprehension. *Proceedings of the National Academy of Sciences*, *111*(38), 13795–13798. Retrieved from http://www.pnas.org/cgi/doi/10.1073/pnas.1401383111 doi: 10.1073/pnas.1401383111

Floccia, C., Butler, J., Girard, F., & Goslin, J. (2009). Categorization of regional and foreign accent in 5- to 7-year-old British children. *International Journal of Behavioral Development*, *33*(4), 366–375. Retrieved from http://journals.sagepub.com/doi/10.1177/0165025409103871 doi: 10.1177/0165025409103871

Foulkes, P., & Docherty, G. J. (2006). The social life of phonetics and phonology. *Journal of Phonetics*, *34*(4), 409–438. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0095447005000525 doi: 10.1016/j.wocn.2005.08.002

Fox, J., & Weisberg, S. (2011). *An {R} Companion to Applied Regression* (Second ed.). Thousand Oaks, CA: Sage. Retrieved from http://socserv.socsci.mcmaster.ca/jfox/Books/Companion

Freixeiro Mato, X. R. (1997). *Lingua galega: normalidade e conflito*. Santiago de Compostela: Laiovento.

Freixeiro Mato, X. R. (2006). *Lingua, Nación e Identidade*. Santiago de Compostela: Edicións Laiovento.

Freixeiro Mato, X. R. (2009). *Lingua de calidade. Vinte reflexións e unha proposta esperanzada para un galego con futuro*. Vigo: Edicións Xerais de Galicia.

Freixeiro Mato, X. R. (2014). Lingua oral, calidade da lingua e futuro do galego. In X. M. Sánchez Rei (Ed.), *Modelos de lingua e compromiso* (pp. 13–76). A Coruña: Baía Edicións.

García-Mateo, C., Cardenal, A., Regueira, X. L., Fernández Rei, E., Martínez,

M., Seara, R., … Basanta Llanes, N. (2014). CORILGA: a Galician Multilevel Annotated Speech Corpus for Linguistic Analysis. *9th Language Resources and Evaluation Conference (LREC)*, 2653–2657. Retrieved from https://pdfs.semanticscholar.org/54a8/0de1f18768d55aab573235d879cd462813d8.pdf?{_}ga=2.2851632.1069562484.1498474753-18093708.1498474753

Giles, H. (1970). Evaluative reactions to accents. *Educational Review*. Retrieved from http://www.tandfonline.com/doi/pdf/10.1080/0013191700220301 doi: 10.1080/0013191700220301

Giles, H. (1971a). Ethnocentrism and the Evaluation of Accented Speech. *British Journal of Social and Clinical Psychology*, *10*, 187–188. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.2044-8260.1971.tb00733.x/full doi: 10.1111/j.2044-8260.1971.tb00733.x

Giles, H. (1971b). Patterns of Evaluation to R.P., South Welsh and Somerset Accented Speech. *British Journal of Social and Clinical Psychology*, *10*, 280–281. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.2044-8260.1971.tb00748.x/abstract doi: 10.1007/BF01553368

Giles, H., & Powesland, P. F. (1975). *Speech style and social evaluation*. London and New York: Academic Press.

Girard, F., Floccia, C., & Goslin, J. (2008). Perception and awareness of accents in young children. *British Journal of Developmental Psychology*, *26*(3), 409–433. Retrieved from http://doi.wiley.com/10.1348/026151007X251712 doi: 10.1348/026151007X251712

Goggin, J. P., Thompson, C. P., Strube, G., & Simental, L. R. (1991). The role of language familiarity in voice identification. *Memory & Cognition*, *19*(5), 448–458. Retrieved from https://link.springer.com/article/10.3758/BF03199567 doi: 10.3758/BF03199567

Goldinger, S. D. (1998). Echoes of echoes? An episodic theory

of lexical access. *Psychological Review*, *105*(2), 251–279. Retrieved from http://doi.apa.org/getdoi.cfm?doi=10.1037/0033-295X.105.2.251 doi: 10.1037/0033-295X.105.2.251

González González, M. (2008). O novo galego urbano. In M. Brea, F. Fernández Rei, & X. L. Regueira (Eds.), *Cada palabra pesaba, cada palabra medía. homenaxe a Antón Santamarina.* (pp. 363–374). Santiago de Compostela: Universidade de Santiago de Compostela.

González González, M., & Regueira Fernández, X. L. (1994). Estudio acústico das vocais tónicas galegas en posición fonética normal. *Actas do Congreso Internacional de Lingüística e Filoloxía Románica*, 141–179.

González González, M., Rodríguez Neira, M., Dosil Maceira, A., Pérez Vilariño, J., Real Deus, E., Casares Berg, H., … Suárez Fernández, I. (2003). *O galego segundo a mocidade*. A Coruña: Real Academia Galega, Seminario de sociolingüística. Retrieved from http://academia.gal/documents/10157/704901/O+Galego+segundo+a+mocidade.pdf

González González, M., Rodríguez Neira, M., Fernández Salgado, A., Loredo Gutiérrez, X., & Suárez Fernández, M. I. (2007). *Mapa sociolingüístico de Galicia 2004. Vol. I: Lingua inicial e competencia lingüística en Galicia*. A Coruña: Real Academia Galega, Seminario de sociolingüística. Retrieved from http://academia.gal/documents/10157/704901/Mapa+Sociolinguistico+vol{_}1.pdf doi: 10.1017/CBO9781107415324.004

González González, M., Rodríguez Neira, M., Fernández Salgado, A., Loredo Gutiérrez, X., & Suárez Fernández, M. I. (2009). *Mapa sociolingüístico de Galicia 2004. Vol. II: Usos lingüísticos en Galicia*. A Coruña: Real Academia Galega, Seminario de sociolingüística. Retrieved from http://academia.gal/documents/10157/704901/Mapa+Sociolinguistico+vol{_}2.pdf

González González, M., Rodríguez Neira, M., Pereiro Rozas, A. X., Loredo

Gutiérrez, X., Suárez Fernández, M. I., & Salgueiro Veiga, E. (2011). *Mapa sociolingüístico de Galicia 2004. Vol. III: Actitudes lingüísticas en Galicia*. A Coruña: Real Academia Galega, Seminario de sociolingüística. Retrieved from http://academia.gal/documents/10157/704901/Mapa+Sociolinguistico+vol{_}3.pdf

Harris, R. (2006). *New ethnicities and language use*. Basingstoke: Palgrave Macmillan.

Hattori, K., & Iverson, P. (2009). English /r/-/l/ category assimilation by Japanese adults: individual differences and the link to identification accuracy. *The Journal of the Acoustical Society of America*, *125*(1), 469–479. Retrieved from http://asa.scitation.org/doi/abs/10.1121/1.3021295 doi: 10.1121/1.3021295

Hazan, V., & Boulakia, G. (1993). Perception and Production of a Voicing Contrast by French-English Bilinguals. *Language and Speech*, *36*(1), 17–38. Retrieved from http://journals.sagepub.com/doi/pdf/10.1177/002383099303600102 doi: 10.1177/002383099303600102

Hermida Gulías, C. (2008). A cantidade e a calidade do galego nos medios. In X. R. Freixeiro Mato (Ed.), *Lingua e Comunicación. IV Xornadas sobre Lingua e Usos* (pp. 57–73). A Coruña: Universidade.

Hornsby, M. (2005). Néo-breton and questions of authenticity. *Estudios de Sociolinguistica*, *6*(2), 191–218. Retrieved from http://www.equinoxjournals.com/ojs/index.php/SS/article/view/3404 doi: 10.1558/sols.v6i2.191

Hornsby, M. (2009). *Globalisation processes and minority languages: Linguistic hybridity in Brittany* (Unpublished doctoral dissertation). University of Southampton.

Hornsby, M. (2015). The "new" and "traditional" speaker dichotomy: bridging the gap. *International Journal of the Sociology of Language*(231), 107–125. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0034/ijsl-2014-0034.xml

doi: 10.1515/ijsl-2014-0034

Huettig, F., & McQueen, J. M. (2007). The tug of war between phonological, semantic and shape information in language-mediated visual search. *Journal of Memory and Language*, *57*(4), 460–482. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749596X07000198 doi: 10.1016/j.jml.2007.02.001

Huettig, F., Rommers, J., & Meyer, A. S. (2011). Using the visual world paradigm to study language processing: A review and critical evaluation. *Acta Psychologica*, *137*(2), 151–171. Retrieved from http://dx.doi.org/10.1016/j.actpsy.2010.11.003 doi: 10.1016/j.actpsy.2010.11.003

Instituto Galego de Estatística. (2008). *Enquisa estrutural a fogares. Coñecemento e uso do galego 2008.* Retrieved from https://www.ige.eu/web/mostrar{_}actividade{_}estatistica.jsp?idioma=gl{&}codigo=0206004{&}num{_}pag=21

Instituto Galego de Estatística. (2013). *Enquisa estrutural a fogares. Coñecemento e uso do galego 2013.* Retrieved from https://www.ige.eu/web/mostrar{_}actividade{_}estatistica.jsp?codigo=0206004

Iverson, P., & Evans, B. G. (2009). Learning English vowels with different first-language vowel systems II: Auditory training for native Spanish and German speakers. *The Journal of the Acoustical Society of America*, *126*(2), 866–877. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/19640051 doi: 10.1121/1.3148196

Iverson, P., Kuhl, P. K., Akahane-Yamada, R., & Diesch, E. (2003). A perceptual interference account of acquisition difficulties for non-native phonemes. *Cognition*, *87*, 47–57. Retrieved from http://www.sciencedirect.com/science/article/pii/S0010027702001981 doi: https://doi.org/10.1016/s0010-0277(02)00198-1

Jaffe, A. (2015). Defining the new speaker: theoretical perspectives and

learner trajectories. *International Journal of the Sociology of Language*, *231*(231), 21–44. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0030/ijsl-2014-0030.xml doi: 10.1515/ijsl-2014-0030

Johnson, E. K., Westrek, E., Nazzi, T., & Cutler, A. (2011). Infant ability to tell voices apart rests on language experience. *Developmental Science*, *14*(5), 1002–1011. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21884316 doi: 10.1111/j.1467-7687.2011.01052.x

Johnstone, B., Andrus, J., & Danielson, A. E. (2006). Mobility, Indexicality, and the Enregisterment of "Pittsburghese". *Journal of English Linguistics*, *34*(2), 77–104. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21884316 doi: 10.1177/0075424206290692

Johnstone, B., & Kiesling, S. F. (2008). Indexicality and experience: Exploring the meanings of /aw/-monophthongization in Pittsburgh. *Journal of Sociolinguistics*, *12*(1), 5–33. Retrieved from http://repository.cmu.edu/cgi/viewcontent.cgi?article=1012{&}context=english doi: 10.1111/j.1467-9841.2008.00351.x

Jones, Z., Yan, Q., Wagner, L., & Clopper, C. G. (2017). The development of dialect classification across the lifespan. *Journal of Phonetics*, *60*, 20–37. Retrieved from http://www.sciencedirect.com/science/article/pii/S0095447016301127 doi: 10.1016/j.wocn.2016.11.001

Jongman, A., Wayland, R., & Wong, S. (2000). Acoustic characteristics of English fricatives. *The Journal of the Acoustical Society of America*, *108*(3), 1252–1263. Retrieved from http://asa.scitation.org/doi/abs/10.1121/1.1288413 doi: 10.1121/1.1288413

Ju, M., & Luce, P. A. (2004). Falling on sensitive ears: Constraints on bilingual lexical activation. *Psychological Science*, *15*(5), 314–318. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/15102140

doi: 10.1111/j.0956-7976.2004.00675.x

Kabatek, J. (1991). Interferencias entre galego e castelán: problemas do galego estándar. *Cadernos de Lingua*, *4*, 39–48. Retrieved from http://www.zora.uzh.ch/id/eprint/84713/ doi: https://doi.org/10.5167/uzh-84713

Kabatek, J. (2000). *Os falantes como lingüistas*. Vigo: Edicións Xerais de Galicia.

Kraljic, T., & Samuel, A. G. (2006). Generalization in perceptual learning for speech. *Psychonomic Bulletin & Review*, *13*(2), 262–268. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/16892992

Kuznetsova, A., Bruun Brockhoff, P., & Haubo Bojesen Christensen, R. (2016). *lmerTest: Tests in Linear Mixed Effects Models*. Retrieved from https://cran.r-project.org/package=lmerTest

Labov, W. (1972). *Sociolinguistic Patterns*. Philadelphia: University of Pennsylvania Press.

Labraña Barrero, S. (2009). Las consonantes fricativas de la lengua gallega. *Estudios de fonética experimental*, *XVIII*, 193–213. Retrieved from http://stel.ub.edu/labfon/sites/default/files/XVIII-16.pdf

Labraña Barrero, S. (2014). Parámetros acústicos dos sons fricativos da lingua galega. *Estudios de Fonética Experimental*, *XXIII*, 203–243. Retrieved from http://diposit.ub.edu/dspace/handle/2445/4084

Labraña Barrero, S., & Oosterzee, C. V. (2003). An Acoustic Approach to Galician Gheada. *Proceedings of the International Congress of Phonetic Sciences*, 945–948. Retrieved from https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2003/papers/p15{_}0945.pdf

Lagrou, E., Hartsuiker, R. J., & Duyck, W. (2011). Knowledge of a second language influences auditory word recognition in the native language. *Journal of Experimental Psychology: Learning, Memory, and*

Cognition, *37*(4), 952–965. Retrieved from http://doi.apa.org/getdoi.cfm?doi=10.1037/a0023217 doi: 10.1037/a0023217

Lambert, W. E. (1967). A Social Psychology of Bilingualism. *Journal of Social Issues*, *23*(2), 91–109. Retrieved from http://doi.wiley.com/10.1111/j.1540-4560.1967.tb00578.x doi: 10.1111/j.1540-4560.1967.tb00578.x

Lambert, W. E., Hodgson, R. C., Gardner, R. C., & Fillenbaum, S. (1960). Evaluational reactions to spoken languages. *The Journal of Abnormal and Social Psychology*, *60*(1), 44–51. doi: 10.1037/h0044430

Lee, H.-W. (2000). The Relative Contribution of Consonants and Vowels in Word Recognition in Reading. *Dissertation Abstracts International, B: Sciences and Engineering*, *60*(11), 189–205. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749596X00927256 doi: 10.1006/jmla.2000.2725

Lee, H.-W., Rayner, K., & Pollatsek, A. (2002). The processing of consonants and vowels in reading: evidence from the fast priming paradigm. *Psychonomic Bulletin & Review*, *9*(4), 766–772. Retrieved from https://link.springer.com/article/10.3758/BF03196333 doi: 10.3758/BF03196333

Lenth, R. V. (2016). Least-Squares Means: The {R} Package {lsmeans}. *Journal of Statistical Software*, *69*(1), 1–33. doi: 10.18637/jss.v069.i01

Levon, E., Maegaard, M., & Pharao, N. (2017). Introduction: Tracing the origin of /s/ variation. *Linguistics*, *55*(5), 979–992. Retrieved from https://www.degruyter.com/view/j/ling.2017.55.issue-5/ling-2017-0016/ling-2017-0016.xml doi: https://doi.org/10.1515/ling-2017-0016Abstract:

Ley Orgánica 1/1981, de 6 de abril, de Estatuto de Autonomía para Galicia. (1981). Boletín Oficial del Estado.

LimeSurvey Project Team / Carsten Schmitz. (2012). *LimeSurvey: An Open*

Source survey tool. Hamburg, Germany. Retrieved from http://www.limesurvey.org

Lively, S. E., Logan, J. S., & Pisoni, D. B. (1993). Training Japanese listeners to identify English /r/ and /l/. II: The role of phonetic environment and talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America*, *94*, 1242–1255. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/8408964

Logan, J. S., Lively, S. E., & Pisoni, D. B. (1991). Training Japanese listeners to identify English /r/ and /l/: A first report. *Journal of the Acoustical Society of America*, *89*(2), 874–886. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/2016438 doi: 10.1016/j.biotechadv.2011.08.021.Secreted

Loredo Gutiérrez, X., Fernández Salgado, A., Suárez Fernández, I., & Casares Berg, H. (2007). Language Use and Language Attitudes in Galicia. In D. Lasagabaster & Á. Huguet (Eds.), *Multilingualism in European Bilingual Contexts: Language Use and Attitudes* (pp. 40– 64). Clevedon: Cromwell Press.

Loureiro-Rodríguez, V. (2007). Are Galicians bound to diglossia? In K. Potowski & R. Cameron (Eds.), *Spanish in Contact: Policy, Social and Linguistic Inquiries* (pp. 119–132). Amsterdam/Philadelphia: John Benjamins Publishing.

Loureiro-Rodríguez, V. (2008). Conflicting values at a conflicting age: Linguistic ideologies in Galician adolescents. In M. Niño-Murcia & J. Rothman (Eds.), *Bilingualism and identity: Spanish at the crossroads with other languages* (pp. 63–86). Amsterdam / Philadelphia: John Benjamins Publishing.

Luce, P. A., & Pisoni, D. B. (1998). Recognizing Spoken Words: The Neighborhood Activation Model. *Ear and Hearing*, *19*(1), 1–36. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9504270{%}5Cnhttp://www.pubmedcentral.nih.gov/

articlerender.fcgi?artid=PMC3467695 doi: 10.1097/MPG.0b013e3181a15ae8.Screening

Macmillan, N. A., & Creelman, C. D. (2004). *Detection Theory: A User's Guide*. Mahwah, NJ: Lawrence Erlbaum Associates.

Magnuson, J. S., Dixon, J. A., Tanenhaus, M. K., & Aslin, R. N. (2007). The Dynamics of Lexical Competition During Spoken Word Recognition. *Cognitive Science*, *31*(1), 133–156. Retrieved from http://doi.wiley.com/10.1080/03640210709336987 doi: 10.1080/03640210709336987

Mariño Paz, R. (1998). *Historia da lingua galega*. Santiago de Compostela: Sotelo Blanco.

Marian, V., & Spivey, M. (2003). Competing activation in bilingual language processing: Within- and between-language competition. *Bilingualism: Language and Cognition*, *6*(2), 97–115. Retrieved from https://eric.ed.gov/?id=EJ677169 doi: 10.1017/S136672890300106897

Marslen-Wilson, W. (1987). Functional parallelism in spoken-word recognition. *Spoken Word Recognition*, *25*, 71–102. Retrieved from http://www.sciencedirect.com/science/article/pii/0010027787900059

Marslen-Wilson, W. (1995). Activation, Competition, and Frequency in Lexical Access. In G. T. M. Altmann (Ed.), *Cognitive Models of Speech Processing: Psycholinguistic and Computational Perspectives* (pp. 148–172). The MIT Press. Retrieved from http://books.google.com/books?id=2R7XTlebSF8C{&}printsec=frontcover{%}5Cnpapers://5860649b-6292-421d-b3aa-1b17a5231ec5/Paper/p8360

Marslen-Wilson, W., & Tyler, L. K. (1980). The temporal structure of spoken language understanding. *Cognition*, *8*(1), 1–71. Retrieved from http://www.sciencedirect.com/science/article/pii/0010027780900153 doi: 10.1016/0010-0277(80)90015-3

Marslen-Wilson, W., & Welsh, A. (1978). Processing interactions and lexical access during word recognition in continuous speech. *Cognitive Psychology*, *10*(1), 29–63. Retrieved from http://pubman.mpdl.mpg.de/pubman/item/escidoc:2359009/component/escidoc:2359008/Marslen{_}Wilson{_}1978{_}Processing.pdf doi: 10.1016/0010-0285(78)90018-X

Martínez-Celdrán, E., & Fernández Planas, A. M. (2007). *Manual de fonética española. Articulaciones y sonidos del español*. Barcelona: Ariel.

Martínez-Celdrán, E., & Regueira, X. L. (2008). Spirant approximants in Galician. *Journal of the International Phonetic Association*, *38*(1), 51–68. Retrieved from http://www.journals.cambridge.org/abstract{_}S0025100308003265 doi: 10.1017/S0025100308003265

Matin, E., Shao, K. C., & Boff, K. R. (1993). Saccadic overhead: information-processing time with and without saccades. *Perception & Psychophysics*, *53*(4), 372–380. Retrieved from https://link.springer.com/article/10.3758/BF03206780 doi: 10.3758/BF03206780

McClelland, J. L., & Elman, J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology*, *18*(1), 1–86. Retrieved from http://www.sciencedirect.com/science/article/pii/0010028586900150 doi: 10.1016/0010-0285(86)90015-0

McLeod, W., & O'Rourke, B. (2015). "New speakers" of Gaelic: perceptions of linguistic authenticity and appropriateness. *Applied Linguistics Review*, *6*(2), 151–172. Retrieved from http://www.degruyter.com/view/j/alr.2015.6.issue-2/applirev-2015-0008/applirev-2015-0008.xml doi: 10.1515/applirev-2015-0008

McQueen, J. M. (1991). The influence of the lexicon on phonetic categorization: stimulus quality in word-final ambiguity. *Journal of Experimental Psychology. Human Perception and Performance*, *17*(2), 433–443.

Retrieved from http://psycnet.apa.org/record/1991-26371-001 doi: 10.1037/0096-1523.17.2.433

McQueen, J. M., & Viebahn, M. C. (2007). Tracking recognition of spoken words by tracking looks to printed words. *The Quarterly Journal of Experimental Psychology*, *60*(5), 661–671. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/17470210601183890 doi: 10.1080/17470210601183890

Meyerhoff, M., & Schleef, E. (2012). Variation, contact and social indexicality in the acquisition of (ing) by teenage migrants. *Journal of Sociolinguistics*, *16*(3), 398–416. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9841.2012.00535.x/abstract doi: 10.1111/j.1467-9841.2012.00535.x

Mishra, R. K., Olivers, C. N. L., & Huettig, F. (2013). Spoken language and the decision to move the eyes: To what extent are language-mediated eye movements automatic? In *Progress in Brain Research* (1st ed., Vol. 202, pp. 135–149). Elsevier B.V. Retrieved from http://dx.doi.org/10.1016/B978-0-444-62604-2.00008-3 doi: 10.1016/B978-0-444-62604-2.00008-3

Mitterer, H. (2011). The mental lexicon is fully specified: Evidence from eye-tracking. *Journal of Experimental Psychology: Human Perception and Performance*, *37*(2), 496–513. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/21463085 doi: 10.1037/a0020989

Mitterer, H., & McQueen, J. M. (2009). Processing reduced word-forms in speech perception using probabilistic knowledge about speech production. *Journal of Experimental Psychology: Human Perception and Performance*, *35*(1), 244–263. Retrieved from http://doi.apa.org/getdoi.cfm?doi=10.1037/a0012730 doi: 10.1037/a0012730

Molinos Castro, R. (2002). As vocais átonas finais en galego: estudio acústico. *Cadernos de Lingua*, *24*, 55–91.

Monteagudo, H. (1999). *Historia social da lingua galega.* Vigo: Galaxia.

Monteagudo, H. (2005). Do uso á norma, da norma ao uso (variación sociolingüística e estandarización no idioma galego). In *Norma lingüística e variación* (pp. 377–436). Santiago de Compostela: Consello da Cultura Galega / Instituto da Lingua Galega.

Monteagudo, H., & Santamarina, A. (1993). Galician and Castilian in contact: historical, social and linguistic aspects. In R. Possner & J. N. Green (Eds.), *Trends in Romance linguistics and philology. vol. 5: Bilingualism and linguistic conflict in Romance* (pp. 117–173). Berlin / New York: Mouton de Gruyter.

Mora, J. C., Keidel, J. L., & Flege, J. E. (2011). Why are the Catalan contrasts between /e/-/E/ and /o/-/O/ so difficult for even early Spanish-Catalan bilinguals to perceive? In M. Wrembel, M. Kul, & K. Dziubalska-Kołaczyk (Eds.), *Achievements and perspectives in the acquisition of second language speech: New sounds 2010* (pp. 183–193). Bern, Switzerland: Peter Lang.

Mora, J. C., Keidel, J. L., & Flege, J. E. (2015a). Effects of L2 use on the production of L1 vowels in early Spanish-Catalan bilinguals. In *The Phonetics-Phonology Interface. Representations and methodologies* (pp. 78–79). John Benjamins Publishing.

Mora, J. C., Keidel, J. L., & Flege, J. E. (2015b). Effects of Spanish use on the production of Catalan vowels by early Spanish-Catalan bilinguals. In J. Romero & M. Riero (Eds.), *The phonetics-phonology interface. representations and methodologies* (pp. 33–53). Amsterdam: John Benjamins.

Moyer, A. (1999). Ultimate attainment in L2 phonology. *Studies in Second Language Acquisition*, *21*, 81–108. Retrieved from https://www.cambridge.org/core/journals/studies-in-second-language-acquisition/article/ultimate-attainment-in-l2-phonology/4842AE227628D30F82DD88C5AD31CCBA doi: 10.1017/S0272263199001035

Nance, C. (2015). 'New' Scottish Gaelic speakers in Glasgow: A phonetic study of language revitalisation. *Language in Society*, *44*, 553–579. Retrieved from http://www.journals.cambridge.org/abstract{_}S0047404515000408 doi: 10.1017/S0047404515000408

Nance, C., McLeod, W., O'Rourke, B., & Dunmore, S. (2016). Identity, Accent Aim, and Motivation in Second Language Users: New Scottish Gaelic Speakers' Use of Phonetic Variation. *Journal of Sociolinguistics*, *20*, 164–191. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/josl.12173/abstract doi: 10.1111/josl.12173

Nazzi, T., Jusczyk, P. W., & Johnson, E. K. (2000). Language Discrimination by English-Learning 5-Month-Olds: Effects of Rhythm and Familiarity. *Journal of Memory and Language*, *43*(1), 1–19. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749596X00926986 doi: 10.1006/jmla.2000.2698

New, B., & Nazzi, T. (2012). The time course of consonant and vowel processing during word recognition. *Language and Cognitive Processes*, *29*(2), 1–15. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01690965.2012.735678 doi: 10.1080/01690965.2012.735678

Norris, D. (1994). Shortlist: a Connectionist Model of Continuous Speech Recognition. *Cognition*, *52*(3), 189–234. Retrieved from http://www.sciencedirect.com/science/article/pii/0010027794900434 doi: 10.1016/0010-0277(94)90043-4

Norris, D., McQueen, J. M., & Cutler, A. (1995). Competition and segmentation in spoken-word recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*(5), 1209–1228. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8744962 doi: 10.1037//0278-7393.21.5.1209

Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. *Cognitive Psychology*, *47*, 204–238. Re-

trieved from http://www.sciencedirect.com/science/article/pii/S0010028503000069 doi: 10.1016/S0010-0285(03)00006-9

Norris, D., McQueen, J. M., Cutler, A., & Butterfield, S. (1997). The possible-word constraint in the segmentation of continuous speech. *Cognitive Psychology*, *34*(3), 191–243. Retrieved from http://www.nature.com/nature/journal/v340/n6230/abs/340229a0.html?foxtrotcallback=true doi: 10.1006/cogp.1997.0671

Nygaard, L., & Pisoni, D. B. (1998). Talker-specific learning in speech perception. *Perception and Psychophysics*, *60*(3), 355–376. Retrieved from https://link.springer.com/article/10.3758/BF03206860

Ó hIfearnáin, T. (2015). Sociolinguistic vitality of Manx after extreme language shift: Authenticity without traditional native speakers. *International Journal of the Sociology of Language*, *2015*(231), 45–62. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0031/ijsl-2014-0031.xml doi: 10.1515/ijsl-2014-0031

O'Rourke, B. (2003). Conflicting values in contemporary Galicia. *International Journal of Iberian Studies*, *16*(1), 33–48. doi: 10.1386/ijis.16.1.33/0

O'Rourke, B., Pujolar, J., & Ramallo, F. (2015). New speakers of minority languages: the challenging opportunity - Foreword. *International Journal of the Sociology of Language*, *231*, 1–20. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0029/ijsl-2014-0029.xml doi: 10.1515/ijsl-2014-0029

O'Rourke, B., & Ramallo, F. (2010). Los nuevos hablantes de lenguas minoritarias: una comparación entre Irlanda y Galicia. *Actas del Congreso Internacional de Lingüística General*, 1684–1700.

O'Rourke, B., & Ramallo, F. (2011). The native-non-native dichotomy in

minority language contexts: Comparisons between Irish and Galician. *Language Problems and Language Planning*, *35*(2), 139–159. Retrieved from http://www.jbe-platform.com/content/journals/10.1075/lplp.35.2.03oro doi: 10.1075/lplp.35.2.03oro

O'Rourke, B., & Ramallo, F. (2013a). Competing ideologies of linguistic authority amongst new speakers in contemporary Galicia. *Language in Society*, *42*(3), 287–305. Retrieved from http://www.journals.cambridge.org/abstract{_}S0047404513000249 doi: 10.1017/S0047404513000249

O'Rourke, B., & Ramallo, F. (2013b). "A miña variedade é defectuosa": a lexitimidade social das neofalas. *Estudos de Lingüística Galega*, *5*, 89–103.

O'Rourke, B., & Ramallo, F. (2015). Neofalantes as an active minority: Understanding language practices and motivations for change amongst new speakers of Galician. *International Journal of the Sociology of Language*, *231*, 147–165. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0036/ijsl-2014-0036.xml doi: 10.1515/ijsl-2014-0036

O'Rourke, B., & Walsh, J. (2015). New Speakers of Irish: shifting boundaries across time and space. *International Journal of the Sociology of Language*, *231*, 63–83. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0032/ijsl-2014-0032.xml doi: 10.1515/ijsl-2014-0032

Ortega, A., Amorrortu, E., Goirigolzarri, J., Urla, J., & Uranga, B. (2014). New Basque speakers: linguistic identity and legitimacy. *Digithum*, 47–58. Retrieved from https://digithum.uoc.edu/articles/abstract/10.7238/d.v0i16.2182/

Ortega, A., Urla, J., & Amorrortu, E. (2015). Linguistic identity among new

speakers of Basque. *International Journal of the Sociology of Language*, *231*, 85–105. Retrieved from http://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0033/ijsl-2014-0033.xml doi: 10.1515/ijsl-2014-0033

Pallier, C., Bosch, L., & Sebastián-Gallés, N. (1997). A limit on behavioral plasticity in speech perception. *Cognition*, *64*(3), B9–B17. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9426508

Pallier, C., Colomé, A., & Sebastián-Gallés, N. (2001). The Influence of Native-Language Phonology on Lexical Access: Exemplar-Based Versus Abstract Lexical Entries. *Psychological Science*, *12*(6), 445–449. Retrieved from http://journals.sagepub.com/doi/10.1111/1467-9280.00383 doi: 10.1111/1467-9280.00383

Pallier, C., Dehaene, S., Poline, J.-B., Argenti, A.-M., Dupoux, E., & Mehler, J. (2003). Brain imaging of language plasticity: can a second language replace the first? *Cerebral Cortex*(13), 155–161. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/12507946

Peereman, R., Dufour, S., & Burt, J. S. (2009). Orthographic influences in spoken word recognition: the consistency effect in semantic and gender categorization tasks. *Psychonomic Bulletin & Review*, *16*(2), 363–368. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/19293108 doi: 10.3758/PBR.16.2.363

Perrachione, T. K., Del Tufo, S. N., & Gabrieli, J. D. E. (2011). Human voice recognition depends on language ability. *Science*, *333*(6042), 5–8. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21798942 doi: 10.1126/science.1207327

Perrachione, T. K., Pierrehumbert, J. B., & Wong, P. C. M. (2009). Differential neural contributions to native- and foreign-language talker identification. *Journal of Experimental Psychology. Human Perception and Performance*, *35*(6), 1950–1960. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2792570/ doi: 10.1037/

a0015869

Pierce, L. J., Chen, J.-K., Delcenserie, A., Genesee, F., & Klein, D. (2015). Past experience shapes ongoing neural patterns for language. *Nature Communications*, *6*, 1–11. Retrieved from http://www.nature.com/doifinder/10.1038/ncomms10073 doi: 10.1038/ncomms10073

Piske, T., Mackay, I. R. A., & Flege, J. E. (2001). Factors affecting degree of foreign accent in an L2: a review. *Journal of Phonetics*, *29*, 191–215. Retrieved from http://jimflege.com/files/Piske{_}MacKay{_}factors{_}affecting{_}JP{_}2001.pdf doi: 10.006/jpho.2001.0134

Preston, D. R. (1986). Five visions of America. *Language in Society*, *15*(2), 221–240. Retrieved from https://www.jstor.org/stable/4167748?seq=1{#}page{_}scan{_}tab{_}contents doi: 10.1017/S0047404500000191

Preston, D. R. (1989). *Perceptual dialectology*. Providence, RI: Foris Publications.

Preston, D. R. (1996). Where the worst English is spoken. In E. W. Schneider (Ed.), *Focus on the USA* (pp. 297–360). Amsterdam: John Benjamins.

Preston, D. R. (1999). *Handbook of Perceptual Dialectology*. Amsterdam: John Benjamins.

Pujolar, J., & Puigdevall, M. (2015). Linguistic mudes: how to become a new speaker in Catalonia. *International Journal of the Sociology of Language*, *231*, 167–187. Retrieved from https://www.degruyter.com/view/j/ijsl.2015.2015.issue-231/ijsl-2014-0037/ijsl-2014-0037.xml doi: 10.1515/ijsl-2014-0037

Purnell, T., Idsardi, W. J., & Baugh, J. (1999). Perceptual and Phonetic Experiments on American English Dialect Identification. *Journal of Language and Social Psychology*, *18*(1), 10–30. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/

0261927X99018001002 doi: 10.1177/0261927X99018001002

Qualtrics. (2015). *Qualtrics.* Provo, Utah, USA. Retrieved from http://www.qualtrics.com

R Core Team. (2013). *R: A Language and Environment for Statistical Computing.* Vienna, Austria. Retrieved from http://www.r-project.org/

RAG. (2017). *O idioma.* Retrieved 2017-06-01, from http://academia.gal/idioma

Ramallo, F. (2007). Sociolinguistics of Spanish in Galicia. *International Journal of the Sociology of Language*(184), 21–36. Retrieved from https://www.degruyter.com/view/j/ijsl.2007.2007.issue-184/ijsl.2007.012/ijsl.2007.012.xml doi: 10.1515/IJSL.2007.012

Ramallo, F. (2010). Cara a unha tipoloxía sociolingüística dos falantes de galego. In *Educación e linguas en Galicia* (pp. 15–37).

Ramallo, F. (2013). Neofalantismo. In E. Gugenberger, H. Monteagudo, & G. Rei-Doval (Eds.), *Contacto de linguas, hibrididade, cambio: contextos, procesos e consecuencias* (pp. 245–258). Santiago de Compostela: Consello da Cultura Galega/Instituto da Lingua Galega.

Ramallo, F., & O'Rourke, B. (2014). Perfiles de neohablantes de gallego. *Digithum*, *16*, 98–105. Retrieved from http://www.redalyc.org/pdf/550/55031422004{_}2.pdf

Ramallo, F., & Rei-Doval, G. (2015). The Standardization of Galician. *Sociolinguistica - International Yearbook of European Sociolinguistics / Internationales Jahrbuch für europäische Soziolinguistik*, *29*(1), 61–81. doi: 10.1515/soci-2015-0006

Ramon-Casas, M., Swingley, D., Sebastián-Gallés, N., & Bosch, L. (2009). Vowel categorization during word recognition in bilingual toddlers. *Cognitive Psychology*, *59*(1), 96–121. Retrieved from http://www.psych.upenn.edu/{~}swingley/papers/ramonCasasSwingley{_}cogPsych09.pdf doi: 10.1016/j.cogpsych

.2009.02.002.Vowel

Regueira, X. L. (1994). Modelos fonéticos e autenticidade lingüística. *Cadernos de Lingua*(10), 37–60.

Regueira, X. L. (1999a). Estándar oral e variación social da lingua galega. In R. Álvarez & D. Vilavedra (Eds.), *Cinguidos por unha arela común: homenaxe ó profesor Xesús Alonso Montero* (pp. 855–875). Santiago de Compostela: Universidade.

Regueira, X. L. (1999b). Galician. *Handbook of the International Phonetic Association: A Guide to the Use of the International Phonetic Alphabet*, 82–85. Retrieved from https://archive.org/details/rosettaproject{_}glg{_}phon-1

Regueira, X. L. (2005). Estándar oral. In R. Álvarez & H. Monteagudo (Eds.), *Norma lingüística e variación* (pp. 69–95). Santiago de Compostela: Consello da Cultura Galega / Instituto da Lingua Galega. Retrieved from http://www.researchgate.net/publication/233985540{_}Lxico{_}dialectal{_}e{_}estandarizacin/file/79e4150dc195116f6f.pdf

Regueira, X. L. (2007). Vocais finais en galego e en portugués: un estudio acústico. *Actas do VII Congreso Internacional de Estudos Galegos*, 859–876. Retrieved from http://dialnet.unirioja.es/descarga/articulo/2944865.pdf

Regueira, X. L. (2009). Cambios fonéticos e fonolóxicos no galego contemporáneo. *Estudos de Lingüística Galega*, *1*, 147–167. Retrieved from http://www.usc.es/revistas/index.php/elg/article/view/1492 doi: 10.3309/1989-578X-09-8

Regueira, X. L. (2012). Autenticidade e calidade da lingua: purismo e planificación lingüística no galego actual. *Estudos de lingüística galega*, *4*, 187–201. Retrieved from http://www.usc.es/revistas/index.php/elg/article/viewFile/410/407 doi: 10.3309/1989-578X-

Regueira, X. L., Dubert García, F., Parga Valiña, E., & Sousa Fernández, X. C.

(1998). *Os sons da lingua*. Vigo: Edicións Xerais de Galicia.

Regueira, X. L., & Ginzo, M. J. (in press). A cross-linguistic study of voiceless fricative sibilants in Galician and European Portuguese. In M. Gibson & J. Gil (Eds.), *Romance Phonetics and Phonology*. Oxford: Oxford University Press.

Rei-Doval, G. (2007). *A lingua galega na cidade do século XX: unha aproximación sociolingüística*.

Repp, B. H. (1981). Two strategies in fricative discrimination. *Perception & Psychophysics*, *30*(3), 217–227. Retrieved from https://link.springer.com/article/10.3758/BF03214276https://www.osapublishing.org/josa/abstract.cfm?uri=josa-57-8-1030

R Library Contrast Coding Systems for Categorical Variables. (2011). UCLA: Statistical Consulting Group. Retrieved from https://stats.idre.ucla.edu/r/library/r-library-contrast-coding-systems-for-categorical-variables/

Robert, E. (2009, jan). Accommodating "new" speakers? An attitudinal investigation of L2 speakers of Welsh in south-east Wales. *International Journal of the Sociology of Language*, *195*, 93–116. Retrieved from http://www.degruyter.com/view/j/ijsl.2009.2009.issue-195/ijsl.2009.007/ijsl.2009.007.xml doi: 10.1515/IJSL.2009.007

Rojo, G. (2004). El español de Galicia. In R. Cano (Ed.), *Historia de la lengua española* (pp. 1087–1101). Barcelona: Ariel.

Saslow, M. G. G. (1967). Latency for Saccadic Eye Movement. *Journal of the Optical Society of America*, *57*(8), 1030. Retrieved from http://www.osapublishing.org/viewmedia.cfm?uri=josa-57-8-1030{&}seq=0{&}html=true doi: 10.1364/JOSA.57.001030

Scharinger, M., Monahan, P. J., & Idsardi, W. J. (2011). You had me at "Hello": Rapid extraction of dialect information from spoken words. *NeuroImage*, *56*(4), 2329–2338. Retrieved from https://

link.springer.com/article/10.3758/BF03214276https://www.osapublishing.org/josa/abstract.cfm?uri=josa-57-8-1030 doi: 10.1016/j.neuroimage.2011.04.007

Schleef, E., Meyerhoff, M., & Clark, L. (2011). Teenagers' acquisition of variation: A comparison of locally-born and migrant teens' realisation of English (ing) in Edinburgh and London. *English World-Wide*, *32*(2), 206–236. Retrieved from http://www.jbe-platform.com/content/journals/10.1075/eww.32.2.04sch doi: 10.1075/eww.32.2.04sch

Schulpen, B., Dijkstra, T., Schriefers, H. J., & Hasper, M. (2003). Recognition of Interlingual Homophones in Bilingual Auditory Word Recognition. *Journal of Experimental Psychology: Human Perception and Performance*, *29*(6), 1155–1178. Retrieved from http://doi.apa.org/getdoi.cfm?doi=10.1037/0096-1523.29.6.1155 doi: 10.1037/0096-1523.29.6.1155

Sebastián-Gallés, N., & Díaz, B. (2012). First and Second Language Speech Perception: Graded Learning. *Language Learning*(62), 131–147. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9922.2012.00709.x/abstract

Sebastián-Gallés, N., Echeverría, S., & Bosch, L. (2005). The influence of initial exposure on lexical representation: Comparing early and simultaneous bilinguals. *Journal of Memory and Language*, *52*(2), 240–255. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749596X04001214 doi: 10.1016/j.jml.2004.11.001

Sebastián-Gallés, N., Rodríguez-Fornells, A., De Diego-Balaguer, R., & Díaz, B. (2006). First-and Second-language Phonological Representations in the Mental Lexicon. *Journal of Cognitive Neuroscience*, *18*(8), 1277–1291. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/16859414

Sebastián-Gallés, N., & Soto-Faraco, S. (1999). Online processing of native and non-native phonemic contrasts in early bilinguals. *Cogni-*

tion(72), 111–123. Retrieved from http://www.sciencedirect.com/science/article/pii/S0010027799000244 doi: 10.1016/S0010-0277(99)00024-4

Sebastián-Gallés, N., Vera-Costán, F., Larsson, J. P., Costa, A., & Deco, G. (2008). Lexical Plasticity in Early Bilinguals Does Not Alter Phoneme Categories : II . Experimental Evidence. *Journal of Cognitive Neuroscience*, *21*(12), 2343–2357. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/18855552 doi: 10.1162/jocn.2008.21152

Shaw, J. A., Tyler, M. D., Kasisopa, B., Ma, Y., Proctor, M., Han, C., … Burnham, D. (2013). Vowel identity conditions the time course of tone recognition. *Proceedings of the Annual Conference of the International Speech Communication Association*, 3142–3146. Retrieved from http://mproctor.net/docs/shaw13{_}IS2013{_}tone{_}perception.pdf

Shook, A., Goldrick, M., Engstler, C., & Marian, V. (2015). Bilinguals Show Weaker Lexical Access During Spoken Sentence Comprehension. *Journal of Psycholinguistic Research*, *44*(6), 789–802. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4379126/ doi: doi:10.1007/s10936-014-9322-6

Silverstein, M. (2003). Indexical order and the dialectics of sociolinguistic life. *Language and Communication*, *23*(3-4), 193–229. doi: 10.1016/S0271-5309(03)00013-2

Simonet, M. (2010). Dark and clear laterals in Catalan and Spanish: Interaction of phonetic categories in early bilinguals. *Journal of Phonetics*, *38*(4), 663–678. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0095447010000744 doi: 10.1016/j.wocn.2010.10.002

Simonet, M. (2011). Production of a Catalan-specific vowel contrast by early Spanish-Catalan bilinguals. *Phonetica*, *68*, 88–110. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/21804334 doi: 10.1159/

000328847

Soares, A. P., Perea, M., & Comesaña, M. (2014). Tracking the emergence of the consonant bias in visual-word recognition: Evidence with developing readers. *PLoS ONE*, *9*(2). Retrieved from http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0088580 doi: 10.1371/journal.pone.0088580

Spivey, M. J., & Marian, V. (1999). Cross Talk Between Native and Second Languages: Partial Activation of an Irrelevant Lexicon. *Psychological Science*, *10*(3), 281–284. Retrieved from http://pss.sagepub.com/content/10/3/281.abstract doi: 10.1111/1467-9280.00151

Stuart-Smith, J., Timmins, C., & Alam, F. (2011). Hybridity and ethnic accents: A sociophonetic analysis of 'Glaswasian'. In F. Gregersen, J. Parrott, & P. Quist (Eds.), *Language Variation - European Perspectives III: Selected papers from the 5th International Conference on Language Variation in Europe (ICLaVE 5), Copenhagen, June 2009. Series: Studies in language variation (7)* (pp. 43–57). Amsterdam: John Benjamins Publishing Company.

Stuart-Smith, J., Timmins, C., & Tweedie, F. (2007). 'Talkin' Jockney??' Variation and change in Glaswegian accent. *Journal of Sociolinguistics*, *11*(2), 221–260. Retrieved from http://doi.wiley.com/10.1111/j.1467-9841.2007.00319.x doi: 10.1111/j.1467-9841.2007.00319.x

Tanenhaus, M. K., Magnuson, J. S., Dahan, D., & Chambers, C. (2000). Eye movements and lexical access in spoken-language comprehension: evaluating a linking hypothesis between fixations and linguistic processing. *Journal of Psycholinguistic Research*, *29*(6), 557–580. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/11196063 doi: 10.1023/A:1026464108329

Tanenhaus, M. K., & Spivey-Knowlton, M. J. (1996). Eye-Tracking. *Language and Cognitive Processes*, *11*(6), 583–588. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/016909696386971 doi:

10.1080/016909696386971

Tanenhaus, M. K., Spivey-Knowlton, M. J., Eberhard, K. M., & Sedivy, J. C. (1995). Integration of visual and linguistic information in spoken language comprehension. *Science*, *268*(5217), 1632–1634. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7777863 doi: 10.1126/science.7777863

Thompson, C. P. (1987). A language effect in voice identification. *Applied Cognitive Psychology*, *1*(2), 121–131. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/acp.2350010205/full doi: 10.1002/acp.2350010205

Tomé Lourido, G., & Evans, B. G. (2015). Switching language dominance for ideological reasons: a study of Galician new speakers' speech production and perception. In *Proceedings of the International Congress of Phonetic Sciences*. Glasgow. Retrieved from https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2015/Papers/ICPHS0459.pdf

Tomé Lourido, G., & Evans, B. G. (2017). Os neofalantes galegos no contexto europeo: A produción e a percepción da fala. In X. L. Regueira & E. Fernández Rei (Eds.), *Cambio lingüístico no galego actual* (pp. 99–127). Santiago de Compostela: Instituto da Lingua Galega / Consello da Cultura.

Tuninetti, A., Chládková, K., Peter, V., Schiller, N. O., & Escudero, P. (2017). When speaker identity is unavoidable: Neural processing of speaker identity cues in natural speech. *Brain and Language*, *174*, 42–49. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0093934X1730161X doi: 10.1016/j.bandl.2017.07.001

Van Ooijen, B. (1996). Vowel mutability and lexical selection in English: Evidence from a word reconstruction task. *Memory & Cognition*, *24*(5), 573–583. Retrieved from http://link.springer.com/10.3758/BF03201084 doi: 10.3758/BF03201084

Vandeberg, L., Guadalupe, T., & Zwaan, R. A. (2011). How verbs can activate things: Cross-language activation across word classes. *Acta Psychologica*, *138*(1), 68–73. Retrieved from http://dx.doi.org/10.1016/j.actpsy.2011.05.007 doi: 10.1016/j.actpsy.2011.05.007

van Heuven, W., Dijkstra, T., & Grainger, J. (1998). Orthographic neighborhood effect in bilingual word recognition. *Journal of Memory and Language*, *39*, 458–483. Retrieved from http://www.sciencedirect.com/science/article/pii/S0749596X98925840 doi: 10.1006/jmla.1998.2584

Ventureyra, V. A. G., Pallier, C., & Yoo, H. Y. (2004). The loss of first language phonetic perception in adopted Koreans. *Journal of Neurolinguistics*, *17*(1), 79–91. Retrieved from http://www.sciencedirect.com/science/article/pii/S0911604403000538 doi: 10.1016/S0911-6044(03)00053-8

Vidal Figueroa, T. (1997). Estructuras fonéticas de tres dialectos de Vigo. *Verba*, *24*, 313–332.

Vieru, B., De Mareüil, P. B., & Adda-Decker, M. (2011). Characterisation and identification of non-native French accents. *Speech Communication*, *53*(3), 292–310. Retrieved from http://www.sciencedirect.com/science/article/pii/S0167639310001615 doi: 10.1016/j.specom.2010.10.002

Vitevitch, M. S., & Luce, P. A. (1999). Probabilistic Phonotactics and Neighborhood Activation in Spoken Word Recognition. *Journal of Memory and Language*, *40*(3), 374–408. Retrieved from http://linkinghub.elsevier.com/retrieve/pii/S0749596X98926183 doi: 10.1006/jmla.1998.2618

Wagner, L., Clopper, C. G., & Pate, J. H. (2014). Children's perception of dialect variation. *Journal of Child Language*, *41*, 1062–1084. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/23985300 doi: 10.1017/S0305000913000330

Walsh, J., & O'Rourke, B. (2014). Becoming a new speaker of Irish: linguistic mudes throughout the life cycle. *Digithum*, *16*, 67–74. Retrieved from https://digithum.uoc.edu/articles/abstract/10.7238/d.v0i16.2186/

Weber, A., & Cutler, A. (2004). Lexical competition in non-native spoken-word recognition. *Journal of Memory and Language*, *50*, 1–25. Retrieved from http://pubman.mpdl.mpg.de/pubman/item/escidoc:58488:3/component/escidoc:58489/Weber{_}2004{_}lexical.pdf doi: 10.1016/S0749-596X(03)00105-0

Wickham, H. (2007). Reshaping Data with the {reshape} Package. *Journal of Statistical Software*, *21*(12), 1–20. Retrieved from http://www.jstatsoft.org/v21/i12/

Wickham, H. (2009). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. Retrieved from http://ggplot2.org

Wickham, H. (2011). The Split-Apply-Combine Strategy for Data Analysis. *Journal of Statistical Software*, *40*(1), 1–29. Retrieved from http://www.jstatsoft.org/v40/i01/

Wickham, H., & Francois, R. (2016). *dplyr: A Grammar of Data Manipulation.* Retrieved from https://cran.r-project.org/package=dplyr

Woolard, K. (2011). Is there linguistic life after high school? Longitudinal changes in the bilingual repertoire in metropolitan Barcelona. *Language in Society*, *40*(05), 617–648. Retrieved from http://www.journals.cambridge.org/abstract{_}S0047404511000704 doi: 10.1017/S0047404511000704

Yamada, R. (1995). Age and acquisition of second language speech sounds: Perception of American English /r/ and /l/ by native speakers of Japanese. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 305–320). Timonium, MD: York Press.

Ying, J., Shaw, J. A., & Best, C. T. (2013). L2 English Learners' Recognition of Words Spoken in Familiar versus Unfamiliar English Accents. *Proceedings of the Annual Conference of the International Speech Communication Association*, 2108–2112. Retrieved from https://campuspress.yale.edu/jasonshaw/files/2017/01/Ying{_}etal{_}2013{_}interspeech-25b55r9.pdf

Ziegler, J. C., Ferrand, L., & Montant, M. (2004). Visual phonology: the effects of orthographic consistency on different auditory word recognition tasks. *Memory & Cognition*, *32*(5), 732–741. Retrieved from http://link.springer.com/article/10.3758/BF03195863 doi: 10.3758/BF03195863

Zwitserlood, P. (1989). The locus of the effects of sentential-semantic context in spoken-word processing. *Cognition*, *32*(1), 25–64. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/2752705 doi: 10.1016/0010-0277(89)90013-9

Appendices

Appendix A

Language Background Questionnaire

This Section presents the questions from the language background questionnaire participants completed in the three studies reported in this thesis. It should be noted that this representation corresponds to an English translation of the actual questionnaire, which was presented in Galician on LimeSurvey (2012) for Study 1 and Qualtrics (2015) for Study 2 and Study 3. The section on organisations was only included in the questionnaire for Study 1, as it was possible to determine participants' language background without this question. The questionnaire was generated dynamically and thus, the questions presented to each participant depended on their previous answer.

General information

1. Name:
2. Sex:

   ☐ Female ☐ Male
3. Address:
4. Email address:
5. Mobile number:
6. Date of birth:
7. Place of birth:
8. Mother's place of birth:
9. Father's place of birth:
10. Place of residence during the academic year:
11. Place of residence during the rest of the year:
12. Have you lived somewhere else?

    ☐ Yes ☐ No (go to question 14)
13. Write down the place and dates

Place	From	To

14. Use this space if you would like to make a comment

Language experience

15. How old were you when you learnt Spanish? How did you learn it?
16. How old were you when you learnt Galician? How did you learn it?
17. Select the option that best describes your linguistic background

    a. The language I use the most is Spanish
    b. The language I use the most is Galician
    c. I use both languages equally

If participant clicked a. The language I use the most is Spanish

i. Have you always spoken Spanish?
    - □ Yes, I have
    - □ No, I used to speak Galician more and now I speak Spanish more

ii. How old were you when you started speaking Spanish?

iii. Why did you switch languages?

If participant clicked b. The language I use the most is Galician

i. Have you always spoken Galician? (go to question 18)
   - □ Yes, I have
   - □ No, I used to speak Spanish more and now I speak Galician more

ii. How old were you when you started speaking Galician?

iii. Why did you switch languages?

iv. Have you made any effort to improve the way you speak Galician?
   - □ Yes
     - ▷ How?
   - □ No

v. Do you think it is important to have a correct pronunciation in Galician?
   - □ Yes
     - ▷ Why?
   - □ No
     - ▷ Why not?
   - □ I haven't thought about it

vi. Have you made any effort to improve your pronunciation in Galician?
   - □ Yes
     - ▷ How?
   - □ No

If participant clicked c. I use both languages equally

i. Have you always spoken both languages equally?

- □ Yes, I have
- □ No, I used to speak more Galician
- □ No, I used to speak more Spanish

18. Use this space if you would like to make a comment

19. Language in education

	Galician	More Galician than Spanish	Both	More Spanish than Galician	Spanish
Primary Education	☐	☐	☐	☐	☐
Secondary Education	☐	☐	☐	☐	☐
University	☐	☐	☐	☐	☐

20. Which do(es) _____ speak the most?

	Galician	More Galician than Spanish	Both	More Spanish than Galician	Spanish
your mother	☐	☐	☐	☐	☐
your father	☐	☐	☐	☐	☐
your siblings	☐	☐	☐	☐	☐

21. Which do(es) _____ speak to you?

	Galician	More Galician than Spanish	Both	More Spanish than Galician	Spanish
your mother	☐	☐	☐	☐	☐
your father	☐	☐	☐	☐	☐
your siblings	☐	☐	☐	☐	☐

22. Do you speak other languages?

    ☐ Yes ☐ No (go to question 24)

23. Indicate which languages you speak, the age you started learning them and your competence level.

Language	Age of acquisition	Competence

24. What do you study?

    Degree:

    Year:

25. Do you have any hearing impairment?

    □ Yes

    ▷ Which one?

    □ No

26. Do you have any speech or language disorder?

    □ Yes

    ▷ Which one?

    □ No

27. Would you be willing to participate in a further study?

☐ Yes ☐ No

28. Use this space if you would like to make a comment

29. Do you belong to any of these organizations?

	Yes	No	If yes, which ones?
Sports organisations	☐	☐	
NGOs	☐	☐	
Organisations in favour of Spanish	☐	☐	
Organisations in favour of Galician	☐	☐	
Student organisations	☐	☐	
Political organisations	☐	☐	

30. Use this space if you would like to make a comment

Language use

31. Which language do you speak...

	Galician	More Galician than Spanish	Both	More Spanish than Galician	Spanish	N/A[13]
to your mother?	☐	☐	☐	☐	☐	☐
to your father?	☐	☐	☐	☐	☐	☐
to your siblings?	☐	☐	☐	☐	☐	☐
to your partner?	☐	☐	☐	☐	☐	☐
to your maternal grandparents?	☐	☐	☐	☐	☐	☐
to your paternal grandparents?	☐	☐	☐	☐	☐	☐
to your closest friends?	☐	☐	☐	☐	☐	☐
to your classmates?	☐	☐	☐	☐	☐	☐
to your lecturers?	☐	☐	☐	☐	☐	☐
to your doctor?	☐	☐	☐	☐	☐	☐
to strangers?	☐	☐	☐	☐	☐	☐
at work?	☐	☐	☐	☐	☐	☐
when shopping?	☐	☐	☐	☐	☐	☐
when flirting?	☐	☐	☐	☐	☐	☐

[13] Not Applicable

32. In which language...

	Galician	More Galician than Spanish	Both	More Spanish than Galician	Spanish	N/A[13]
do you dream?	☐	☐	☐	☐	☐	☐
do you think?	☐	☐	☐	☐	☐	☐
do you count?	☐	☐	☐	☐	☐	☐
do you swear?	☐	☐	☐	☐	☐	☐
do you tell jokes?	☐	☐	☐	☐	☐	☐
do you take notes?	☐	☐	☐	☐	☐	☐
do you write forms formal letters (bureaucracy)?	☐	☐	☐	☐	☐	☐
do you use in social networks (Facebook, Twitter...)?	☐	☐	☐	☐	☐	☐

33. Use this space if you would like to make a comment

Appendix B

Study 1: Word list target words

Variable	Segment	Word	Transcription	English translation
Reference vowel	/a/	*pazo*	[ˈpaθo̞]	pazo
Reference vowel	/i/	*pita*	[ˈpita̞]	hen
Reference vowel	/u/	*pucho*	[ˈput͡ʃo̞]	calf
Mid vowel	/ɛ/	*peza*	[ˈpɛθa̞]	piece
Mid vowel	/e/	*seca*	[ˈseka̞]	dry (F)
Mid vowel	/e/	*peto*	[ˈpeto̞]	pocket
Mid vowel	/ɔ/	*pote*	[ˈpɔte̞]	pot
Mid vowel	/ɔ/	*sota*	[ˈsɔta̞]	knave (cards)
Mid vowel	/o/	*pozo*	[ˈpoθo̞]	well (N)
Mid vowel	/o/	*sopa*	[ˈsopa̞]	soup
Fricative	/s/	*pase*	[ˈpase̞]	pass
Fricative	/ʃ/	*paxe*	[ˈpaʃe̞]	page
Reference vowel	[a̞]	*peza*	[ˈpɛθa̞]	piece
Reference vowel	[a̞]	*sopa*	[ˈsopa̞]	soup
Reference vowel	[a̞]	*pata*	[ˈpata̞]	paw
Reference vowel	[a̞]	*pita*	[ˈpita̞]	hen
Reference vowel	[a̞]	*seca*	[ˈseka̞]	dry (F)
Reference vowel	[a̞]	*sota*	[ˈsɔta̞]	knave (cards)
Word-final vowel	[e̞]	*pote*	[ˈpɔte̞]	pot
Word-final vowel	[e̞]	*pare*	[ˈpaɾe̞]	stop (V)
Word-final vowel	[e̞]	*pase*	[ˈpase̞]	pass
Word-final vowel	[e̞]	*paxe*	[ˈpaʃe̞]	page
Word-final vowel	[o̞]	*pazo*	[ˈpaθo̞]	pazo
Word-final vowel	[o̞]	*peto*	[ˈpeto̞]	pocket
Word-final vowel	[o̞]	*pozo*	[ˈpoθo̞]	well (N)
Word-final vowel	[o̞]	*pucho*	[ˈput͡ʃo̞]	calf
Word-final vowel	[o̞]	*sapo*	[ˈsapo̞]	toad
Word-final vowel	[o̞]	*saco*	[ˈsako̞]	sack bag
Word-final vowel	[o̞]	*sito*	[ˈsito̞]	situated
Word-final vowel	[o̞]	*suco*	[ˈsuko̞]	furrow

Table B.1: List of target words included in the word list and used for analysis. Each of these words was recorded in phrase-final position in the carrier sentence *digo a palabra* _____ (I say the word _____) and in phrase-medial position in the carrier sentence *digo a palabra* _____ *con coidado* (I say the word _____ carefully). For the mid-vowel set, Only the mid-vowels /e ɛ o ɔ/ were included in the statistical analysis. The vowels /a i u/ were used in the normalisation procedure and were included in plots for reference. For the word-final vowel set, only the mid unstressed vowels were included in the statistical analysis; [a̞] was included for reference. F = feminine gender, N = noun, V = verb.

Appendix C

Study 1: Text

Galician version: O vento e o sol

O vento do norte e mailo sol porfiaban sobre cal deles era o máis forte, cando cadrou de pasar un viaxeiro envolto nunha longa capa azul. Conviñeron en que o que antes conseguise facerlle quitar a capa ao viaxeiro sería considerado o máis forte. *Comezaron a pensar na súa mellor estratexia para gañar o reto xa que ambos eran moi competitivos e por fin decidiron que facer*[14]. O vento do norte soprou con gran furia, e canto máis sopraba máis se envolvía o viaxeiro na súa longa capa azul; finalmente o vento do norte abandonou o seu empeño. Entón o sol quentou con forza e inmediatamente o viaxeiro sacou a capa. E daquela o vento do norte tivo que recoñecer a superioridade do sol.

[14] This sentence was added to increase the number of instances of key variables

English version: The North Wind and the Sun

The North Wind and the Sun were disputing which was the stronger, when a traveller came along wrapped in a warm cloak. They agreed that the one who first succeeded in making the traveller take his cloak off should be considered stronger than the other. *They began to think about their best strategy to win the challenge as they were both very competitive and they finally decided what to do*[14]. Then the North Wind blew as hard as he could, but the more he blew the more closely did the traveller fold his cloak around him; and at last the North Wind gave up the attempt. Then the Sun shined out warmly, and immediately the traveller took off his cloak. And so the North Wind was obliged to confess that the Sun was the stronger of the two.

Appendix D

Study 1: Vowel identification task stimuli

Variable	Segment	Word	Transcription	English translation
Mid vowel	/ɔ/	*óso*	[ˈɔsọ]	bone
Mid vowel	/o/	*oso*	[ˈosọ]	bear
Mid vowel	/ɛ/	*pé*	[ˈpɛ]	foot
Mid vowel	/e/	*pe*	[ˈpe]	'p'
Mid vowel	/ɔ/	*só*	[ˈsɔ]	alone
Mid vowel	/o/	*so*	[ˈso]	under
Mid vowel	/ɛ/	*té*	[ˈtɛ]	tea
Mid vowel	/e/	*te*	[ˈte]	't'

Table D.1: List of target words included in the mid-vowel word identification task. Each of these words was embedded in the carrier sentence *Digo a palabra* _____ (I say the word _____). The carrier sentence was produced in two accents; (1) standard-accented Galician [ˈdiɣọapaˈlaβɾạ] (2) regionally-accented Galicia [ˈdihọapaˈlaβɾạ].

Appendix E

Study 2: Definitions

- Normalmente fala galego: Esta persoa fala galego no seu día a día e sempre falou máis galego que castelán.
- Normalmente fala castelán: Esta persoa fala castelán no seu día a día e sempre falou máis castelán que galego.
- É neofalante: Esta persoa sempre falaba máis castelán, pero agora fala galego no seu día a día.

Appendix F

Study 2: Trial Procedure

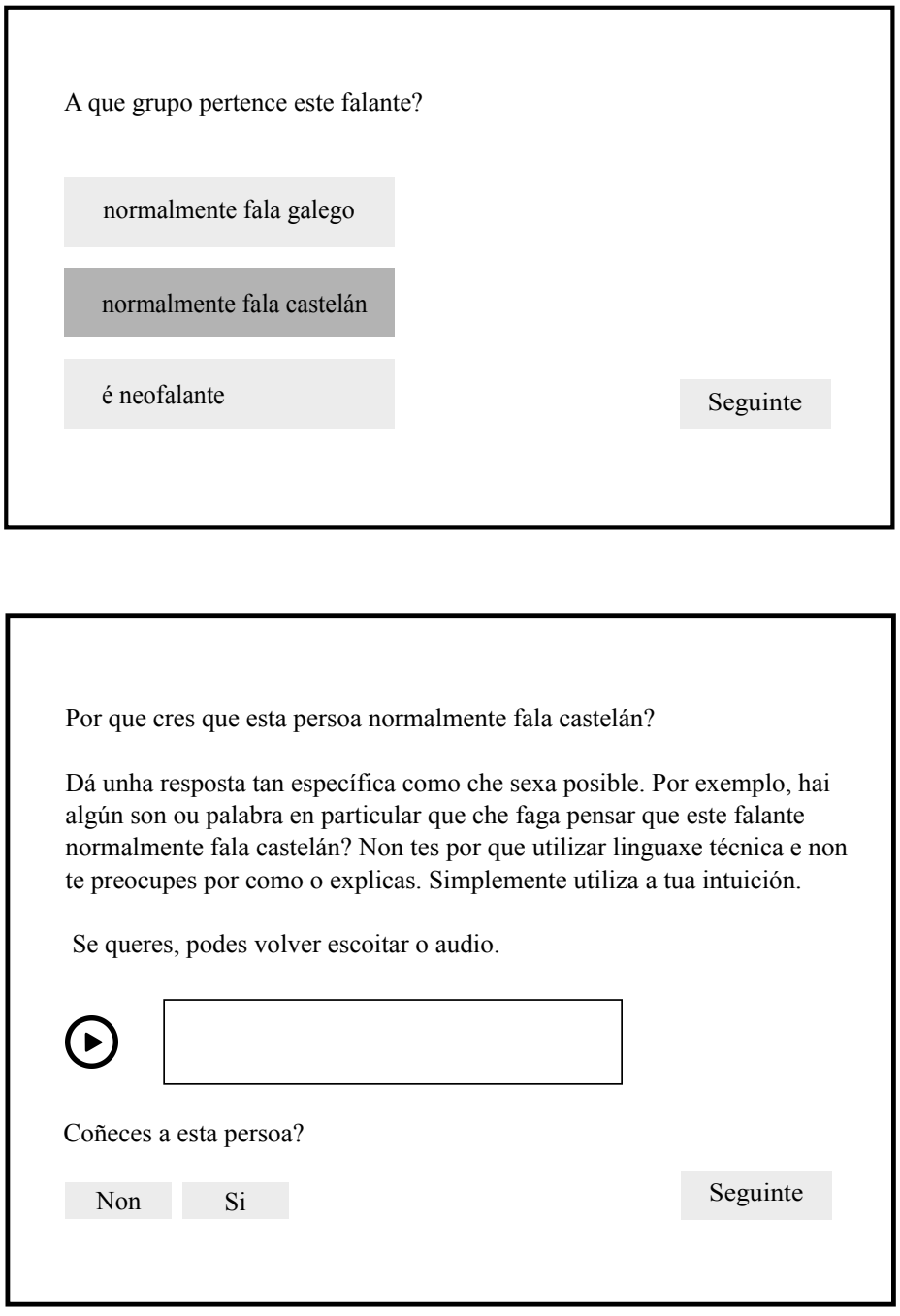

Figure F.1: Representation of the trial procedure in Study 2 in Galician. First, participants identified what group they thought the speaker belonged to. Then, they provided comments about what influenced their decision. They also indicated whether they thought they knew the speaker.

Appendix G

Study 3: Stimuli

Target			Competitor 1			Competitor 2			Unrelated		
xullo	[ˈʃuʎo̞]	July	*suba*	[ˈsuβa̞]	go up	*churra*	[ˈtʃura̞]	hen	*peto*	[ˈpeto̞]	pocket
xaque	[ˈʃake̞]	check (N)	*sapo*	[ˈsapo̞]	toad	*Charo*	[ˈtʃaro̞]	Charo (PN)	*bruta*	[ˈbɾuta̞]	brute (F)
xira	[ˈʃiɾa̞]	turn (V)	*siga*	[ˈsiɣa̞]	follow	*chile*	[ˈtʃile̞]	chilli	*rolo*	[ˈrolo̞]	roll
xuro	[ˈʃuro̞]	swear	*sucia*	[ˈsuθja̞]	dirty (F)	*chucho*	[ˈtʃutʃo̞]	shiver (N)	*trece*	[ˈtɾeθe̞]	thirteen
xene	[ˈʃɛne̞]	gene	*serra*	[ˈsɛra̞]	saw (N)	*cheque*	[ˈtʃɛke̞]	cheque	*baño*	[ˈbaɲo̞]	bathroom
xoia	[ˈʃɔja̞]	jewel	*sota*	[ˈsɔta̞]	knave (cards)	*choca*	[ˈtʃɔka̞]	crash (V)	*pino*	[ˈpino̞]	leaning
Xana	[ˈʃana̞]	Xana (PN)[a]	*saia*	[ˈsaja̞]	skirt	*chapa*	[ˈtʃapa̞]	sheet	*buque*	[ˈbuke̞]	ship
xiga	[ˈʃiɣa̞]	gigabyte	*sidra*	[ˈsiðɾa̞]	cider	*china*	[ˈtʃina̞]	pebble	*gromo*	[ˈgɾomo̞]	sprout
xoto	[ˈʃoto̞]	unfriendly	*sono*	[ˈsono̞]	dream (N)	*chopo*	[ˈtʃopo̞]	gulp	*luva*	[ˈluβa̞]	glove
xerra	[ˈʃera̞]	jug	*sega*	[ˈsɛɣa̞]	reap (V)	*checa*	[ˈtʃɛka̞]	Czech (F)	*moño*	[ˈmoɲo̞]	bun
seco	[ˈseko̞]	dry	*xema*	[ˈʃema̞]	gem	*chepa*	[ˈtʃepa̞]	hump	*clase*	[ˈklase̞]	class
saco	[ˈsako̞]	sack	*xato*	[ˈʃato̞]	calf	*chaga*	[ˈtʃaɣa̞]	ulcer	*plebe*	[ˈple(ɛ)βe̞]	masses
suco	[ˈsuko̞]	furrow	*xuño*	[ˈʃuɲo̞]	June	*chulo*	[ˈtʃulo̞]	cocky	*cita*	[ˈθita̞]	appointment
sete	[ˈsɛte̞]	seven	*xeque*	[ˈʃɛke̞]	sheikh	*checo*	[ˈtʃɛko̞]	Czech	*milla*	[ˈmiʎa̞]	mile
sala	[ˈsala̞]	living-room	*xade*	[ˈʃaðe̞]	jade	*chave*	[ˈtʃaβe̞]	key	*teso*	[ˈteso̞]	rigid
saba	[ˈsaβa̞]	sheet	*xara*	[ˈʃaɾa̞]	rockrose	*chafa*	[ˈtʃafa̞]	fail	*coco*	[ˈko(ɔ)ko̞]	coconut
sumo	[ˈsumo̞]	add (V)	*xura*	[ˈʃuɾa̞]	swear (V)	*chuzo*	[ˈtʃuθo̞]	stick	*breve*	[ˈbɾɛβe̞]	brief
serie	[ˈsɛɾje̞]	series	*xefe*	[ˈʃɛfe̞]	boss	*chega*	[ˈtʃɛɣa̞]	arrive (V)	*gnomo*	[ˈnomo̞]	gnome
socio	[ˈsɔθjo̞]	partner	*xofre*	[ˈʃɔfɾe̞]	sulphur	*choio*	[ˈtʃɔjo̞]	bargain	*drama*	[ˈdɾama̞]	drama
sino	[ˈsino̞]	bell	*xiba*	[ˈʃiβa̞]	hump	*chica*	[ˈtʃika̞]	small (F)	*nobre*	[ˈnoβɾe̞]	noble

Table G.1: List of target words included in the consonant condition in the eye-tracking task. F = feminine gender, N = noun, PN = proper noun, V = verb.

[a] Proper nouns are not translated.

Target			Competitor 1			Competitor 2			Unrelated		
peza	[ˈpɛθa̪]	piece	*pesoÌÍ*	[ˈpeso̪]	weight	*pato*	[ˈpato̪]	duck	*torre*	[ˈtore̪]	tower
neto	[ˈnɛto̪]	grandson	*neno*	[ˈneno̪]	boy	*nada*	[ˈna̪ð̞a̪]	nothing	*cume*	[ˈkume̪]	summit
tese	[ˈtɛse̪]	thesis	*tello*	[ˈteʎo̪]	lid	*tarro*	[ˈtaro̪]	jar	*pluma*	[ˈpluma̪]	feather
neve	[ˈnɛβ̞e̪]	snow (N)	*nena*	[ˈnena̪]	girl	*nata*	[ˈnata̪]	cream	*sogro*	[ˈsoɣ̞ro̪]	father-in-law
mero	[ˈmɛro̪]	grouper	*mesa*	[ˈmesa̪]	table	*mata*	[ˈmata̪]	kills (V)	*zume*	[ˈθume̪]	juice
ferro	[ˈfɛro̪]	iron (N)	*fecho*	[ˈfetʃo̪]	lock	*faba*	[ˈfa̪β̞a̪]	bean	*prole*	[ˈprɔle̪]	descendants
prego	[ˈpɾeɣ̞o̪]	fold (V)	*prezo*	[ˈpɾeθo̪]	price	*prato*	[ˈpɾato̪]	plate	*mina*	[ˈmina̪]	mine
crego	[ˈkɾeɣ̞o̪]	priest	*crecho*	[ˈkɾetʃo̪]	frizzy	*cravo*	[ˈkɾaβ̞o̪]	nail	*brida*	[ˈbɾið̞a̪]	bridle
berro	[ˈbɛro̪]	shout (V)	*veda*	[ˈbeð̞a̪]	close season	*bala*	[ˈbala̪]	bullet	*tute*	[ˈute̪]	tute (card game)
lebre	[ˈlɛβ̞ɾe̪]	hare	*letra*	[ˈletɾa̪]	letter	*lacre*	[ˈlakɾe̪]	wax seal	*solo*	[ˈso(ɔ)lo̪]	ground
ceta	[ˈθeta̪]	zed (‘z’)	*cero*	[ˈθɛro̪]	zero	*zaga*	[ˈθaɣ̞a̪]	rear	*lume*	[ˈlume̪]	fire
leña	[ˈleɲa̪]	firewood	*leve*	[ˈlɛβ̞e̪]	mild	*laca*	[ˈlaka̪]	hairspray	*iodo*	[ˈjɔð̞o̪]	iodine
feto	[ˈfeto̪]	foetus	*fero*	[ˈfɛro̪]	fierce	*fallo*	[ˈfaʎo̪]	mistake	*lima*	[ˈlima̪]	file
dedo	[ˈdeð̞o̪]	finger	*demo*	[ˈdɛmo̪]	devil	*data*	[ˈdata̪]	date	*cobre*	[ˈkɔβ̞ɾe̪]	copper
seca	[ˈseka̪]	dry (F)	*serio*	[ˈsɛrjo̪]	serious	*saña*	[ˈsaɲa̪]	fury	*quite*	[ˈkite̪]	idea
teto	[ˈteto̪]	udder	*terra*	[ˈtɛra̪]	earth	*taxa*	[ˈtaʃa̪]	tax	*cine*	[ˈθine̪]	cinema
preso	[ˈpɾeso̪]	prisoner	*preto*	[ˈpɾɛto̪]	near	*praia*	[ˈpɾaja̪]	beach	*mole*	[ˈmɔle̪]	block
selo	[ˈselo̪]	stamp	*seria*	[ˈsɛrja̪]	serious (F)	*sabio*	[ˈsa̪β̞jo̪]	wise	*coche*	[ˈkɔtʃe̪]	car
meta	[ˈmeta̪]	finish line	*meca*	[ˈmɛka̪]	mecca	*mago*	[ˈmaɣ̞o̪]	magician	*chifre*	[ˈtʃifɾe̪]	whistle (N)
remo	[ˈremo̪]	oar	*regra*	[ˈrɛɣ̞ra̪]	ruler	*rata*	[ˈrata̪]	rat	*bloque*	[ˈblɔke̪]	block

Table G.2: List of target words containing front vowels included in the vowel condition in the eye-tracking task. F = feminine gender, N = noun, V = verb.

Target			Competitor 1			Competitor 2			Unrelated		
dote	[ˈdɔt̪e̞]	dowry	*dono*	[ˈdono̞]	owner	*duro*	[ˈduɾo̞]	hard	*cala*	[ˈkala̪]	cove
nove	[ˈnɔβ̞e̞]	nine	*noxo*	[ˈnoʃo̞]	disgust	*nulo*	[ˈnulo̞]	invalid	*rella*	[ˈreʎa̪]	plough
bote	[ˈbɔt̪e̞]	tin	*boca*	[ˈboka̪]	mouth	*burra*	[ˈbura̪]	donkey (F)	*galo*	[ˈgalo̞]	rooster
rosa	[ˈrɔsa̪]	rose	*roto*	[ˈroto̞]	broken	*runa*	[ˈruna̪]	rune	*cafre*	[ˈkafɾe̞]	uncouth
tose	[ˈtɔse̞]	cough	*todo*	[ˈtodo̞]	all	*tuno*	[ˈtuno̞]	tuno[a]	*Sara*	[ˈsaɾa̪]	Sara (PN)
moda	[ˈmɔda̪]	fashion	*morro*	[ˈmoro̞]	snout	*muro*	[ˈmuɾo̞]	wall	*base*	[ˈbase̞]	basis
pobre	[ˈpɔβ̞ɾe̞]	poor	*pomo*	[ˈpomo̞]	doorknob	*puxo*	[ˈpuʃo̞]	put (V)	*frase*	[ˈfɾase̞]	sentence
zoco	[ˈθɔko̞]	clog	*zona*	[ˈθona̪]	zone	*zulo*	[ˈθulo̞]	hiding place	*case*	[ˈkase̞]	almost
troco	[ˈtɾɔko̞]	barter	*trono*	[ˈtɾono̞]	throne	*trufa*	[ˈtɾufa̪]	truffle	*sabe*	[ˈsabe̞]	knows (V)
brocha	[ˈbrɔt̪ʃa̪]	brush	*bromo*	[ˈbɾomo̞]	bromide	*bruxo*	[ˈbɾuʃo̞]	wizard	*saque*	[ˈsake̞]	kickoff
forro	[ˈforo̞]	lining	*foca*	[ˈfɔka̪]	seal	*fura*	[ˈfuɾo̞]	pierce	*crime*	[ˈkɾime̞]	crime
lobo	[ˈloβ̞o̞]	wolf	*lote*	[ˈlɔt̪e̞]	batch	*luso*	[ˈluso̞]	Portuguese	*trama*	[ˈtɾama̪]	plot
tolo	[ˈtolo̞]	crazy	*tope*	[ˈtɔ[e̞]	limit	*tubo*	[ˈtuβ̞o̞]	tube	*sana*	[ˈsana̪]	heals (V)
pozo	[ˈpoθo̞]	well (n.)	*pota*	[ˈpɔt̪a̪]	pot	*puño*	[ˈpuɲo̞]	fist	*fame*	[ˈfam|ˈe]	hunger
cono	[ˈkono̞]	cone	*cola*	[ˈkɔla̪]	glue	*cura*	[ˈkura̪]	cure	*paxe*	[ˈpaʃe̞]	page
foto	[ˈfot̪o̞]	photo	*fosa*	[ˈfɔsa̪]	pit	*fume*	[ˈfume̞]	smoke	*lapa*	[ˈlapa̪]	limpet
mozo	[ˈmoθo̞]	guy	*mora*	[ˈmɔɾa̪]	blackberry	*mula*	[ˈmula̪]	mule	*traxe*	[ˈtɾaʃe̞]	suit (N)
coro	[ˈkoɾo̞]	choir	*copa*	[ˈkɔpa̪]	glass	*cuco*	[ˈkuko̞]	cuckoo	*vale*	[ˈbale̞]	voucher
sobre	[ˈsoβ̞ɾe̞]	envelope	*sodio*	[ˈsɔdjo̞]	sodium	*sucio*	[ˈsuθjo̞]	dirty	*traca*	[ˈtɾaka̪]	firecracker
sopa	[ˈsopa̪]	soup	*sola*	[ˈsɔla̪]	sole	*suma*	[ˈsuma̪]	addition	*negro*	[ˈnɛɣ̞ɾo̞]	black

Table G.3: List of target words containing back vowels included in the vowel condition in the eye-tracking task. F = feminine gender, N = noun, PN = proper noun, V = verb.

[a] Member of student music group.