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The Role of Cognates in Conditioning Phonological Crosslinguistic Influence on Portuguese as a Third Language

by

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Abstract

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This study of phonology in Third Language Acquisition investigates the role of localised, lexical similarity in conditioning the source of phonological crosslinguistic influence on L3 production. It examines learners of L3 Portuguese who are native speakers of English with a Romance second language.

The study analyses participants' ability to discriminate and produce several speech sounds across their three languages, with a focus on fortis plosives, the vowels [æ, a, ɐ, o, ɔ, ɒ, u, e, ə], and the pre-palatal affricate /ʧ/ and fricative /ʃ/. 12 UK university students studying L3 Portuguese, with L1 English and L2 French or Spanish completed a Language Questionnaire, Aural Perception Tasks, and Oral Production Tasks at three time phases over 8 months. The Language Questionnaire evaluated participants' perceptions of language distance between their L3 and their background languages and their desires to suppress or encourage CLI in their L3 Portuguese production. The Aural Perception Tasks examined CLI in aural perception, and the Oral Production Tasks elicited target L1, L2 and L3 speech sounds from participants produced in real words both in isolation and in a sentence-embedded context.

Results suggest that localised lexical similarity has an impact on CLI source language selection, that L3 learners' perceptions of language similarity are not made on a macro scale, and that CLI occurs selectively from both the L1 and the L2. It is argued that the current models of L3A cannot fully account for phonological CLI in L3A, and it is suggested that L3 phonology be considered in a framework which combines L3 theory with models of aural perception.

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Research Thesis: Declaration of Authorship

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Definitions and Abbreviations

List of Acronyms

APDT	Aural Perception and Distinction Task
CEM	Cumulative Enhancement Model
CLI	Crosslinguistic Influence
F1	First formant
F2	Second formant
GLMM	Generalised Linear Mixed Model
IL	Interlanguage
L1	First language
L2	Second language
L2A	Second language acquisition
L2SF	L2 status factor
L3	Third language
L3A	Third language acquisition
LHQ	Language History Questionnaire
ms	millisecond(s)
NLM	Native Language Magnet
NLM-e	Native Magnet Language – expanded
NNL	Non-native language
NNLA	Non-native language acquisition
n-VOT	Normalised Voice onset time
OPT	Oral Production Task
PAM	Perceptual Assimilation Model
SLA	Second Language Acquisition
SLM	Speech Learning Model
TL	Target language
TPM	Typological Primacy Model
UG	Universal Grammar
VOT	Voice onset time

Chapter 1 **Introduction**

This study examines phonological crosslinguistic influence (CLI) in the production of Portuguese as a third language. It focuses on the potential for morpholexical similarity between learners' first, second, and third languages (L1, L2, and L3 respectively) to influence the employment of phonological properties of the L1 and L2 during L3 speech (i.e. oral production). This chapter provides a brief overview of the study and some key, relevant concepts, outlining the relevance of this study to the field of third language acquisition (L3A), the objectives of the project and relevant gaps in the extant literature. It additionally details the rationale for this study and presents the research questions that this study addresses. Finally, this chapter describes the methods by which the research questions will be answered.

1.1. Language Acquisition Research

Relatively recently, research in non-native language (NNL) learning has recognised that the acquisition of a third language (i.e. a non-native language acquired after the first NNL) differs from the processes of second language acquisition (L2A). In the study of L3A within a generative paradigm, the influence of previously acquired linguistic structures on the newly developing L3 (i.e. crosslinguistic influence) is noted as a key difference between L2A and L3A and the nature of CLI in L3A remains a key focal point for models of third language acquisition. Differences between second and third language acquisition are discussed in greater detail in Section 2.2. Current models of L3A propose differing predictions of potential source languages for CLI on the L3, with the Cumulative Enhancement Model (CEM: Flynn, Foley and Vinnitskaya, 2004), the Typological Primacy Model (TPM: Rothman, 2010, 2011, 2013, 2015) and the scalpel model (Slabakova, 2017) predicting that CLI may come from either an L1 or an L2, whilst the L2 Status Factor model (L2SF: Bardel and Falk, 2007; Falk and Bardel, 2011) predicts CLI only from an L2. These models further predict CLI to occur in different ways, either as crosslinguistic influence exclusively from a single background language (predicted by the TPM and the L2SF), or as partial, selective CLI from more than one language (predicted by the CEM and the scalpel model). Section 2.3 discusses these models of L3A and their relative merits and caveats.

Whilst the study of third language acquisition continues to expand rapidly, research into L3 phonology remains scarce (Cabrelli Amaro, 2012) and thus investigation into L3 phonological acquisition presents itself as a field in need of greater development; by comparison, studies of phonology in first and second language acquisition abound. Models of L1 phonological acquisition, such as the Native Language Magnet (NLM-e) model (Kuhl et al., 2008), and models developed within an L2 paradigm to predict NNL phonological development, such as the Speech Learning Model (SLM: Flege, 1995), appear to propose that the phonological system of the first language influences the ability to accurately perceive and produce any non-native language which differs from the L1 (see below for further discussion of these models). However, considering the potentially wider range of phonological knowledge available to an L3 learner, to assume that only L1 phonological properties may influence L3 acquisition would be to assume that L2A and L3A processes are the same. As highlighted by Jennifer Cabrelli Amaro (2012), this appears to not be the case, considering that claims of L1-only CLI in L3A, when re-examined, do not truly exclude other potential factors in precluding CLI from an L2.

The following sections briefly overview this work, beginning with outlining the rationale for the study, identifying a gap in the current literature in L3A. The project's research questions are presented, followed by a brief overview of the methods by which these questions are approached.

1.2. The Present Study: Rationale

As mentioned above, the role and nature of crosslinguistic influence in third language acquisition has become a rapidly developing field of study, with a variety of factors that distinguish L2A and L3A as separate, though interrelated, processes. Research in L3A has primarily studied lexical and morphosyntactic CLI, attempting to identify which language(s) may become the source of CLI on the L3, with some speculation towards the driving forces behind the selection of an L1 or an L2 as the source language and the development of several models of L3 acquisition and the formation of the L3 initial state. A deeper discussion of such studies and models is presented in Chapter 2.

By contrast, the field of L3 phonology continues to be comparatively understudied, with only a few researchers to date presenting substantial data on transfer in L3 production (see Section 2.8 for review). Given the diverse nature of this small selection of studies, many questions on the role of CLI in L3 phonology are yet to be answered, such as whether the L1 phonology acquired in infancy overrides any potential influence from the L2, or if phonological patterns acquired in the L2 are preferred in L3 production. The latter has been argued to be potentially due to a desire to 'sound foreign' by supressing L1 influence and encouraging CLI from the L2 based on a conscious or unconscious assumption that the L2 is more likely to facilitate target-like L3 production by the merit of L2 and L3 both being foreign languages. Such arguments assert that learners perceive the L1 as distant from the L3 because of its status as a native, not foreign, language (as discussed in de Angelis, 2005; Williams and Hammarberg, 1998; Hammarberg and Hammarberg, 2005).

Several aspects of crosslinguistic influence in L3A remain untested in all areas of linguistic structure, notably so in phonology. These include, for example:

- Whether the source language for CLI may change as L3 proficiency increases (see Williams and Hammarberg, 1993, 1998 for one case study which approaches the issue)
- Whether transfer occurs exclusively from a single background language or selectively from multiple L1(s) and/or L2(s)
- Whether crosslinguistic similarity or some other factor (or combination of factors) is the key driving force behind the selection of a source language for CLI on the L3.

Furthermore, the potential for crosslinguistic similarity in one aspect of language (e.g. morphosyntactic or lexical similarity) to exert an influence over CLI processes in another aspect (e.g. phonology) in which there is dissimilarity also remains untested in the field of L3 phonology. Whilst Rothman (2015) predicts that lexical similarity is the primary driving force behind the selection of a source language for all CLI on the L3, to date (to my knowledge), no study has yet tested this prediction, thus presenting an evident gap in the extant literature on third language acquisition.

As evident sites of heightened crosslinguistic lexical similarity, cognates represent an area of language through which the potential for crosslinguistic similarity at the lexical level to directly impact on CLI in other aspects of language may be tested. This thesis proposes the following four research questions to be investigated within this work:

1. Can phonological CLI on L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?
3. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects are neutral?
4. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects exist with both L1 and L2?

The Romance languages offer a context in which a relatively high degree of crosslinguistic lexical and morphosyntactic similarity may be found, alongside phonologies which display similarities in some areas, such as Voice Onset Time (VOT) in plosives, but differences in others, such as speech rhythm and vowel qualities. Beyond the Romance family, English, as a Germanic language, has a less evident degree of morphosyntactic similarity with Romance languages, however historic influences in the English language have led to parts of the English lexicon which have clear similarities to Romance languages. Hence, a language grouping of English and two Romance languages provides a context of differing levels of lexical, morphosyntactic and phonological crosslinguistic similarity, allowing for the examination of differing factors which may condition CLI in L3A.

This work will contribute new knowledge to the field of third language phonology by addressing the previously unstudied potential for the selection of source language for crosslinguistic influence of L1 and L2 phonological properties during L3 production to be influenced by localised crosslinguistic similarity at the morpholexical level. Furthermore, by testing a range of linguistic properties in which differing similarity and dissimilarity exists between the languages of the study's participants, this study's design allows for the examination of the nature of CLI in L3 production as either occurring from only a single language or from more than one language. Previous L3 phonology studies have focussed either too narrowly (such as examining only VOT in fortis plosives e.g. Llama et al., 2010), or too broadly (such as examining 'general accentedness' e.g. Wrembel 2010). This study addresses the newly emerging question within the field of L3A of whether CLI will occur exclusively from a single background language, or selectively, with specific elements of the grammars of one or more languages influencing the L3 on a property-by-property basis.

1.3. The Present Study: Methodological Overview

This study addresses the research questions proposed above through a series of experiments of L3 perception and production. Participants in this study are adult L3 learners enrolled on undergraduate language major degree programmes at a university in the United Kingdom. All participants are L1 speakers of British English, with either L2 French or L2 Spanish at intermediate level, acquiring European Portuguese as a third language from beginner level. Experiments were conducted to assess participants' ability to perceive and produce distinctions in plosives, the pre-palatal fricative-affricate pair, and a selection of front, central, and back vowels from their L1, L2 and L3. Portuguese differs from British English in the production of plosives, whilst it shares great similarity with both French and Spanish in this phonological property. Although British English utilises both the pre-palatal fricative /ʃ/ and the affricate /ʧ/ in phonemic contrast, European Portuguese and French each only use the fricative /ʃ/, whilst standard Spanish contains only the affricate /ʧ/. Vowels in European

Portuguese differ from those of Spanish, French, and English, however some vowels have properties which are similar, though not identical, to standard French, Spanish and British English vowels, creating an area of the L3 phonology in which subtle but interesting CLI effects may be observed in both perception and production. A fuller contrastive analysis of the phonological properties studied within this project are presented in Section 2.9.

Perception of the target phonological properties is tested through an Aural Perception and Distinction Task (APDT). This task examines participants' ability to distinguish between plosives and vowels from the L1, L2, and L3; it also tests participants' ability to distinguish /ʃ/ and /ʧ/. The role of cognates in influencing the source language for phonological CLI in L3 production forms a core focus of this project. It is tested by eliciting tokens of the target L3 Portuguese phonological structures described above during Oral Production Tasks (OPTs), produced within L3 words which will be divided amongst four cognate status conditions: Cognate with L1, Cognate with L2, Cognate with both L1 and L2, and Non-Cognate (i.e. cognate with neither the L1 nor the L2). All tests were conducted at three separate times over the course of one academic year.

The research questions of this project are addressed through a phonetic analysis of the properties described above, testing for interaction effects of cognate condition in order to assess the CLI processes in L3 Portuguese production. The phonological properties analysed were selected in order to offer a range of similarities and differences across the target languages of the research participants. This allows for CLI effects to be observed in a way that distinguishes between evidence of CLI on the L3 as occurring exclusively from a single background language, or occurring selectively from multiple background languages.

This chapter has introduced the core elements of this study, overviewing the rationale for the project, the research questions it addresses, and a brief insight into the methods by which the study is conducted. The following chapter reviews literature relevant to this work, including a discussion of crosslinguistic influence in non-native language acquisition, a review of cognates, lexical processing, and the multilingual lexicon, and a detailed introduction to the field of third language acquisition. It appraises several influential models of L3A, and considers studies in first, second, and third language phonology, before presenting a contrastive analysis of the phonological properties of English, French, Spanish, and Portuguese relevant to this study. Finally, it reviews the gaps in the L3A literature that this study addresses, reiterates the research questions and presents the hypotheses to be tested.

Chapter 2 **Literature Review**

This chapter presents a review of the literature pertinent to the focus of this project. It first examines crosslinguistic influence in non-native language acquisition, exploring this term, reviewing the way in which CLI is observed in NNL use, and defining how it is considered within this study. The chapter then introduces the field of third language acquisition, presenting and evaluating debate on terminology in the field and the differences between L2A and L3A, as well as prominent models of third language acquisition. The chapter subsequently examines lexical processing in multilinguals, the structure of the multilingual lexicon and the nature of cognates, before reviewing literature on the study of phonology in the L1, L2, and L3 contexts. This chapter also presents a contrastive analysis of the phonological properties of English, French, Spanish, and Portuguese that are relevant to this study. The chapter concludes with identifying gaps in the current L3A literature and how this study will contribute to the field. The study's research questions are reiterated, and the hypotheses that this study tests are set out.

2.1. Crosslinguistic Influence in Non-native Language Acquisition

Crosslinguistic influence (CLI) is seen to occur in the language use of a multilingual where elements of one known language impact on the perception or production of another language. This may occur in a multilingual's language use unconsciously or through deliberate, conscious choice.

Several prominent researchers in the field of non-native language acquisition (NNLA) have highlighted that CLI (also termed 'transfer' and 'interference') is frequently defined in very different ways within different studies (cf. Odlin, 1989; Selinker, 1992; Jarvis, 2000). Odlin (1989) argues that achieving a true definition of CLI is a huge task, requiring a thorough understanding and definition of all other language contact phenomena that it may encompass. By contrast Selinker (1992) claims more simply that in order to study CLI, it is necessary for researchers to carefully define what is meant by the term in accordance with the focus of each study in which CLI effects are examined. In his seminal work, Ringbom (1987:52) defines CLI as being the "reliance on L1 patterns which are assumed to be similar in L2", claiming that it is utilised as "one way in which the learner tries to cope with a gap of knowledge", whilst Odlin (1989:27) describes CLI as "the influence resulting from similarities and differences between the target language and any other language that has been previously acquired" and Jarvis and Pavlenko (2008:9) more generally define CLI as the use of existing linguistic knowledge as a basis from which to form hypotheses as to the nature of the target language. It is noteworthy that Jarvis and Pavlenko's (2008) definition of crosslinguistic influence does not specify that CLI will always surface in language use; furthermore their definition accounts more clearly for the influence that previously acquired linguistic knowledge will have on the process of language acquisition, not just on the observable result of this knowledge on language use.

Many previous studies of NNLA have used the terms 'transfer', 'interference', and 'crosslinguistic influence' interchangeably to refer to this phenomenon in non-native language acquisition, perception and production. However, as argued by Grosjean (2011) transfer and interference are themselves relatively broad terms which require separation. He defines 'transfer' as being a permanent and static feature of a language and therefore relating to the underlying mental representations; he defines 'interference' as being temporary and dynamic, and therefore relating to surface-level realisations of language use.

Jarvis and Pavlenko (2008) consider the terms 'transfer' and 'interference' to hold some issues in their history and connotations, highlighting in particular that 'transfer', being grounded in behaviourist theory, links primarily to the more general concept of transferring skills rather than linguistic properties, and that 'interference' causes attention to be drawn only to negative impact of CLI and thus does not account for potential positive effects. They further argue that crosslinguistic influence serves effectively as a "theory neutral cover term" (ibid 2008:3), and therefore this work adopts the term 'crosslinguistic influence' to refer to the impact of linguistic knowledge from one of a multilingual's known languages on another.

Jarvis and Pavlenko note that other authors in language contact fields have criticised CLI as a term because of implications it could have for the storage of language knowledge in the multilingual mind. They highlight that the term 'crosslinguistic influence' may be thought to suggest that a multilingual's languages exist as whole, discrete systems and that influence across languages occurs on a macro-scale of an entire language system influencing another. Much research however has strongly suggested that a multilingual's languages exist in a single, combined linguistic space (cf. Flege, 1995; Kroll et al., 2013; i.a.) I therefore argue that crosslinguistic influence can very effectively imply a micro-scale influence of a property of one language on another and does not have to suggest only macro-scale influence. I am thus in agreement with Jarvis and Pavlenko (2008:3) that such criticisms do not present a substantial impediment to the use of the term 'crosslinguistic influence'. By conceptualising a single, unified language space as comprising elements of linguistic knowledge associated (or 'tagged') with (a) particular language system(s) which may then interact with one another, CLI can thus be understood as leading to perception or production of one language in which linguistic properties surface which can be attributed to knowledge of another linguistic system. This may appear in the form of ‘positive CLI’, e.g. the ability to understand novel L2 lexis due to similarity in form and meaning in the L1, or in the form of ‘negative CLI’, e.g. the use of non-target-like phonological features in L2 production due to their substitution with L1-like phonemes.

Hence, despite the criticisms of the term crosslinguistic influence reported by Jarvis and Pavlenko (2008), I maintain that the term ‘CLI’ is compatible with a conceptualisation of multilinguals’ language knowledge as existing in a single unified space. I agree with Jarvis and Pavlenko’s (2008) assertions that the term ‘interference’ is overshadowed by connotations of negative CLI, and the term ‘transfer’ is marred by behaviourist implications. Furthermore ‘transfer’ may be considered a more simple process than the nuances available to the broader term ‘crosslinguistic influence’. As highlighted by previous authors (cf. Odlin, 1989; Jarvis, 2000; Jarvis and Pavlenko, 2008), ‘transfer’ refers more strictly to the direct overlay of a linguistic property from one language into the production or perception of another.

As is discussed below (in section 2.2.2), the nature of CLI in L3 acquisition is more complex than in L2 due to the larger pool of linguistic knowledge available to a beginning L3 learner. Thus, neither ‘interference’ nor ‘transfer’ appear adequate for the broader nature of L3 acquisition, in which compound CLI (influence of a background language which is itself subject to CLI) and combined CLI (simultaneous influence of a multiple background languages) effects may occur in L3 usage (cf. de Angelis, 2007). Furthermore, adopting the term ‘crosslinguistic influence’ throughout this work allows for consistency with the work of prominent authors in the field of L3 phonology, such as Magdalena Wrembel and Jennifer Cabrelli Amaro, who amalgamate the commonly used term ‘transfer’ with the broader-reaching term ‘crosslinguistic influence’ (cf. Cabrelli Amaro and Wrembel, 2016; Wrembel, 2015).

Based on the definitions in previous works discussed above (Ringbom, 1987; Odlin, 1989; Jarvis and Pavlenko, 2008), this work defines CLI as follows:

> Crosslinguistic influence is the use of previously acquired linguistic knowledge in the perception or production of another language, driven by learners’ assumptions on crosslinguistic similarities and differences.

In non-native language acquisition research, CLI is therefore observed as either:

1. A positive influence leading to target-like language use that would not occur without knowledge of linguistic structures from prior language experience, or:

2. A negative influence leading to non-target-like language use that would not occur without knowledge of linguistic structures from prior language experience.

Ringbom (1987) highlights that positive CLI can be difficult to observe and that this led early research to focus most strongly on negative CLI. Examples of positive CLI in NNL use may include a learner being able to comprehend novel TL lexis due to similarity to L1 lexical items where a learner of a different L1 cannot, or being able to aurally distinguish two TL phones where other learners cannot due to their proximity or distance to previously acquired phonemes.

By contrast, negative CLI has long been observed in NNL usage. In lexis and morphosyntax this may include misuse of partially synonymous terms or ungrammatical sentence structures. In phonology, this is frequently noted as a 'foreign accent', in which non-target like phonological structures influence the production of the target NNL but also includes the inability to consistently distinguish between NNL phonemes due to influence from the phonology of an L1 or another NNL.

However, recognising language use as being definitively impacted by CLI is not simple. Jarvis (2000) and Jarvis and Pavlenko (2008) criticise previous approaches to the study of CLI in language research as having treated CLI as a 'you know it when you see it' phenomenon. They argue that research methodologies frequently assume that target language use which exhibits structures similar to those found in previously acquired languages is due to CLI processes without sufficiently discounting other potential factors. In earlier work, Jarvis (2000), notes the frequently contradictory findings on the nature of CLI and sets out his intention to create a unified framework for CLI research incorporating:

> 1. a theory-neutral definition of L1 influence (or transfer) that would serve as a methodological heuristic for studies of this type,
>
> 2. a concise but exhaustive statement of the types of evidence that must be considered when presenting a case for or against L1 influence (cf. Ellis, 1985; Jarvis, 1998), and
>
> 3. a list of outside variables to be controlled in any rigorous investigation of transfer.
>
> (Jarvis, 2000:249)

To this end, Jarvis (2000) identifies three important factors which he argues research methodology should account for in order to define observed language use as being caused by CLI:

1. Intragroup similarity.
2. Intergroup differences.
3. Crosslinguistic performance similarities.

Jarvis and Pavlenko (2008) further argue that in order for language research to claim that observed effects are the result of CLI and not other factors (e.g. individual variation, general IL development) its methodology should meet preferably two, if not all three, of the following factors:

- Intragroup homogeneity
    - Subjects within a group should:
        - have clearly similar language backgrounds.
        - produce similar structures in their TL usage.
        - be consistent in their use of a structure in the source language.
        - be consistent in their use of a comparable feature in the TL.
- Intergroup heterogeneity
    - The experimental group's TL performance should be compared to, and found to be different from:
        - monolinguals of the TL with no relevant exposure to the source language, and/or
        - a 'mirror' experimental group i.e. a group of a different language background using the same TL.
- Crosslinguistic performance congruity
    - Subjects within a group should perform similarly in their L1 compared to their L2. This may be in terms of:
        - Similar performance in L1 and L2 when conceptualising prototypical and peripheral meanings in their form to meaning mapping. This may be due to assumptions regarding universality of matching concepts to lexical items.

- Under- or overuse of structures e.g. phrasal verbs, indirect speech, passive voice which may or may not constitute grammatical errors in the TL.

Jarvis and Pavlenko (2008) acknowledge that it is not possible for all studies to be strong in all three of these factors. They emphasise that whilst they believe it important to attempt to address these factors, CLI can still be effectively identified if justification for weaknesses is adequate.

Issues with intragroup homogeneity may arise due to the potential existence of universal interlanguage developmental processes. Comparing the participants of a study where intragroup homogeneity is weak to those of a study where similar participants performed in similar ways can counter this issue. Small sample sizes may also cause issues of intragroup homogeneity due to the individual variation between participants. A careful analysis of individual participants and evaluating participant performance internally as well as comparing them to one another can help to smooth out these issues.

Issues with intergroup heterogeneity may arise in studies of CLI which focus on a single group of participants without a mirror experimental group or a control group against which to make direct comparison. Nonetheless, as argued by Jarvis and Pavlenko (2008) such issues may be accounted for through data external to the study. This may most commonly take the form of comparing data from new studies to data of previous works which examine subjects of a different language background using the same TL, or subjects of the same language background using a different TL. It may also include comparing experimental groups' performance against externally determined monolingual baselines.

Problems in addressing crosslinguistic performance congruity in CLI research may arise where methodological and data analysis procedures do not adequately assess participants' language use. It is important therefore to ensure that error analysis procedures account not only for deviation from grammaticality, but also from norms of language use. However, issues of this nature are not generally salient in the type of CLI examined within this study.

2.1.1. Introducing CLI in L3A

Crosslinguistic influence has been a focus in non-native language research for some time, with rises and falls in interest in CLI over the decades (Jarvis and Pavlenko, 2008). More recently, the study of non-language language acquisition (NNLA) has expanded, as recognition has grown that the CLI processes in acquiring a second non-native language (NNL) differ from those in acquiring the first NNL, necessitating the study of L3 acquisition as a phenomenon distinct from L2A. Processes of CLI have heavily shaped work in the field of L3A since its inception leading to the role of CLI as being highly salient and a core focus of several models of L3A. Models of CLI in L2A such as the Full Transfer/Full Access model (Schwartz and Sprouse, 1996) have also evidently had a substantial impact on modelling L3 initial state and development. Models of third language acquisition are discussed in greater detail in Section 2.3, below.

CLI has been studied extensively in a wide range of aspects of second language acquisition, from morphosyntax (Gundel and Tarone, 1992; Jarvis and Odlin, 2000; Rah, 2010), lexis (Fraser, 1999; Gass, 1999; Helmes-Park, 2001), semantics (Gass, 1996; Sorace 1993) and even the understanding of spatial awareness (Odlin, 2005). Studies in L2 phonology have found evidence of L1 CLI both in perception of phonemic distinctions (e.g. Flege and Hillenbrand, 1987; Aoyama et al., 2004; Darcy et al., 2012) and in L2 production (e.g. Flege, 1997; Fowler et al., 2008; Aoyama et al., 2004).

Whilst it has been shown that both positive and negative CLI can occur in L2 acquisition and usage, by contrast studies of L2 phonology have generally found that for late, consecutive bilinguals (i.e. those for whom onset of L2A occurs post-infancy, and after the L1 has reached a stable end-state), CLI from the L1 has a predominantly negative impact on learners' ability both to perceive phonemic distinctions in the TL, and to accurately produce the L2's phonological patterns. Nonetheless, it has been proposed that, for L3 acquisition, some positive CLI, i.e. the use of linguistic structures from one language in another language which lead to convergence on target-like forms, may be employed due to a wider range of phonological experience. This may be considered to exist in the broader repertoire of phonological and phonetic patterns available to the L3 learner than those that are available to an L2 learner, due to the acquisition of new phonemic contrasts and phonological properties which occurs within the L2A process. Furthermore it may be argued that, through a successful L2A process, L3 learners will have acquired an ability to utilise linguistic knowledge and an understanding of the processes and learning strategies in NNLA, as well as an understanding of the relevance of seeking and utilising similarities between the new NNL to be acquired and previously acquired languages, thus allowing for greater potential for learners to attempt to actively encourage positive CLI from the L1 and L2 into the L3. These differences in L3 acquisition may be potentially useful tools available to L3 learners, accelerating the L3A process by allowing learners to actively focus on attempting to employ phonological structures from the L2 instead of the L1 when they are notably more similar to the target L3 structures, thus allowing for more rapid convergence on target-like forms. See Marx and Melhorn (2010) for further discussion of the merits of actively encouraging L2 CLI in an L3A context.

As mentioned above, the study of crosslinguistic influence constitutes a substantial and important area of research in the field of third language acquisition, with both the source of CLI and the driving factors behind such influence becoming prominent questions to be researched. Whilst evidence of L1 CLI in L2 perception and production is now widely considered “as SLA fact” (Selinker, 1992:171), in the L3 context the potential for CLI becomes more complex; the very nature of L3A implies that the learner has already acquired (or is in the process of acquiring) an L2. Thus the L1 is no longer the only linguistic system available to the learner, and consequently not the only potential source of influence on the target language.

The following section introduces Third Language Acquisition beginning with discussions of terminology, before evaluating core differences between L2A and L3A and the factors which lead into these differences.

2.2. Third Language Acquisition: An Introduction

This section approaches the issue of defining Third Language Acquisition and the very nature of a third language. It begins with a discussion of terminology within the field of L3A, establishing the manner in which key terms are used within this work, before examining the development of Third Language Acquisition as a field independent from Second Language Acquisition, and the ways in which L2A and L3A differ.

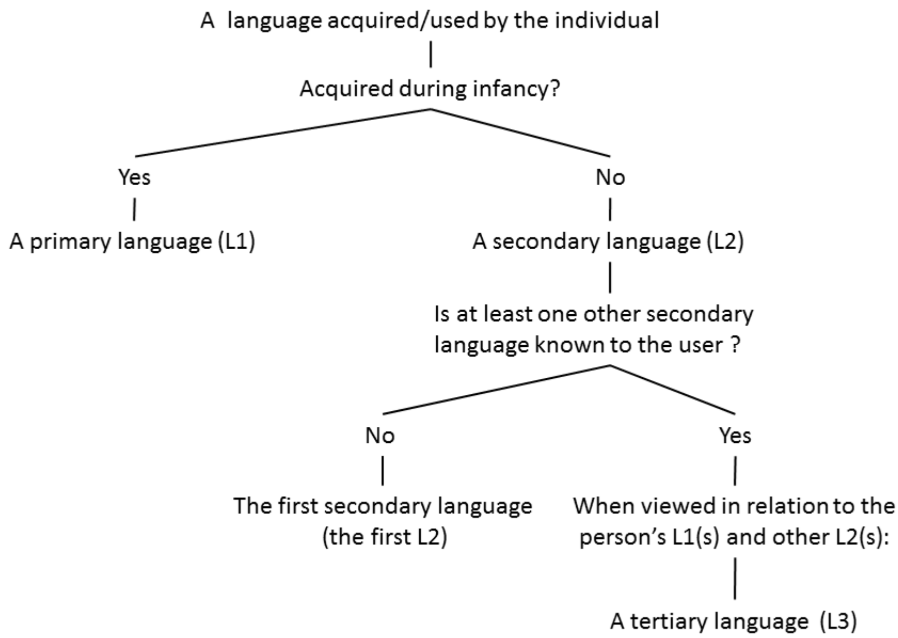
Earlier studies in NNLA tended to classify all languages as either L1 or L2. In consecutive bilinguals, the L1 was considered the native language, acquired naturalistically during infancy, and the L2(s) was (were) acquired later as (a) foreign language(s). Meanwhile, in studies of simultaneous bilinguals (i.e. those who had acquired two languages naturalistically during infancy), the terms L1 and L2 were frequently used for the two languages, with the L1 being either the most used or ‘dominant’ language, or the language for which onset of acquisition occurred first. In these studies, distinction was rarely made between the first NNL and subsequent NNLs, since it was assumed that the acquisition process was essentially the same. More recent work on the L3 initial state (see Rothman and Cabrelli Amaro, 2010; Iverson, 2010; Rothman, 2011) has shown this not to be the case; this is expanded on below.

2.2.1. Terminology in L3A

As noted by Gessica de Angelis, terminology in early work in third language acquisition and multilingualism was primarily adopted or adapted from the fields of second language acquisition and bilingualism (de Angelis, 2007). This adoption of L2 terminology has, on the whole, been relatively unproblematic, given the fundamentally interrelated nature of the two fields. Indeed, this crossover in terminology is, to some extent, necessary and useful to allow for comparison of research in L2 and L3. As a rapidly developing field there is a need to ensure consistency in L3A terminology and, when doubts arise, to be clear and precise on the usage of terms adopted or adapted from other, related fields of academic study.

In light of the complex reality of L3 learners' linguistic backgrounds, Hammarberg (2010) proposes abandoning the terms 'first', 'second', and 'third' language, offering in their place 'primary', 'secondary', and 'tertiary' language respectively, in order to move away from the implied chronological ordering of acquisition of an L3 learner's various languages. As Hammarberg (2010) argues, it is not uncommon for learners to begin acquiring an L3 before their L2 has reached end-state, or to cease using one language for a period of time, then later return to continue acquiring it. Thence, Hammarberg proposes a hierarchy for determining which of a subject's languages should be considered L1(s), L2(s) and the L3 (see Figure 1).

Figure 1: The Ordering Hierarchy (Hammarberg, 2010:101)



However I argue that the proposed usage of primary, secondary, and tertiary in lieu of first, second, and third does not entirely alleviate the perceived problematic ordering of languages as Hammarberg (2010) suggests. Whilst the chronological element becomes less overt, this hierarchy may imply a degree of importance, of frequency of use, or of proficiency applied to each language, which may not be appropriate for or representative of the linguistic reality of L3 users. Thus, although 'first, second, third' can imply a chronological order which may not always be appropriate, in the absence of another, more fitting set of terms, they are adequate and allow for consistency across work in L2 and bilingualism, and L3 and multilingualism; they are therefore adopted throughout this work.

Nonetheless, some elements of Hammarberg's (2010) ordering hierarchy are highly pertinent in defining the bounds of an L1, L2, and L3 and their relations to one another. Hence, I propose the following definitions of these terms; these are adhered to throughout this work.

- L1: A language acquired during infancy in an essentially naturalistic (i.e. non-classroom) manner, and in which full, native-like proficiency is obtained.
- L2: A language acquired after infancy; a non-native language. An L2 may still be under development or may have reached a stable end-state, with or without divergence from native-like target language norms.
- L3: A language acquired after infancy; a non-native language. Not the only non-native language known to the subject. The language currently under observation in development or use. An L3 may still be under development or may have reached a stable end-state, with or without divergence from native-like target language norms.

It should be noted that these definitions allow for multiple L1s and L2s, but for only one L3. When examining L3 use and development, and crosslinguistic influence on the L3, the term 'background languages' is frequently used to encompass all L1s and L2s of an L3 user. Whilst somewhat imprecise as a tool for describing the complexity of a multilingual's linguistic experience, the term does offer a degree of conciseness. Its use is adopted for this work in order to refer to learners' L1(s) and L2(s) collectively in a simplified, concise manner.

2.2.2. Beyond the L2: On the Differences between Second and Third Language Acquisition

Whilst earlier work conducted within the L2 research paradigm considered the process of acquiring any NNL to be fundamentally the same, it is now more widely accepted that L2A and L3A cannot be considered equal (see Leung, 2005 for discussion). Despite notable similarities, there are key differences between L2A and L3A which make it clear that the two can neither be treated equally nor studied within identical frameworks. This section highlights similarities between the L2A and L3A processes, before discussing the differences that separate them.

One evident similarity between the developmental processes of L2 and L3 grammars may be found in their end state. In both, there exists the potential for fossilisation leading to non-target like structures and the potential for near-native grammars, possibly with optionality not found in L1 grammars (see for example Sorace, 1993 for further discussion of optionality in near-native grammars). Similarly, the development of L3 interlanguage rules has been observed (Pyun, 2005), with non-target like forms in the L3 which could not be evidently traced to CLI from background languages. Finally, it has been seen that areas of difficulty in L3A can occur in agreement with predictions made by influential models of L2 acquisition.

Slabakova (2012) evaluates four prominent models of L2 acquisition in terms of their implications for L3A, reviewing the predictions that would be made for the L3A process by the Interface Hypothesis (Sorace, 2000, 2003), the Interpretability Hypothesis (Hawkins and Hattori, 2006; Tsimpli and Dimitrakopoulou, 2007), the Feature Reassembly Hypothesis (Lardiere, 2007, 2008) and the Bottleneck Hypothesis (Slabakova, 2006, 2008, 2013, 2014). Through her assessment of these models Slabakova (2012) concludes that although some of the challenges faced by an L3 learner differ to those of an L2 learner, several difficulties seen in L2 morphosyntax development are mirrored in the L3A context. She further highlights that the strengths and weaknesses of these models exposed by L2 data are also seen with L3 data.

Slabakova (2012) observes that both the Feature Reassembly Hypothesis and the Bottleneck Hypothesis are able to effectively predict difficulty and account for observed processes of transfer in acquisition of L3 aspectual morphemes in Romance languages, whilst the Interpretability Hypothesis was unable to account for such data. She additionally argues that although the Feature Reassembly Hypothesis and the Bottleneck Hypothesis can effectively explain and predict much of L3A data, they lack the fine-detailed approach necessary to adequately account for the complexity of L3 transfer processes. See Slabakova (2012) for a fuller account of the application of these L2A models to the L3 context. Although based in the study of morphosyntax and not phonology, Slabakova's (2012) analysis shows that modelling of language development beyond L3A can be highly relevant to the L3 context. Thus I argue that in studying L3 phonology it is pertinent to also review L1 and L2 phonology and the prominent models that have influenced those fields.

Studies in L3 phonology remain few in number, however it is clear that processes of CLI in L3 phonology are complex and show both similarities and differences to those of L2 phonology. L3 phonology research has argued that CLI can impact on the production of the L3 in as wide a variety of aspects as those seen in work on L2A, however most L3 phonology research to date has focussed on either voice onset time (VOT; see, for example Pyun, 2005; Llama et al., 2010;

Gut, 2010) or general accentedness (Wrembel, 2010, 2012). Similar to results seen in many L2 studies of these properties, non-target like phonological features arise within L3 production which appear to be traceable to properties of previously acquired linguistic systems, such as L1 influenced VOT in production of NNL fortis plosives.

Nonetheless, differences in L3A and L2A have also been noted in research on phonological CLI, with many L3 phonology studies seeking to identify which background language(s) may become the source of crosslinguistic influence on the newly developing L3. Whilst some studies argue in favour of L1-only CLI (cf. Wunder, 2011), or L2-only CLI (cf. Wrembel, 2010; Hammarberg and Hammarberg, 2005), others conclude that either L1 or L2 may become the source language of CLI on the L3 (cf. Llama et al., 2010; Rothman 2011). These studies are discussed in greater detail in Section 2.8, below. As discussed above, an additional difference between phonological development in L2A and L3A may be found in Marx and Melhorn's (2010) argument that a potential for positive CLI may be found in the augmented phonological repertoire of an L3 learner as compared to an L2 learner. Models of L1 and L2 phonology such as the NLM-e (Kuhl et al., 2008) and the SLM (Flege, 1995) would predict that the restructuring of the perceptual phonological space undergone during the L2A process will lead an L3 learner to differ from an L2 learner, due to novel L3 sounds being processed in the context of both established L1 and L2 phonemic categories. Models of L1 and L2 phonology and their implications for third language acquisition are discussed in greater detail below.

As mentioned above, differences between L2A and L3A have been a salient issue in the literature of recent decades. One noteworthy distinction which has played a key role in the development of several models of L3A is that of the initial state, which is discussed extensively in the generative L3 literature (see for example Rothman and Cabrelli Amaro, 2010; Iverson, 2010; Rothman, 2011).

2.2.3. The Initial State in L3

The role of the L1 in establishing the initial state of the L2 forms a major component of various models of L2A. The Full Transfer/Full Access model (Schwartz and Sprouse, 1996) considers the initial state of L2 to be the end-state of the L1, transferred in its entirety, whilst other models such as the Minimal Trees Hypothesis (Vainikka and Young Scholten, 1994, 1996) consider L1 influence to be partial. However when considering L3 acquisition the picture is more complex.

Whilst in L2A the only potential source of crosslinguistic influence on the L2 is the L1, at the onset of L3 acquisition there are at least two linguistic systems already known to the learner. Thus the logical possibility exists that the L1 and L2 systems have the potential to form the initial state of the L3, be this in its entirety or in part. In both of these contexts (L2 and L3 acquisition), beyond the initial state the new, non-native language must develop, with interlanguage progressing through restructuring of features according to the input and within the constraints of Universal Grammar. Figures 2, 3, 4 and 5 demonstrate an application of the above discussion to graphically represent the formation of initial state of L2 and L3, and the continuing development of L2 and L3 (adapted from White, 2003), where NNL restructuring is condensed into a single, “interlanguage” (IL) box.

It should be noted that in figures 4 and 5 the L2 may be either a developing IL or a have reached a stable end-state. Whilst an L2 IL may not be a native-like form of the target language, it remains a linguistic system, governed within the confines of UG (see Selinker, 1972, 1992 for more on the systematicity of interlanguages) and thus may be a potential source of CLI, a proposition argued particularly by Jason Rothman (2015). In these figures, dotted lines represent the potential for CLI, as theoretical discussion and empirical evidence presented within the extant L3 literature is not yet considered conclusive on whether the L1, the L2, or both may become sources of CLI on the L3.

Figure 2: L2 Initial State

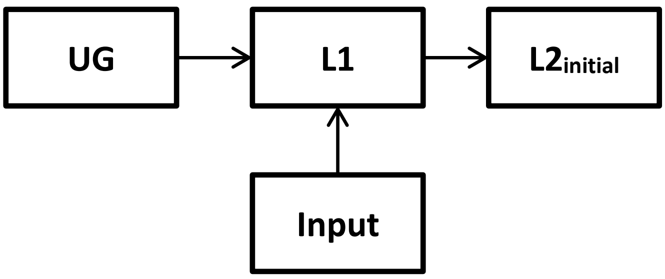


Figure 3: L2 Development

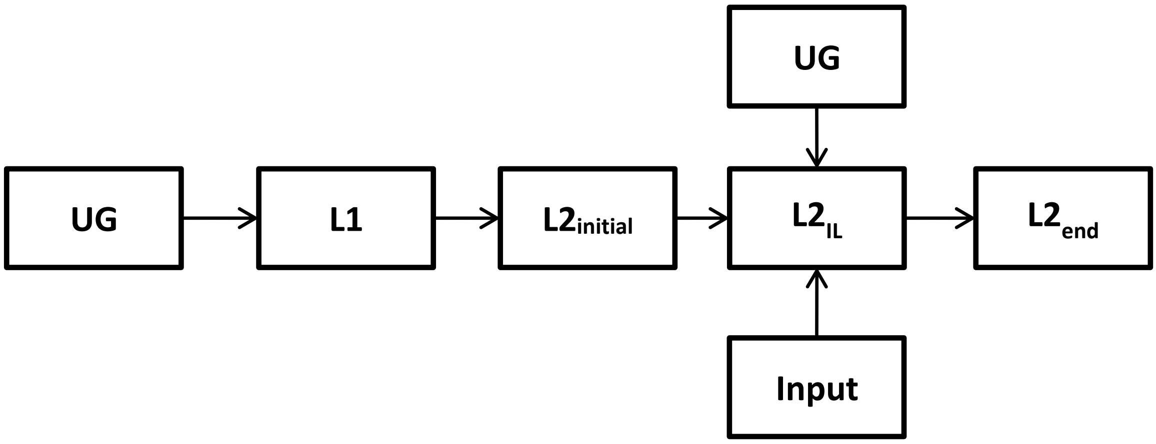


Figure 4: L3 Initial State

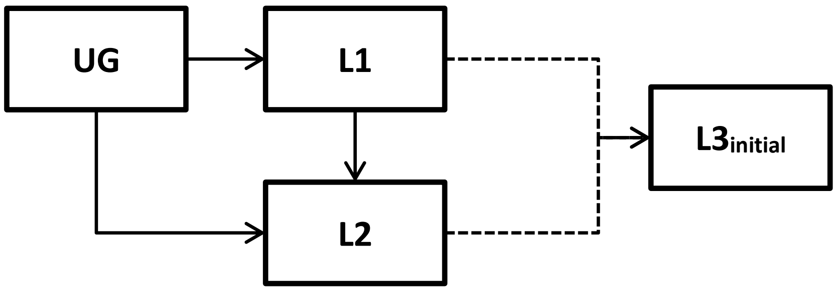
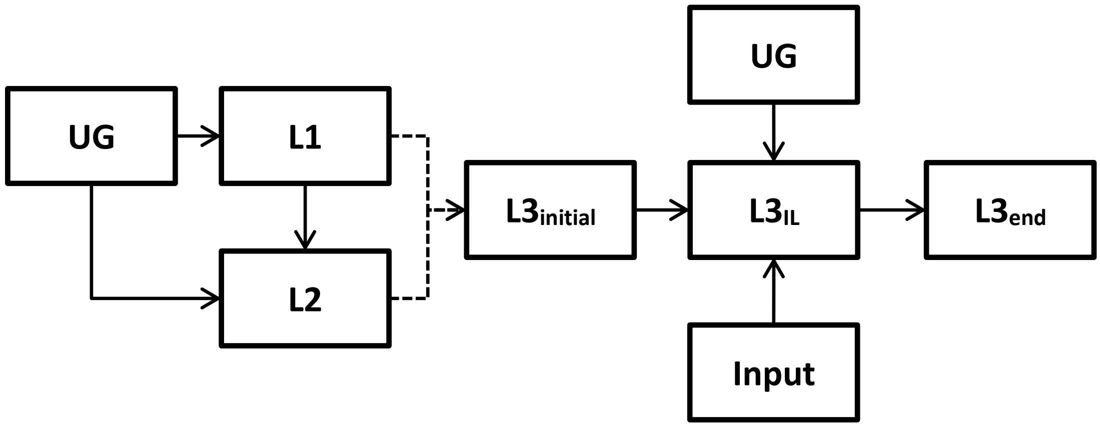


Figure 5: L3 Development



Whilst the initial state of L3 and the role of L1 and L2 in its formation have been scrutinised in the literature, other factors which are and are not shared in L2A and L3A have also been debated and are discussed below.

2.2.4. Further Factors in L3 Acquisition

Aside from the differences in the initial state considered above, further distinguishing factors between second and third language acquisition have been discussed by several authors (see Hufeisen, 2005; Ó Laoire, 2005; Marx and Melhorn, 2010; Cenoz et al., 2001 i.a.). Britta Hufeisen (2005) proposes the factor model of language acquisition to demonstrate the various aspects which play a role in the language acquisition process, postulating that with each language learnt these will be different and greater in number. In this model, five factors that influence L2 development are set out:

- Neurophysiological factors (e.g. learner age, language aptitude)
- Learner external factors (e.g. quantity and quality of input)
- Affective factors (e.g. motivation, anxiety)
- Cognitive factors (e.g. metalinguistic awareness, learning strategies)
- The L1

For third language acquisition, Hufeisen adds one further factor to the model, termed “Foreign Language Specific Factors” (Hufeisen, 2005:38), considered to include such elements as previous experiences of non-native language acquisition and learning strategies developed during L2A; previously learnt languages, i.e. the L1(s) and L2(s); and the interlanguage of the L3 itself, in a similar way to the ‘Multilingualism Factor’ proposed in the Dynamic Model of

Multilingualism (Herdina and Jessner, 2000, 2002). Whilst somewhat lacking in specific details and making no predictions for the development of the third language, the Factor Model of L3A (Hufeisen, 2005) does highlight that whilst apparently similar to L2A in many ways, L3A is influenced by not only the wider linguistic repertoire of the learner, but also by the fact of the L3 not being the learner's first experience of learning a foreign language. Thus, it further underlines that L3 learners will not behave in the same way as L2 learners, due not only to the effects of crosslinguistic influence, but also to their previously developed metalinguistic knowledge and language strategies.

However, Cabrelli Amaro (2012) highlights that, in studies of L3 phonology, the role of metalinguistic knowledge and phonological learning awareness in facilitating L3 acquisition lacks substantial empirical support. She argues that L3 phonemic distinctions which L3 learners have not acquired from their background languages are no easier to distinguish for them than they are for monolinguals who do not have that distinction in their L1. Cabrelli Amaro (2012) thus postulates that only specific linguistic experience with an L3 structure can offer facilitation in L3 acquisition, and that non-specific experience, such as general language learning experience, is of limited use for effective acquisition of novel linguistic properties. Further research is needed in order to better assess factors beyond CLI in facilitating or inhibiting the L3A process, however such concerns lie beyond the focus of this study.

This section has introduced third language acquisition, reviewed the application and usage of terminology in the field, and discussed the essential differences that separate third language acquisition from second language acquisition. The following section reviews four influential models of third language acquisition.

2.3. Models of Third Language Acquisition

As studies of third language acquisition as a phenomenon distinct from second language acquisition began to emerge, early research in the field often focussed on lexical CLI on the L3, examining the source of both positive and negative CLI. Based primarily on evidence of lexical CLI in L3 production observed in a case study of one learner, Williams and Hammarberg (1998:322) propose four factors that may lead to the selection of a background language as a source of crosslinguistic influence on the L3:

- Proficiency
- Typological proximity to the target language
- Recency of use
- L2 status

In their work they consider L2 status to be a uniquely influential factor, postulating that should there not be a substantial difference between L2 and L1 in terms of proficiency, typological proximity, or recency, then the L2 will become the preferred source of CLI on the L3, due to a relationship established between the two linguistic systems by dint of their both being non-native languages. This position is supported by other authors, notably Gessica de Angelis (2007) who postulates an 'association of foreignness' which creates a cognitive link between all non-native languages to the exclusion and isolation of the L1(s) due to learners perceiving their L1(s) as inherently distant from all non-native linguistic systems. However, the data on which de Angelis bases these hypotheses come from a test of L3 Italian which revealed CLI from L2 Spanish in favour of L1 English, hence it is unclear whether the CLI observed was conditioned by the L2 status of Spanish, or by other factors, most notably typological similarity and evident, objectively observable similarity in lexical and morphosyntactic structure between the L2 and L3.

Building upon the factors proposed by Williams and Hammarberg (1998), several models of the role of CLI in creating the L3 initial state have been proposed, based on studies of L3 morphosyntax. Four of these models that remain influential within the field are discussed here: the Cumulative Enhancement Model (Flynn, Foley and Vinnitskaya, 2004), the L2 Status Factor Model (Bardel and Falk, 2007; Falk and Bardel, 2011), the Typological Primacy Model (Rothman, 2010, 2011, 2013, 2015), and the scalpel model (Slabakova, 2017). Although support for the CEM and the L2SF has begun to diminish in recent years, their impact on the field has been noteworthy and they thus merit discussion here. Through comparison of the four aforementioned models two salient, current questions in L3A emerge:

1. Which language(s) can and will become the source of CLI in L3A – the L1, the L2, or both?
2. Does CLI occur exclusively i.e. only properties of one background language grammar forming the L3 initial state, or selectively i.e. on a property-by-property basis from multiple background languages?

2.3.1. The Cumulative Enhancement Model

Flynn et al. (2004) studied the acquisition of L3 English by speakers of Kazakh and Russian. Their experiment tested the production of relative clauses in L3 English by L1 Kazakh – L2 Russian subjects, yielding results which suggest that positive CLI from L2 Russian and avoidance of negative CLI from L1 Kazakh allowed for correct positioning of lexically headed relative clauses in the L3. They thus claim that the L1 does not play a privileged role in conditioning crosslinguistic influence on non-native languages and proposed the Cumulative Enhancement Model which predicts that CLI can be selective, and will come from whichever background language would allow for positive CLI and thus lead to successful acquisition of a property. It further predicts that *only* positive CLI (i.e. the use of linguistic structures from one language in another language which lead to convergence on target-like forms) will occur; should there only be opportunity for negative CLI (i.e. the use of linguistic structures from one language in another language which lead to divergence from target-like forms), this will not obtain.

Whilst this model plays an important role in demonstrating that the L1 is not the only potential source of CLI in L3A, it is not able to account for evidence of negative CLI observed in other studies (see, for example, Williams and Hammarberg, 1998; Bardel and Falk, 2007; Wrembel, 2010; Slabakova and García Mayo, 2015). Furthermore, the CEM predicts that the acquisition of L3 properties for which neither the L1 nor the L2 may provide a facilitative effect is achieved through access to UG. Consequently, it would appear to suggest that the end-state of the L3, with only positive CLI and direct access to UG, should eventually achieve full, native-like attainment, in a similar vein to the No Transfer/Full Access model of L2A (Epstein et al., 1996). However, if UG is available to an L3 learner in this manner, the relevance of CLI may be questioned, beyond potentially expediting the process of acquiring specific properties for which positive CLI is possible. The neutralisation of all negative CLI on the L3 proposed by this model implies that, should there be no opportunities for positive CLI, any and all properties of the L3 can and will be acquired through input and access to UG. Thus, within the context of the CEM's predictions, any positive CLI which does occur merely bypasses the intermediary step of (re)setting L3 parameters through L3 input and direct access to UG.

Hence, this model's use for predicting the source language for CLI in L3A is limited, and its predictions for both the formation of the L3 initial state and the continuing development of the L3 are unclear and ultimately inconclusive.

2.3.2. The L2 Status Factor Model

Two studies conducted by Ylva Falk and Camilla Bardel into L3 Dutch and Swedish negation (Bardel and Falk, 2007) and L3 German object pronoun placement (Falk and Bardel, 2011) both found that acquisition of the property under investigation was influenced by the L2, regardless of whether this CLI was positive or negative. They thus propose the L2 Status Factor Model of third language acquisition, which predicts that all CLI from the L1 is blocked in favour of exclusive influence from the L2 system, assuming a cognitive link between non-native language systems, such as that postulated by de Angelis (2007).

Several studies have claimed to support the L2 status factor (see Burton, 2013; Hammarberg and Williams, 1993 [reprinted 2009]; Williams and Hammarberg, 1998; Llama et al., 2010), however such studies have frequently failed to account for other factors, having studied subjects with language combinations that render the L2 and L3 either typologically related or evidently structurally similar to one another and distant from the L1. Furthermore, this model has not been tested in cases with more than one L2, thus it is unclear what predictions the L2 status factor would make in such situations. It therefore remains unable to predict which L2s will become the source language(s) and whether multiple L2s would lead to exclusive influence from one L2 system, or selective CLI from multiple L2s.

2.3.3. The Typological Primacy Model

In contrast to the CEM and the L2SF, the TPM (Rothman, 2010, 2011, 2013, 2015) hypothesises that CLI on the L3 may obtain from either an L1 or an L2 and that CLI may be positive or negative. This model is proposed in light of data from a study of the syntax-semantics relation of adjective placement in L3 Spanish and Portuguese by speakers of Italian, Spanish and English (Rothman, 2011). This study tested two groups: 1) L1 English – L2 Spanish – L3 Portuguese, and 2) L1 Italian – L2 English – L3 Spanish and found that both groups' L3 grammar was influenced by the relevant property from the background language most similar to the target language. It was thus postulated that it is structural similarity (perceived or actual) that determines the source language for CLI on the L3. Later expansion of this model (Rothman, 2015) further proposed a hierarchy of elements of crosslinguistic structural similarity in conditioning CLI, advancing lexical similarity to be the primary driving force behind choice of CLI source, followed by phonological similarity, then similarity in functional morphology, and finally syntactic structure. Should similarity not be perceived at the highest level of this hierarchy (i.e. in the lexicon) then the next level is considered, working downwards until a structural similarity is perceived.

Hence, the TPM predicts CLI to come from whichever background language is perceived (unconsciously) by the learner to be most similar to the target language, in accordance with the aforementioned hierarchy. However, I note that such learner perceptions are not necessarily the same as what may be termed 'Objectively Observable Structural Similarity' i.e. similarity determined through the objective application of descriptive linguistics and contrastive analysis. The TPM further predicts that crosslinguistic influence is exclusive: once a candidate language has been selected as the most similar to the target language based on learner-perceived similarity, only this linguistic system is used in the formation of the initial state of the L3, leading to the potential of both positive and negative CLI. Rothman (2015) speculates that CLI will be exclusive because it may be more efficient in terms of processing to draw upon only one grammar once evidence that it is useful has been observed in the input. However the logic that it may seem inefficient to maintain activation of the L1(s) and L2(s) and search through all known linguistic systems for relevant structures is countered by Slabakova (2015, 2017) in her proposal of the scalpel model (discussed below).

The Typological Primacy Model effectively accounts for evidence that CLI may be positive or negative and may come from an L1 or an L2, however studies have recently emerged that suggest that CLI may have occurred against both typological relatedness and (seemingly) obvious overall structural similarity (Sanz, Park and Lado, 2015; Hermas, 2015). Furthermore, the prediction that CLI is lexically driven remains untested. Additionally, despite an emphasis placed on the role of learner perceptions, attempts to assess psychotypology in L3 studies are rare (see Singleton and Little, 2005 for one approach to gathering data on learner perceptions of crosslinguistic similarity). Frequently, the assumption is made that learner perceptions will match Objectively Observable Structural Similarity. If learner perceived similarity is to be considered of greater impact in conditioning CLI on the L3 than actual structural similarity, then such an assumption cannot be made without a substantial body of evidence that the two are consistently the same. Nonetheless, this model has garnered support from several studies (see Ringbom, 1992, 2007; Odlin and Jarvis, 2004; Wrembel, 2012; Giancaspro, Halloran and Iverson, 2015 i.a.).

2.3.4. The Scalpel Model

Similarly to the TPM, the recently proposed scalpel model (Slabakova, 2015, 2017) predicts that CLI may come from either L1 or L2 and that CLI is conditioned by structural similarity. In further agreement with the TPM, but in contrast to the CEM, the scalpel model allows for CLI to be either positive or negative. However in contrast to the TPM, the scalpel model does allow for selective CLI, i.e. CLI on a property-by-property or feature-by-feature basis. In contrast to the CEM, the scalpel model does not assume that all potentially positive CLI will occur, postulating several factors which may prevent potential positive CLI from one background language (and thus open the opportunity for negative CLI from another) including: the complexity of the linguistic processing required for the construction at hand, misleading or insufficient evidence in the input, and proficiency in the L2(s).

Whilst evidence of the selective CLI predicted by this model remains to be empirically demonstrated (see García Mayo and Slabakova, 2015 for suggestions on methodologies required to examine exclusive vs. selective transfer), Slabakova (2015) argues that the sophistication of multilingual grammars is such that crosslinguistic influence exclusively from one linguistic system need not be the only option, and a more precise, property-by-property type of CLI may be possible. She further speculates that, considering the fundamentally interconnected nature of linguistic systems in the brain and observed coactivation of all languages during lexical access (see Kroll, Gullifer and Rossi, 2013 for a review), attempting to suppress one or more languages in order to allow CLI solely from one system may result in inefficiency. She argues that expending resources on restructuring the L3 when the appropriate property could have been utilised from a previously established linguistic system for which it had been acquired is inefficient. In essence, the scalpel model of L3 acquisition predicts that both positive and negative CLI can occur on a property-by-property basis from either the L1(s) or L2(s). It further stipulates that it is neither typological relatedness nor any impression of overall crosslinguistic similarity that conditions the selection of a source language for CLI, but rather a more precise analysis of the input and its relation to previously acquired linguistic properties.

This section has presented four influential models of third language acquisition, each with different predictions on the nature of CLI in L3A, which are summarised in Table 2.3.1. Although each model has different strengths and weaknesses, three common themes are apparent, namely:

1. Which language(s) may become the source of CLI.
2. Whether transfer is exclusive or selective.
3. The factor(s) which drive(s) the selection of source language(s)

Table 2.3.1: Models of L3 Acquistion

Model	Allows L1 CLI	Allows L2 CLI	Transfer type	Driving factor(s)	Caveats
L2SF	No	Yes	Exclusive	L2 status	• Does not account for observed L1 CLI • Unclear predictions with multiple L2s
CEM	Yes	Yes	Selective	Facilitation effect of L1/L2 property	• Does not account for observed negative CLI

TPM	Yes	Yes	Exclusive	Learner-perceived general structural similarity (primary lexical)	• Does not account for new data suggesting CLI against general similarity • Hierarchy untested
Scalpel	Yes	Yes	Selective	Structural similarity at property-by-property level	• Empirical evidence for selective CLI yet to emerge: further study needed.

Whilst these models were developed through the study of L3 morphosyntax, they have frequently been applied to lexical CLI, and it has been argued that they can all be applied to phonological development in L3A (Cabrelli Amaro, 2012). However, as mentioned above, a substantial body of empirical evidence now falsifies the predictions of the L2SF (that only L2 CLI will occur) and of the CEM (that all CLI will either be positive or remain neutral). Future study and testing of L3 models should therefore focus on two remaining questions in L3 development processes: does CLI occur exclusively or selectively, and which factors condition CLI source selection in L3A. This study addresses these questions within the context of L3 phonology.

Sections 2.2 and 2.3 have discussed the core literature on which the study of third language acquisition is based. As mentioned in Chapter 1, this study examines the role of L3 morpholexical processing in conditioning phonological CLI in L3 Portuguese. Therefore, the following sections review lexical processing and the multilingual lexicon, before discussing phonology in the L1, the L2, and the L3.

2.4. Lexical Processing in Multilinguals

As was the case with much early research into CLI in second language acquisition (Jarvis and Pavlenko, 2008), lexical processing dominated early work in the field of L3A. In his seminal work, Ringbom (1987) examines the study of lexical CLI in the acquisition of third language English with speakers of Finnish and Swedish. In this early stage of L3A research, Ringbom (1987) argues that CLI from the L2 on the L3 will be overwhelmingly focussed in lexical CLI, and is dismissive of the potential for CLI to occur within morphosyntactic or phonological structures. More recent work however has shown that substantial CLI can and does occur in both of these areas (see discussion throughout Chapter 2). He further argues that the primary source of CLI in L3A will be the L1, claiming that where evidence of lexical CLI from the L2 arises, this is a case of superficial lexical borrowing from a more structurally similar language. In his study, Ringbom (1987) found that L1 Finnish participants commonly used function words from their L2 Swedish in L3 English but that L1 Swedish participants were more likely to use content words as well. These results appear to support the assumption that the L1 is the primary source of lexical CLI, however the methodology employed within this study makes it difficult to separate superficial lexical borrowing from more deeply rooted CLI processes. Nonetheless, this early work in L3 CLI proved important in highlighting that it is much more difficult to identify positive CLI in NNLA research than it is to identify negative CLI. Thence, contrary to the direction of much NNLA research at the time, Ringbom (1987) shows that CLI may be positive as well as negative, in addition to demonstrating that CLI processes of L3A differ from those of L2A due to the broader pool of linguistic knowledge from which the learner may draw.

Studies in L3 lexis conducted within the context of the models of L3A discussed above have generally lent support to either the L2 Status Factor model (Bardel and Falk, 2007; Falk and Bardel, 2011), or the Typological Primacy Model (Rothman, 2010, 2011, 2013, 2015). A number of studies have proposed that their data support the L2SF (see Williams and Hammarberg, 1998; Vogel, 2005; Burton, 2013), however a closer examination of the methods employed in these studies reveals that other factors may have played a role in selection of a source language for CLI, but were disregarded.

Several studies which argue in favour of the L2SF fail to account for factors of typological relatedness and structural similarities (see, for example, Williams and Hammarberg, 1998; Vogel, 2005; Burton, 2013). Burton (2013) in particular hypothesises that non-native language systems are ‘tagged’ as ‘foreign’ within the lexicon, in a similar vein to de Angelis’ (2007) ‘association of foreignness’, causing the L2 to take a privileged role as the source of CLI into the L3. By contrast, several works in L3 lexis have argued that either the L1 or the L2 may become the source of CLI in the L3, with data seen to support the hypothesis that typological relatedness or structural similarity will be the primary factor in determining the source language for CLI (Odlin and Jarvis, 2004; de Angelis, 2005; Ringbom, 2005). Furthermore, de Angelis (2005) and Ringbom (2005) both show evidence of selective CLI. In their studies lexical CLI into the L3 was seen to occur primarily from the most structurally similar language. Both of these studies found that L3 function and content words were influenced by the L2, however participants whose L1 was more distant than the L2 from the target L3 also employed some content words from the L1 in their L3 production.

2.4.1. Lexical-Phonological Processing

Research on code switching in bilinguals has revealed that coactivation of the languages of a multilingual through exposure to lexical items of both languages leads to increased phonological CLI. Grosjean (2011) proposes that all bilinguals (and, by extension, multilinguals) move along a continuum between a 'unilingual mode', in which only one language is activated and 'bi[multi]lingual mode', in which both or several languages are simultaneously activated. Several studies have examined the impact of language mode on CLI processes by attempting to induce a bi/multilingual mode in participants and examining phonological CLI at sites of forced codeswitching. Through the use of picture naming exercises Goldrick et al. (2014) and Olson (2013) show that in 'switch' trials (i.e. naming a picture in a different language to the previous picture) a residual effect of the previous language's phonology was seen in the pronunciation of the new language, with acoustic qualities of the oral production being different to those seen in 'stay' trials (i.e. naming a picture in the same language as the previous picture). Goldrick and colleagues (Goldrick et al., 2014) saw that for a group of L1 Spanish - L2 English participants, VOT in L2 English was shorter in switch trials than in stay trials, which they attribute to a lingering activation of L1 Spanish phonology.

In two studies of the impact of language switching on phonological processing, Olson (2013, 2016) examined Spanish-English early bilinguals' production of VOT in fortis plosives under conditions of attempting to shift participants' language mode towards monolingual and bilingual modes. In his earlier study Olson (2013) tested two experimental groups in a picture naming exercise utilising language switches in order to examine phonological processing at sites of code switching, thus touching upon interactions of lexical and phonological processing in the multilingual brain. Olson (2013) attempts to manipulate participants' language mode in this study through creating monolingual and bilingual environments for testing sessions. In monolingual mode tests, all instructions were given in a single language (one test in English, one test in Spanish) and 95% of the picture stimuli were to be named in the target language. In bilingual mode tests, instructions were given evenly half in Spanish and half in English and the picture naming task required 50% of responses to be in each language. In monolingual mode, the L1 Spanish - L2 English experimental group showed no significant difference in their English VOT on switch trials against stay trials, however VOT for /k/ in Spanish was significantly longer in switch trials than in stay trials. By contrast, the L1 English - L2 Spanish group showed no impact of switch vs stay trials on their VOT in either language within monolingual mode. In bilingual mode, participants in Olson's (2013) study showed no impact of switch vs. stay trials. Olson thus hypothesises that CLI is more impactful when switching into a new language that is not (or not highly) activated, arguing for an understanding of language activation based on a gradient version of the Inhibitory Control Model (Green, 1998).

Olson's later study (Olson, 2016) further explored the impact of language switching and language mode on phonological CLI using textual stimuli with two groups of early bilinguals (one English-dominant i.e. L1 English - L2 Spanish; one Spanish-dominant, i.e. L1 Spanish - L2 English). In this study, participants read aloud written sentences which varyingly contained no language switches, single-word language switches, and full, phrase-level language switches. VOT of fortis plosives produced in these sentences was measured for testing. Noting that previous studies of CLI in highly proficient bilinguals had shown that crosslinguistic influence was generally increased when participants produced their languages in a bilingual mode context, Olson (2016:268) hypothesises that there will be a compound effect of language switching and bilingual mode leading to increased CLI compared to language switches in a monolingual mode context condition. Results of this study showed that English fortis plosive VOT was significantly shorter in switch trials (switching from Spanish into English) than in stay trials for both the English-dominant and Spanish-dominant groups, suggesting that CLI had occurred from Spanish for both groups. Language mode had no further impact on English VOT for the English-dominant group, however the Spanish-dominant group produced significantly longer English VOT in bilingual mode than in monolingual mode, contrary to Olson's hypothesis. In Spanish VOT, the English-dominant group in this study showed no effect of language switching or language mode, however the Spanish-dominant group produced significantly longer Spanish VOT in switch trials (switching from English into Spanish) than in stay trials, though no additional effect of language mode was observed.

Olson (2016) argues that the observed lack of any compound effect leading to increased CLI for language switches in bilingual mode may be due to an upper limit on the degree of influence that one language's phonological system can exert on the other's. He consequently claims that whilst bilinguals will produce speech with evident CLI, they will strive for intelligibility and maintain relevant distinctions between their two languages. I, however, argue that the fact that CLI into English from Spanish was seemingly reduced in bilingual mode for the Spanish-dominant group, but not for the English group may be influenced by relative activation levels of the two languages. As mentioned above, monolingual mode tests for the each group were primarily in the participants' dominant language with few switches into the other language, whilst bilingual mode tests comprised an even split of usage of the two languages. For the English-dominant group, English will have been highly activated in both monolingual and bilingual modes leading to no difference in the degree of CLI seen from Spanish, whilst for the Spanish-dominant group English will have only been highly activated in bilingual mode. For the English-dominant group, therefore, there was comparatively less cost in switching to English than for the Spanish-dominant group in monolingual mode. I further argue that this reduced CLI into English seen for the English-dominant group in both language modes and for the Spanish-dominant group in bilingual mode may also be due to an increased resilience to CLI due to a higher level of activation. With English more highly activated, Olson's (2016) participants may have been less reliant on the phonological structures of Spanish in producing English fortis plosives because they were more able to switch quickly to target-like English structures.

These works strongly suggest not only that coactivation of a background language increases the prominence CLI, but also that a strong link exists between lexical and phonological processing in the multilingual mind. An approach to lexical and phonological processing based in a lexical phonology model (see Kiparsky, 1982) argues that phonological processing occurs within the lexicon, and thus that the link between lexical and phonological processing makes the two inseparable i.e. lexical structures cannot be processed without the phonological information attached to them due to the cyclical application of phonological rules at each stage of lexical recomposition. It may therefore be expected that any CLI which impacts either phonological or lexical processing in a multilingual may in fact impact both. The link between phonological and lexical processing in the context of its impact on CLI processes remains, to my knowledge, unexplored in the L3 context. Whilst L3 lexical CLI has been explored to a reasonable extent and research has begun on CLI in L3 phonology, the potential for increased activation of a background language through lexical access to impact on phonological CLI in L3 production has not.

Cognates represent sites of localised, heightened crosslinguistic lexical similarity and form a key element of this study. Therefore, Section 2.5 examines the nature of cognates as well as the structure of the multilingual lexicon.

2.5. Cognates and the Mental Lexicon

This section discusses cognates and the bi- and multilingual mental lexicon, beginning with an evaluation of the nature and definition of cross-language cognates. It further addresses the structure of the lexicon, the storage of lexical items through lexical decomposition, and processes of lexical access and retrieval involving activation of multiple languages. Although lexical decomposition is now widely accepted as a process in L1 usage, some debate continues as to the nature of morpholexical access in non-native lexical processing.

2.5.1. Cognates

Although at a superficial level it may appear clear whether two words from different languages may or may not be defined as cognates, in studying the influence of cross-language cognates on linguistic processing it is necessary to evaluate carefully what precisely constitutes a cognate. Hoshino and Kroll (2008:503) assert that “cognates are translations that are phonologically similar and potentially orthographically similar in same-script languages”, thus emphasising the role of phonological similarity above orthographical overlap. Nonetheless, considering the apparent influence of orthographical similarity on cross-language cognate processing when orthographic representations are present (see discussion below), orthographic similarity cannot be discounted in studies of cognates in which orthographical stimuli are employed.

Van Orden’s (1987) algorithm of objective graphemic similarity attempts to provide an objective measure of the degree of overlap of form of two words and has been used in several previous studies (see, for example, Yates, Locker and Simpson, 2003; Schwartz, Kroll and Díaz, 2007). This measure places particular emphasis on the relative lengths of two words, the number of shared adjacent pairs of letters and the sharing of initial and final letters. Schwartz, Kroll and Díaz (2007) further extend ‘letters’ in this context to phonemes in order to assess phonological similarity through Van Orden’s (1987) algorithm. However, in accepting lexical decomposition within the mental lexicon as discussed in detail below, defining two words as cognates based on graphemic and/or phonemic similarity at the whole word level may require re-evaluation. Analysis of the cognate status of two lexical items may therefore be conducted based upon similarity of root morphemes, disregarding functional morphemes such as inflectional affixes. Thus, it becomes clear that, for example, Portuguese *passa* /pasɐ/ becomes potentially an equally strong cognate with English *pass* /p^{h}ɑ:s/ as it is with Spanish *pasa* /pasa/ and French *passe* /pas/, since the root morpheme in each language (*pass-* in French and English, *pas-* in Spanish and Portuguese) begins and ends with extremely similar graphemes and phonemes, and all four contain the same vowel grapheme <a>, mapping to similar phonemes, i.e. low, unrounded vowels[1]. It is therefore proposed that, when studying language use beyond early beginner level, cross-language cognates should primarily be classified by analysis of phonological and orthographic similarity of their root morphemes in each language.

Cognates and the coactivation of multiple languages that they cause constitute a core focus of this study. Within the context of this study, cognates are defined as follows:

> A cognate is a word whose meaning is shared across two or more languages and whose root morpheme is highly similar in form across those languages. Such similarity arises through similarity of form in the orthographic and/or phonetic properties of the graphemes/phonemes.

The following sections discuss in detail the concept of lexical decomposition and the processes of lexical activation, access and retrieval in the multilingual mental lexicon.

2.5.2. Lexical Decomposition in morpholexical processing

Evidence from studies of lexical priming have consistently demonstrated that, in the L1, polymorphemic lexemes are not stored in the lexicon as single, whole units, but rather that they are decomposed, with root morphemes stored separately from functional affixes. Roots and affixes are subsequently recombined through the application of productive rules during lexical access. Studies of lexical access (de Diego Balaguer et al., 2005; Silva and Clahsen, 2008; Neubauer and Clahsen, 2009; Bowden et al., 2010; Feldman et al., 2010; Gor and Jackson, 2013) have revealed this lexical decomposition in the L1 by the priming of subjects with a root morpheme (such as *play*) leading to faster processing of combined root plus bound morpheme forms (such as plays, played, playing). Were lexemes stored in and retrieved from the lexicon as whole-word units (i.e. plays, played, play, etc. stored individually), no such facilitative effect would be observed. However, despite the well-recognised employment of lexical decomposition in L1 lexical access, studies of the late bilingual lexicon suggest that L1 and L2 processes are not entirely identical.

At the earliest stages of L2 acquisition, learners appear unable to decompose polymorphemic lexical items into root morphemes and affixes and instead rely on memorising and reproducing the L2 in unanalysed ‘chunks’ (Ellis, 2001). However, as Gor and Jackson (2013) argue, it seems that learners later begin to be able to decompose L2 words as proficiency in the L2 increases.

[1] It should be noted that in several varieties of English, including many in North America, Northern England, and Scotland this vowel would be the front, low, unrounded /æ/ (Roach, 2010; Bailey, 2015), with even greater similarity to the French, Spanish and Portuguese vowel /a/.

The Declarative/Procedural model of memory (Ullman, 2001, 2004) in which morpholexical units are stored in declarative memory and are decomposed and recombined by productive rules in procedural memory, suggests that L2 learners are, at least initially, more reliant on declarative memory. Whilst the Declarative/Procedural model proposes that L2 users' reliance on whole-word storage in declarative memory during L2 lexical access is due to the link between declarative and procedural memory growing weaker with age, evidence that learners *are* capable of lexical decomposition beyond the early stages of L2A suggests that learners' initial reliance on whole-word storage may not be due to a lack of access to procedural memory in order to analyse morpholexical information. It may be argued that, without sufficient input, L2 learners are unable to determine which phonetic or orthographic sequences represent stem morphemes and which represent productive, functional affixes; identification and acquisition of functional morphology is logically a necessary precursor to NNL lexical decomposition, and thus L2 lexical decomposition will only emerge at higher proficiency levels.

Whilst some work in the field of L2 storage and processing has suggested that NNL lexical processing remains permanently a system of whole-word storage with no systematic decomposition of polymorphemic words (Silva and Clahsen, 2008; Neubauer and Clahsen, 2009), recent research (Bowden et al., 2010; Diependaele et al., 2011; Feldman et al., 2010) has revealed that L2 learners are in fact able to decompose polymorphemic words. However, as highlighted by Gor and Jackson (2013), there appear to be several factors which limit L2 users' ability to decompose L2 words, including L2 proficiency, the transparency of the morphological structure of a word (see also Bowden et al., 2010) and the degree of productivity of L1 inflectional morphology[2] (see also Basnight-Brown et al., 2007).

Gor and Jackson (2013) suggest a link between the transparency of NNL functional morphology and the relative processing efficiency of lexical decomposition in comparison to whole-word storage and retrieval. They argue that, although potential limits on memory capacity may appear to make whole-word storage inefficient, the complexity of the cognitive task involved in decomposing polymorphemic words with opaque morphology may in fact render whole-word storage efficient, whilst words with transparent morphological structures may be

[2] Although research on L3 lexical access processes remains limited (Kroll, Gullifer & Rossi, 2013), one may speculate that the productivity of L2 inflectional morphology may be a factor in L3 lexical processing, providing that the L2 is sufficiently developed to allow for lexical decomposition.

processed more efficiently via lexical decomposition. Studies comparing lexical priming effects in regular and irregular verbs appear to support such a claim (see Bowden et al., 2010; Feldman et al., 2010: Gor and Jackson, 2013).

Whilst Gor and Jackson (2013) argue that the use of lexical decomposition processes for an L2 with highly productive functional morphology is not precluded by an L1 with an unproductive or very limited morphological system, it may be supposed that L1 morphological productivity impacts on the level of L2 proficiency required for L2 lexical decomposition to be possible. Comparison of studies of learners of L2 English suggests that speakers of an L1 with very minimal functional morphology, such as Chinese, have difficulty in acquiring English functional morphology (Jiang, 2007), whilst speakers of similar L2 proficiency with an L1 of greater morphological productivity are able to utilise English inflectional morphology (Basnight-Brown et al., 2007) and show facilitation effects for processing polymorphemic English words when primed with root morphemes (Feldman et al., 2010).

This section has reviewed studies of lexical storage and access in the bilingual lexicon. The application of productive rules in order to decompose and reconstitute polymorphemic words in the L1 is generally regarded as commonplace, whereas the development of this ability is not so easily achieved for lexical processing in a non-native language. Nonetheless, empirical evidence now primarily indicates that, beyond beginner proficiency, L2 users are able to analyse and decompose L2 lexical items, with transparency of morpholexical structures and the L1's inflectional morphology system potentially facilitating or inhibiting the process.

2.5.3. Lexical Access in the Multilingual Lexicon

Much research into the structure of the bi- and multilingual lexicon has attempted to address the question of whether lexical access in the multilingual brain is language specific, with separate lexicons for each language searched through in sequence, or if access is non-selective, with all languages searched in parallel. Studies of recent decades have principally suggested a unified multilingual lexicon, in which lexemes of all known languages are contained and thus coactivation of all known language occurs during lexical processing (see Dijkstra, 2005; Kroll, Bob and Wodniecka, 2006).

Whilst parallel activation of both native and non-native languages has been found to be effected by linguistic input in any known language, cross-language coactivation of lexical items becomes highly evident where there is some degree of orthographic, phonological or semantic overlap, such as in cognate words (Kroll, Gullifer and Rossi, 2013). It has been observed that both true cognates (i.e. those similar in both form and meaning) as well as false cognates (i.e.

those similar in form but dissimilar in meaning) have significant impact on lexical processing in bilinguals in opposite directions, with false cognates having an inhibitive effect, leading to slower processing, and true cognates having a facilitative effect, leading to faster processing (Dijkstra, 2005). Studies have also shown that instructed L2 learners take longer to reject incorrect L1 translations of L2 words that are similar in form than those that are dissimilar (Linck, Kroll and Sunderman, 2009).

The empirical evidence of cross-language cognates influencing processing time in lexical access demonstrates that lexical access is not language-selective and that lexemes from multiple languages simultaneously compete for selection when exposed to input which is language-ambiguous due to similarity of form across more than one language. Furthermore, this coactivation appears to be unaffected by the nature of the lexical processing task undertaken (see Kroll, Gullifer and Rossi, 2013), however some data suggest that the processing of cross-language cognates may become more, though not completely, selective when the surrounding linguistic context renders a word highly predictable (Schwartz and Kroll, 2006). Nonetheless, cross-language coactivation has been attested as a strong effect in several studies of bilingual lexical processing with cognates, revealing that lexical access is not language-selective and that similarity of orthographical and phonological representations of words leads to cross-language competition for lexical selection.

Schwartz, Kroll and Díaz (2007) tested a group of L1 English – L2 advanced Spanish learners on their reaction times to single-word orthographic stimuli in order to evaluate the impact of true and false cognates on lexical processing time. In their experiment, participants read aloud words presented in isolation with cognates and non-cognates mixed at random; lexical processing time was measured as subjects' reaction times in terms of the time between onset of exposure to the stimulus and the initiation of a verbal response. Results from Schwartz and her colleagues' study indicated that the participants named cognate words slower than non-cognate words when a disparity between the degree of orthographic and phonological similarity existed, though a less inhibitive effect of cognates was observed when phonological and orthographic codes did not conflict. This reveals a significant effect of crosslinguistic coactivation and competition between candidates in both languages during lexical access; a monolingual L1 control group showed no significant effect for the English-Spanish cognate words. Further analysis of these data additionally suggested that the degree of orthographic and phonological similarity of cognate words is a relevant factor in cross-language coactivation in lexical processing. Schwartz, Kroll and Díaz's (2007) data show that when orthography of a cognate word is similar across two languages, greater phonological similarity significantly reduced reaction time compared to cognates with dissimilar phonology; their results additionally indicated that when orthography was dissimilar, the degree of phonological similarity did not have a significant effect on subjects' reaction times. Schwartz, Kroll and Díaz (2007) thus propose that the consistency of orthography – phonology mapping across languages can influence lexical processing in bilinguals, and that coactivation of lexical codes in a bilingual's two languages occurs to a greater degree when exposed to a cognate with highly similar orthography than when the cognate words across the two languages are orthographically more distant. They further propose that their data constitute evidence that activation may feed from orthography to phonology but not from phonology to orthography. However, it is likely that the stimuli used in this study, being orthographic in nature, influenced the data.

Hoshino and Kroll (2008) conducted a picture naming study of cross-language coactivation with cognates which yielded somewhat different results from those of Schwartz, Kroll and Díaz (2007). Hoshino and Kroll's (2008) experiment examined whether the effect of cross-language coactivation was facilitative across both languages with shared orthographic systems and languages with differential orthographic systems. They compared two experimental groups of late bilinguals: one L1 Spanish – L2 English, and the other L1 Japanese – L2 English. In this study, both groups demonstrated significantly faster reaction times when naming pictures in the L2 which represented cognates between L1 and L2, with no significant differences between the two groups. Both groups appeared to be equally facilitated by cognates with their L1, despite the differences in script type and thus orthographic representations in the L1. Hence, it is suggested that without the presence of an orthographical stimulus, phonological similarity in cognates across languages does cause coactivation of both languages during lexical production, at least to the point of phonological planning (Hoshino and Kroll, 2008). The results further suggest that orthographic forms do not play a role in speech planning when orthographic stimuli are not present and that orthography does not necessarily modulate phonological processing in speech production.

This section reviewed cognates and the multilingual lexicon. It presented a definition of cognates built on previous research, proposing that the primary unit of analysis of cognate status be the root morphemes of words. This section also addressed issues of lexical decomposition and lexical storage and access. The following Sections 2.6, 2.7 and 2.8 examine phonology in L1, L2, and L3 respectively.

2.6. Phonology in the L1

Models and theoretical work in second language acquisition have informed the study of third language acquisition and proven influential in the development of models of L3A. Considering also the role of the L1 in influencing the L2, it is pertinent to review the development of phonology in both L1 and L2 acquisition prior to discussing literature in L3 phonology. Hence, this section discusses L1 phonology with a focus on two models of the development of phonological perception and phonemic distinction in the L1, looking at both monolingual and bilingual development. This section is followed by a review of several studies of both perception and production in L2 phonology.

As highlighted by Diane Ohala (2008), L1 phonological patterns are acquired before other linguistic structures, with acquisition beginning in utero (Ohala, 2008). This may be seen as a stark contrast to adult L2 acquisition, where lexical items are initially processed through the grammar (phonology and morphosyntax) of the L1. This contrast may be argued to be entirely logical; infants acquiring their L1 are unable to process neither morpholexical units nor syntactic structure before they are capable of identifying the phonemes that create the morphemes of the language they are acquiring, thus the ability to communicate through the language of their environment relies on first acquiring the phonemic distinctions necessary to perceive and produce it. In the L2A context, the learner will initially process the L2 through their L1, and thus are able to begin acquiring target language lexis and syntax prior to properly acquiring any L2 phonological structures which differ from those of their L1.

It is generally acknowledged that the acquisition of perception (i.e. the ability to perceive target language phonemic contrasts) necessarily precedes that of production (see, for example, Aoyama et al., 2004; Rauber, Escudero, Bion and Baptista, 2005; Baker and Trofimovich, 2006). Whilst in the L1 this is a simple, logical progression, in L2A it is necessary to specify that although learners may appear able to produce an L2 contrast which does not exist in their L1, especially in earlier stages of the NNLA process (Saito and Poeteren, 2018), truly consistent, accurate production and thus true acquisition of a contrast cannot be achieved if a learner is not able to also perceive the contrast in L2 input. This perception-production link in the L2 context is discussed in further detail in Section 2.6.

2.6.1. Modelling L1 Phonology

Much research has been conducted on L1 development and the acquisition of native phonemic contrasts by infants within the earliest stages of life. Studies of both monolinguals and simultaneous bilinguals have demonstrated that prior to the age of around 4 months, infants appear able to distinguish between any range of potential human speech sounds, whether or not the sounds exist in phonemic contrast in their native language i.e. the majority language of the infant's environment which will be acquired as the L1 (Kuhl et al., 2005; Kuhl et al., 2008; Bosch and Sebastián-Gallés, 2003). This may be taken as evidence that, initially, all humans are born with a universal inventory of human speech sounds from which they must identify which sounds exist in phonemic contrast within the language(s) to which they are exposed in infancy.

Patricia Kuhl proposes the Native Language Magnet (NLM) model of L1 phonological development (Kuhl, 1992, 1994), later augmented as the Native Language Magnet expanded model (NLM-e: Kuhl et al., 2008) based on further empirical evidence from a head turning procedure experiment involving a group of infants acquiring English as their L1. The NLM-e is based on the principle that infants over 4 months are able to quickly differentiate between sounds at the far ends of a 'scale' such as, for example, from /ɐ/ to /ɨ/ if they have been exposed to speech sounds at the extremes of such a continuum, but cannot differentiate as easily if they have been exposed to a wider range of values within it or to only intermediary values, such as an L1 English learner exposed to /ə/ and /ɜ/. Kuhl and colleagues further propose that the brain quickly decides which phonetic sequences are useful and which are not relevant, and neural networks develop and commit themselves to patterns of speech in the L1, later aiding in morpheme acquisition based on known phonetic patterns. During this process, labelled Native Language Neural Commitment (Kuhl et al., 2005), sensitivity to other 'phonetic schemes' weakens, thus reducing NNL speech perception ability.

The NLM-e proposes that, through exposure to linguistic input, infants define categories for relevant phonemes, placing a 'magnet' at the centre of a prototypical example of a phoneme. A 'magnetic field' is then established, based on what linguistic input shows to be acceptable boundaries of that particular phoneme. It is thus postulated that whilst sensitivity to sounds near the boundary of a magnetic field or between two magnetic fields is increased, sensitivity to sounds which are similar to established categories is reduced, due to their proximity to a 'magnet'. The NLM-e further hypothesises that magnets are made stronger as the most frequent realisation is calculated, increasing the coherence between the possible variations of that phoneme. This aids in perception of the L1, but will naturally warp and distort perception of NNL phones which are similar to, but not the same as, L1 phonemes.

Kuhl et al. (2008) propose that there are four phases of development for L1 phonological acquisition. In Phase 1, infants are able to discriminate the acoustic cues that code phonemic differences in any language. In Phase 2, phonetic learning begins, aided by infants' sensitivity to phonetic patterns. Vowels are seemingly learnt before consonants (vowels ages 4-8 months, consonants ages 10-12 months). At this phase, the NLM-e predicts that perception – production links begin to be formed and that influence between the two is bi-directional. By the end of phase 2, NNL perception ability has dramatically reduced; magnets have begun to form and will warp perception of sounds to categorise them according to the L1 sound system. In Phase 3, language specific perception improves and the infant learns phonetic patterns, word and syllable segmentation and transitions, and phonetic details of early words. This is hypothesised to involve bidirectional learning; perception abilities help to learn words, whilst learning phonetically similar words helps to further refine the ability to discriminate contrasts. Finally, in Phase 4, neural commitment is considered to be more stable. This means that NNL input is likely to be perceived through an L1 filter. In addition, the representations of L1 sounds are deemed to be firm enough to not be influenced by relatively short exposure to a NNL.

Hence, the NLM-e makes clear predictions for the development of L1 phonology and proposes a method by which the L1 acquisition process ensures that phonemic perception becomes an efficient exercise. It further predicts that the phonology acquired for the L1 will have a clear impact on non-native language acquisition, due to the warping effect of the magnetic fields created by the determination of L1 phonemes. Whilst this model is not proposed within a generative framework, it can be argued that its essential predictions are entirely compatible with Universal Grammar, since prior to onset of L1 acquisition the mind, in essence, contains a universal 'inventory' of potential speech sounds, from within which relevant phonemes are identified in accordance with evidence in linguistic input.

Nonetheless, considering the nature of phonology, it may be argued that determining which speech sounds represent relevant phonemes and exist in contrast with others within the language of the environment is not as simple as merely selecting relevant phonemes from a discrete, finite set of predetermined potential speech sounds used in phonemic contrast in human language. Speech sounds may be considered to exist as discrete points within a continuum of possible sounds, limited only in its extremities by the physical possibilities of the human vocal tract, and contained within this continuum is an essentially infinite number of sounds that may be produced. The predictions of the NLM-e allow for the L1 acquisition process to convert these infinite possibilities into discrete categories, representing specific phonemes, at the expense of the initial ability to perceive all points on the continuum as potentially phonemically distinct.

It must be noted that the NLM-e is primarily proposed for monolingual L1 acquisition, and its authors recognise that the model does not make specific predictions for differences that may be observed in simultaneous bilingual infants. It assumes that the manner of L1 phonological acquisition for bilingual infants is principally the same as it is for monolinguals, creating categories for perceived speech sounds and following the phases described above. However, data from studies of simultaneous bilinguals' ability to distinguish phonemic contrasts which exist in only one of their two languages have revealed that the developmental path of phonological perception in bilingual infants is not the same as that generally observed in their monolingual counterparts, and that this development can further vary as a function of the degree of exposure to each of the two languages being acquired.

A related, though somewhat contrasting model of first language phonemic distinction, the distributional account of L1 phonological acquisition (Maye, Werker and Gerken, 2002), presents a statistical basis for development of L1 phonemic distinctions. The distributional account proposes that infants define the phonemic categories of their L1 by observing the statistical properties of speech sounds to which they are exposed, such as vowel formant frequencies and length of voice onset time in plosives and consider the distribution of these statistical properties within the perceptual phonological space. Areas within which speech sounds are observed to occur with high frequency are considered by the infant to constitute phonemic categories, whilst areas of sparse speech sound distribution are considered to be either irrelevant to L1 speech perception, or to be boundaries between relevant phonemic categories. The distributional account considers that where exemplars of speech sounds appear to be spread widely over a large area of the phonological space, the infant perceives this unimodal distribution to represent a large, single phonemic category (such as the mid front unrounded vowel area in Spanish and English); where two areas of high density are separated by an area of sparsity, the infant is considered to perceive a bimodal distribution, forming a clear boundary between two speech sounds (such as the acquisition of the English contrast /æ – ɛ/).

The distributional account (Maye, Werker and Gerken, 2002) emphasises the importance of frequency of occurrence of speech sounds within a statistically definable distribution, however studies of simultaneous bilingual infants and of early bilinguals present a challenge to the distributional account, notably studies of the acquisition of infrequently produced Catalan vowels by Spanish – Catalan bilinguals. Such studies of infrequent Catalan vowels appear to counter the distributional account's predictions due to the overlap between categories of several Catalan vowels with Spanish equivalents, such as the Catalan contrasts /o – u/, /e – ɛ/, and /ɔ – o/ (Sebastián-Gallés and Bosch, 2009; Mora, Keidel and Flege, 2011). In each of these cases, one vowel is substantially less frequent in the Catalan input than the other, and the phonemic categories of the more frequent vowels /e, o/ are not perfectly aligned with categories for the Spanish equivalents. In these cases, the distributional account would predict that the separate Catalan mid front and mid back vowel categories would be merged as single, unimodal distributions i.e. one mid front category and one mid back category, as in Spanish.

However, studies of bilingual development have revealed that bilingual infants do acquire these contrasts, though later than their monolingual counterparts (Bosch and Sebastián-Gallés, 2003; Sebastián-Gallés and Bosch, 2009; Ramón-Casas et al., 2009). Whilst a distributional account of L1 acquisition is unable to account for such data, the NLM-e may be able to account for this development by considering that new phonemic prototype magnets can be formed as input in the two languages becomes sufficient to establish multiple magnets in the mid front and mid back vowel space. As noted, studies in bilingual acquisition present differing challenges to the two L1 phonology models presented here, however where the distributional account appears unable to explain empirical evidence, the primary principles of the NLM-e are sufficient, provided a less strict concept of Native Language Neural Commitment (Kuhl et al., 2005) is accepted.

2.6.2. Phonological L1 Acquisition in Simultaneous Bilinguals

This section reviews research in L1 phonology of simultaneous bilinguals. Study of simultaneous bilingual infants has revealed that their phonological development is not identical to that of their monolingual peers. Results of research in L1 phonology for simultaneous bilinguals tend to demonstrate that their performance in phonemic distinction tests is on par with that of monolinguals in the earliest and latest stages of acquisition, however their developmental paths differ.

Many studies of bilingual phonological development have been conducted on Spanish-Catalan bilingual infants and the development of the perception of vowels in Catalan which do not exist in phonemic contrast in Spanish. Bosch and Sebastián-Gallés (2003) examined the developmental pattern of L1 vowel perception in monolingual Spanish and Catalan infants and bilingual Spanish-Catalan infants at ages 4, 8, and 12 months. Their experiment employed the head turning procedure method, whereby infants are exposed to two different speech sounds in sequence and will turn their heads to face the source of the second sound only if they perceive it as different from the first. Their study examined the ability of infants to distinguish the contrast /e - ɛ/ as a function of age; this contrast is phonemic in Catalan, but allophonic in Spanish. Comparison of three test groups: Spanish monolinguals, Catalan monolinguals, and Spanish-Catalan simultaneous bilinguals, found that at age 4 months all experimental groups were able to distinguish the contrast, however by 8 months only the Catalan monolinguals were able to do so. At age 12 months, the bilingual infants regained the ability to distinguish /e/ and /ɛ/, with no significant difference found between the performances of the 12 month old bilingual infants and the 8 month old monolingual Catalan infants. Bosch and Sebastián-Gallés (2003) thus propose that bilinguals follow a different developmental path to their monolingual peers and that, at least initially (and prior to any substantial L1 lexical acquisition), phonological information is not stored separately, even though infants are able to distinguish the two languages as different from a very early age.

This U-shaped development for phonemic distinction acquisition in bilinguals was further supported by later work (Sebastián-Gallés and Bosch, 2009), comparing the ability of monolingual Spanish, monolingual Catalan and Spanish-Catalan bilinguals to distinguish the /o – u/ and /e – u/ contrasts at ages 4, 8 and 12 months. Whilst both Spanish and Catalan do distinguish between these two sets of vowels as distinct phonemes, the distance between /o/ and /u/ in Catalan is smaller than it is in Spanish. Furthermore, the vowel /o/ is infrequent in Catalan, primarily due to frequent reduction of /o/ to /ə/ and the presence of another mid back rounded vowel /ɔ/. The results from this series of experiments demonstrated that all groups were able to distinguish the /o – u/ contrast at 4 months, but that at 8 months only the monolinguals showed a significant ability to distinguish the two phonemes. By age 12 months however, the bilinguals demonstrated that they had acquired the contrast, thus agreeing with the results from the earlier study (Bosch and Sebastián-Gallés, 2003). These experiments were further repeated with several adaptations, such as removing individual speaker variation and number of syllables in the stimuli, as well as selecting tokens of /o/ and /u/ which were the most distant available, so as to maximise perception facilitation. Even with these extraneous factors removed, 8 month old bilingual infants were not able to distinguish the contrast, suggesting that the categories had been merged at this age. In further support of this U-shaped development for contrasts which are salient and phonemic in one of a bilingual infant's languages but not the other, the study found that for the /e – u/ contrast, both monolinguals and bilinguals continued to be able to distinguish the two phonemes, with no significant difference between the groups. Of particular interest, Sebastián-Gallés and Bosch (2009)'s data suggest that, since both monolingual Catalan and monolingual Spanish groups were able to distinguish the /o – u/ contrast at 8 months where the bilingual group was not, the different developmental paths observed is not due to the contrast existing only in one specific languages being acquired by the study's subjects, but rather by the fact of bilingualism and the input containing a very broad range of vowels in the mid to high back vowel space, from /ɔ/ to /u/.

Within the context of the L1 phonological development proposed by the NLM-e (Kuhl et al., 2008), these studies of simultaneous bilinguals would appear to suggest that Native Language Neural Commitment begins to occur initially at a similar age as it does for monolinguals, leading to the loss of ability to perceive some contrasts as phonemic. However, the apparent 'backtracking' observed, leading to the reestablishment of a phonemic contrast in an area which had previously been merged into one category (such as the mid front vowel space representing /e/ and /ɛ/) that appears to surface at a later age may somewhat contradict the more linear development predicted in the NLM-e. The data from the studies of bilingual phonological development thus suggests that although at 4 months and 12 months monolinguals and bilinguals appear to have developed similarly, the concept of Native Language Neural Commitment (Kuhl et al., 2005) may not be as irreversible a commitment as suggested, considering the observed restructuring of the previously established categories in accordance with the input in order to account for more subtle contrasts which exist in only one of a simultaneous bilingual's two languages.

Other research in phonological perception development of bilinguals with older (toddler) Spanish – Catalan bilinguals has tested the influence of dominant versus balanced bilingualism (Ramón-Casas et al., 2009) on the ability to perceive subtle Catalan phonemic contrasts, as well as the lasting effects of phonemic distinction ability into adulthood, comparing simultaneous versus early bilingual speakers (Sebastián-Gallés, Echevarría and Bosch, 2005), and the influence of age of onset and frequency of use (Mora, Keidel and Flege, 2011). In a study of 2 to 4 year old Spanish and Catalan monolingual and Spanish-Catalan bilingual toddlers, Ramón-Casas et al. (2009) found a significant effect for the quantity of exposure to Catalan in the ability to distinguish the mid front vowel /e - ɛ/ contrast; whilst monolingual Catalan toddlers, balanced bilinguals, and Catalan dominant bilinguals did not differ significantly in their perception of this contrast, the Spanish dominant bilinguals performed significantly poorer than did their peers with greater degrees of exposure to Catalan.

Ramón-Casas and colleagues claim that the Spanish dominant bilinguals should, given more input, eventually acquire the contrast (Ramón-Casas et al., 2009) however such a hypothesis clearly has implications for the concept of a critical or sensitive period for phonology, and by extension for L2 acquisition. A full discussion of the critical period hypothesis lies beyond the scope of this work, however evidence from studies of adult bilingual speakers and early learners of Catalan and Spanish may suggest that simple continued input beyond infancy is not enough to allow for new phonemic contrasts to be established to the same degree as a monolingual speaker. This difficulty in perceiving mid-open versus mid-close vowel contrasts was also shown to apply to adult early bilinguals. One study has suggested that perception of the /e – ɛ/ contrast may vary as a function of the frequency and quantity of Catalan use, irrespective of whether Catalan was acquired as an L1 with early L2 Spanish, or vice versa (Mora, et al., 2011), however other work has shown that L1 Spanish early learners of L2 Catalan perform significantly poorer in perceiving this contrast than simultaneous bilinguals, who in turn are outperformed by L1 Catalan early learners of L2 Spanish (Sebastián-Gallés et al., 2005).

As mentioned above, the acquisition of phonemic distinctions in L1 vowels has been found to precede that of L1 consonants. Sundara, Polka and Molnar (2008) examined the acquisition of the voiced plosive /d/, comparing monolingual French, monolingual English, and bilingual French-English infants. Although in both languages /d/ exists as a phoneme, French and English /d/ vary in both place of articulation and in voice onset time (see Section 2.9.1 for a more detailed discussion); within each language, the distinction between the two is merely allophonic. A head turning procedure experiment determined that at age 6-8 months both monolingual groups and the bilingual group all showed the ability to discriminate [d̬̪ – d], as would be predicted by the NLM-e, however at 10-12 months only the French monolingual group lost the ability to perceive this contrast, whilst the bilingual group and the English monolingual group continued to distinguish between the two sounds.

Whilst it is unsurprising that the French monolingual group did not retain this contrast as phonemic within their L1 phonology, the fact that the English monolingual group retained the ability to perceive this contrast is unexpected. It may further be argued that the evidence that the bilingual group retained the contrast is also somewhat surprising since they should not have received input to suggest that the contrast is phonemic in either language. Furthermore, the data from the bilingual group in Sundara et al.'s (2008) study present a challenge for the distributional account of L1 acquisition, since the high frequency distribution of sounds in the [d̬̪ – d] area should have led the bilinguals to create a single category for these speech sounds, just as the French monolingual group did. Sundara et al. (2008) propose that, for the bilingual group and the English monolinguals, the presence of phonemic /ð/ may play a role in these infants' continued distinction between the dental and alveolar voiced stops, however a lack of data on the French monolinguals' perception of /ð/ leaves this hypothesis untested. Nonetheless, the predictions of the NLM-e can explain these data. Due to the formation of a perceptual magnet for prototypical /ð/, examples of [d̬̪] may be warped and hence perceived as more distant from [d]; thus, the [d̬̪ – d] distinction continues to be perceived by the English monolinguals and the bilingual group. Additionally, in Sundara et al.'s (2008) study it is unclear if the bilingual group retain this distinction because they have established two separate phonemic categories and thus consider the distinction to be phonemic, or if they have established a link between each sound and the language in which it occurs, requiring either two separate phonological systems to be established, or a single, unified phonology with language tags applied to relevant speech sounds. The former would imply that the grammars of the two languages develop independently, whilst the latter would imply that the two languages may be formed in a more unified manner, however it would necessitate a degree of lexical acquisition in order to establish a linguistic distinction between these two otherwise allophonic speech sounds. Further research into lexical and phonological development in 10-12 month old bilinguals and a more precise examination of development with a wider range of phonemes would be required to evaluate such a hypothesis.

The results from this range of studies of simultaneous and early bilinguals have notable implications not only for the acquisition of L2 phonology in late bilinguals and the ability to overcome L1 influence on NNL perception and production, but also for the developmental paths of simultaneous bilinguals' L1 phonologies, especially for imbalanced bilinguals, i.e. those who receive substantially more input in one of their languages than the other. Empirical evidence suggests that simultaneous bilinguals' perceptual phonological development differs from that of monolinguals during the first year of life (Bosch and Sebastián-Gallés, 2003; Sebastián-Gallés and Bosch, 2009). Studies also suggest that imbalanced bilinguals and heritage speakers may establish their phonologies differently to monolinguals and balanced bilinguals (Atoniou et al., 2010; Amengual, 2018; Caramazza et al., 1973) It has also been seen that whilst early bilinguals may appear to be able to perceive subtle phonemic distinctions in their L2, certain categories may not be clearly defined within their phonology as they are in monolinguals or simultaneous bilinguals (Mora et al., 2011). In late bilinguals, it would seem that the task of overcoming L1 influence in L2 phonology is an even greater task, and it would appear likely that, for L2 phonemic contrasts which are similar to existing L1 phonemes, the influence of the L1 on the L2 phonology will persist even in high proficiency L2 users.

The Native Language Magnet model of L1 phonological acquisition has clear implications for the acquisition of NNL phonology, with the effects of L1 magnets seen to have significant influence on even early bilinguals' L2 phonology. The presence of an L1 prototype phoneme in proximity to phonetic settings which represent two distinct NNL phonemes will warp perception, leading to the assimilation of two distinct L2 phonemic categories, such as /ɐ, ɨ/, into a single category, such as /ə/. By extension, this warped perception will consequently lead to L1 influenced production. In L3A, one must consider that, whilst the phonemic prototypes and magnet effects of the L1 phonological system(s) may continue to be relevant, any restructuring of the phonological perceptual space and formation of new magnets which may have occurred during L2A may also influence the perception, and therefore production, of the L3, be this in terms of positive or negative CLI. Unfortunately, the role of the L1 and L2 in influencing L3 phonemic distinction remains under-tested in the previous L3 phonology literature, but is approached in this study through Aural Perception and Distinction Tasks; see Section 2.8 for a deeper discussion of studies in L3 phonology.

This section examined the acquisition of L1 phonology during infancy, reviewing a range of studies, including those on simultaneous and early bilinguals, in which the role of CLI in influencing phonological perception has been observed, seemingly an effect which continues into adulthood. The following section approaches this issue in late bilinguals, reviewing studies of L2 phonology, both in perception and production.

2.7. Phonology in L2

This section discusses studies of non-native phonology conducted within the paradigm of second language acquisition, reviewing experiments on L2 phonological systems in both perception and production. It begins with a review of two influential models of second language phonology: the Speech Learning Model (Flege, 1995) and the Perceptual Assimilation Model (Best, 1995).

2.7.1. Modelling Second Language Phonology

The Speech Learning Model (SLM: Flege, 1995) is formed of a series of postulates and hypotheses which allow for predictions to be made on the acquisition of L2 phonology and the influence of the L1 in L2 oral production. The model postulates that the process by which L1 phonemic categories are acquired during L1A can be applied to L2A, leading to the establishment of categories to account for L1 and L2 speech sounds identified as examples of each category. These categories occupy a unified phonological space with the L2 user's grammar. The SLM further postulates that the L2 user maintains some distinction between L1 and L2 categories, however it is unclear how, if L1 and L2 are held within a singular phonological space, such a native – non-native distinction is established and whether or not L1 categories may overlap with those established for the L2. An ability to identify L1 sounds and L2 sounds in definitive distinction whilst maintaining a unified perceptual phonological space may further imply that a multilingual should be able to identify which language is being spoken through analysis of oral input at the phonemic level and thus prior to accessing the lexicon. Considering observed effects of crosslinguistic activation within the multilingual lexicon (see

Kroll, Gullifer and Rossi, 2013 for a review), and the enhanced coactivation of lexical items within denser lexical neighbourhoods (Janse and Newman, 2013), it would appear that such a precise L1-L2 distinction between L1 and L2 phonetic categories remains somewhat unfounded and difficult to test effectively.

The hypotheses of the SLM predict that similar L1 and L2 phones will be perceptually linked at a “position sensitive allophonic level” (Flege, 1995: 239), in a less abstract manner than the phonemic level that would be assumed by the Contrastive Analysis Hypothesis (Lado, 1957). The SLM further hypothesises that new categories may be established for L2 phonemes only if the learner is able to perceive a difference between the ‘new’ L2 phone and existing L1 phonemes. The more similar the L2 sound is to an L1 sound, the greater the difficulty of acquisition will be, and difficulty in establishing a new category will also increase as the learner’s age increases. Failure to establish a new, distinct category for novel L2 sounds may lead to category assimilation, where an L2 sound will be perceptually linked to an L1 sound, creating a single phonetic category or the merging of two or more L2 sounds into a single category, generally in line with a category previously established in the L1. The hypotheses necessitate predictions which are very similar to those of the NLM-e (Kuhl et al., 2008, discussed above) and demonstrate a tenable link to the NLM-e’s hypotheses for the L1 acquisition process and economy of phonemic distinction in aural perception in terms of their application to the L2A context.

Beyond the predictions of the NLM-e, the SLM hypothesises that even in cases of apparently successful creation of new categories for L2 phonemes, the L2 user’s representation of TL speech sounds may vary from those of monolingual speakers of the TL as their L1. In such cases, the SLM hypothesises that in order to maintain a clear contrast, the L2 category may be formed at a greater distance from a similar L1 phonemic category, and thus in a different area within the phonological space than would occur for a monolingual speaker acquiring the language as their L1, and hence with no such competition from other, previously established phonologies. This prediction of the SLM demonstrates that it is possible for an L2 learner to overcome L1 influence during L2A to some extent, and that the perception of non-native phonemic contrasts will not necessarily be perpetually distorted by the phonemic categories established during L1A in the direction predicted by the NLM-e (i.e. assimilation of similar categories). Finally, the SLM hypothesises that perception is directly linked to production, i.e. the phonetic categories established within the perceptual phonological space will correspond to the production of the speech sounds which they represent; consequently, this hypothesis implies that acquisition of target-like L2 phonological production can only be achieved after the establishment of a target-like category for perception. The Speech Learning Model does not make specific predictions for differences between the acquisition of consonantal and vocalic L2 contrasts, however some data have suggested that the perceptual distortion effect of the L1 is stronger for similar L2 consonants than for vowels (Chan, 2012), thus making new L2 consonantal contrasts more difficult to acquire than new L2 vocalic contrasts which exist in proximity to L1 phonemes.

The SLM is intended to explain the phonological representations of very advanced or end-state L2 users, however many of its principles may be applied equally effectively to lower proficiency learners and further extrapolated to the context of the early stages of L3A. Although the phonetic categories for L2 and L3 interlanguages may be established within the perceptual phonological space in a less stable manner than those in an end-state language, and thus there exists the potential for their influence on L2 and L3 production to vary from that hypothesised in the SLM, difficulties in establishing new NNL phonetic categories due to the proximity of L1 phonemes will undoubtedly impact upon perception and production of the L3. Furthermore, the warping effects caused by L1 phonemic categories established during L1A as hypothesised by the NLM-e should continue to impact upon the ability to distinguish L3 phonemic contrasts in much the same way as it influences L2 phonological development, with the additional possibility that new magnets formed as part of the L2A process may also influence L3 perception.

Empirical studies which support the SLM have been criticised for only testing contrasts which exist phonemically in the learner's L2 (and therefore contrasts of which the learner has experience), and for not testing subjects' perceptions of unfamiliar contrasts from other languages or other varieties of the L1 of which the learners have no prior experience (Best and Tyler, 2007). The Perceptual Assimilation Model (PAM: Best, 1995) was developed based on data of monolingual listeners' ability to discriminate non-native phonemic contrasts to which they had not been previously exposed. Later expansion of the model to include predictions for L2 learners who are exposed to novel L2 phonemic contrasts was made, with the same essential predictions of underlying processes (Best and Tyler, 2007).

Similar to the SLM (Flege, 1995), the PAM may be used to assess areas of difficulty for perceiving phonemic contrasts which do not exist in the L1. However whilst the SLM is based on L2 learners' perception of acoustic-phonetic cues (such as formant frequencies, formant transitions and voice onset time), the principles of the PAM are based on the hearer perceiving non-native phones in terms of their articulatory properties; the PAM predicts that unfamiliar phones are therefore either assimilated to the L1 phoneme which is most similar in terms of its articulation, or not assimilated at all. Within the Perceptual Assimilation Model, L2 phones will be dealt with in one of three ways:

1. Categorised as a good or a poor example of an extant L1 phone
2. Uncategorised (unlike any L1 phone)
3. Non-assimilable (considered a non-linguistic, non-speech sound)

When considering a pair of L2 contrastive phonemes, if both phonemes are categorised in relation to an L1 phoneme, three types of categorisation may occur:

1. Two-Category Assimilation: Each of the L2 phones is assimilated to a different L1 category and thus is perceived as distinct.
2. Single-Category Assimilation: Each of the L2 phones is assimilated to the same L1 category, being considered equally good or poor equivalents of the L1 phone; no distinction is perceived.
3. Category Goodness: Each of the L2 phones is considered a version of the same L1 phonemic category, but with different goodness of fit (i.e. one may be a good exemplar and the other a poor exemplar). The hearer will be able to distinguish the two L2 phones reasonably well, though not as well as a Two Category Assimilation.

The PAM further predicts that where one phoneme in an NNL is categorised and the other is not, or where both NNL phones are non-assimilable, the learner will be able to distinguish the two phones well. By contrast, if both NNL phonemes remain uncategorised, the PAM predicts that discrimination will be poor. However the phonological properties which underlie these predictions are unclear.

One key way in which the PAM (Best, 1995) differs from the SLM (Flege, 1995) is that the PAM assumes that the L1A process defines the outer limits of the perceptual phonological space and therefore considers some speech sounds to be potentially perceived as existing outside of the perceptual phonological space. This concept is claimed to be demonstrated by studies of click phonemes in Bantu languages (Best, McRoberts and Sithole, 1998; Best et al., 2003). Aural speech sound discrimination tasks found that monolingual L1 American English speakers were able to distinguish a phonemic click contrast in Zulu, whilst speakers of other African Languages in which other clicks exist in phonemic contrast found it more difficult to distinguish the Zulu clicks. Best and colleagues (Best, McRoberts and Sithole, 1998; Best et al., 2003) make the assumption that the ability of the L1 English group to distinguish the click contrast was due to these subjects considering the clicks as non-assimilable. However, even within the tenets of the PAM it is not entirely possible to distinguish whether these Zulu phonemes were non-assimilable or merely uncategorised by the L1 English subjects with sufficient distance between the two to allow for distinction to be perceived. By contrast, the SLM would predict this outcome in a more clearly defined manner, since the acoustic properties of the click sounds would be distinguishable because no other similar sounds existed as L1 phonemic categories.

Whilst the Perceptual Assimilation Model may appear to account for much of the data of L2 phonological perception, the unclear divide between uncategorised and non-assimilable present a clear caveat for its predictions. Furthermore, whilst the proposal of an intermediate degree of assimilation (Category Goodness) may have implications for predicting the ability of L2 learners to perceive very subtle L2 contrasts, the degree of abstractness with which this concept must be applied in order to define a 'good' or 'poor' fit render it less capable of making concrete predictions of difficulty in L2 production than the SLM.

A highly salient difference between the two models discussed here may be seen in the fact that whilst the SLM accounts for the (in)ability to perceive all speech sounds, novel or otherwise, in a similar manner, the PAM attempts to define subtly different processes of perception for speech sounds which differ substantially from those which exist as phonemes in the L1. It is claimed that the manner of articulation of non-pulmonic click consonants utilised in experiments conducted in support of the PAM (Best et al., 1998) renders them completely 'unique' (i.e. unlike any L1 phone), however it was seen and noted that differences in voicing and place of articulation contribute to the discrimination of clicks; the acoustic-phonetic cues associated with such properties can be related to cues acquired through L1 phones and thus allow for discrimination of otherwise novel sounds through the same processes as those utilised in order to distinguish known phonemes. Thus, I argue that the PAM does not effectively demonstrate how the perception and processing of 'assimilable' and 'unassimilable' speech sounds differ at a fundamental level. It would appear that both are interpreted through the acoustic-phonetic properties present in the speech signal, with the perception of assimilable speech sounds subsequently warped by the presence of previously established phonemic categories, however this process is accounted for far more clearly and concisely in such models of speech perception as the NLM-e and the SLM.

2.7.2. Studies in L2 Phonology

Many studies in L2 phonological perception and production have demonstrated the difficulties for learners in acquiring L2 phonemic contrasts in which L2 phonemes are similar to, but not the same as, phonemes which exist in their L1. Studies of L2 phonology have also suggested that the relative difficulties of acquiring consonantal contrasts and vocalic contrasts in the L2 may be different (Chan, 2012), and that in some cases learners' mental representations of seemingly acquired L2 phonemic contrasts may differ in their nature from the representations acquired by monolinguals during L1A (Díaz et al., 2012).

In a study of L2 English production by L1 speakers of Dutch, Flege (1997) found that, when produced in a /h_V_t/ sequence, learners appeared to have acquired the English vowel /æ/, which is dissimilar from any Dutch vowel, and were capable of producing it at, or very close to, target language norms. By contrast, this study found that its subjects' realisations of the L2 vowels /ɒ/ and /ʌ/, which have similar, but not the same, representations in Dutch were subject to influence from the L1, with vowel qualities produced by the L2 users being closer to norms for these vowels in monolingual L1 Dutch speakers than their counterparts in monolingual L1 English speakers. Flege's (1997) study appears to suggest that the acquisition of L2 English /æ/ should be relatively unproblematic for L1 Dutch learners, however the results of a study of L2 perception (Díaz, Mitterer, Broersma, and Sebastián-Gallés, 2012) testing L1 Dutch – L2 advanced English learners on the L2 phonemic /æ – ɛ/ distinction suggest that the L2 English learners' representation of /æ/ may not have been fully target-like.

In their study of 55 L1 Dutch learners of L2 English, Díaz and colleagues (Díaz et al., 2012) tested their subjects on their ability to perceive the English /æ – ɛ/ phonemic distinction, testing for effects of vowel length and lexical processing requirements on phoneme recognition. They found that, although both L1 English controls and learners appeared capable of distinguishing /æ/ from /ɛ/ when vowel length was similar to typical length in native speech, only the native controls continued to be able to perceive the contrast when /ɛ/ was heard at typical /æ/ length and /æ/ at typical /ɛ/ length. Tests involving variation of lexical processing requirements also found that the greater the lexical processing requirements, the greater the difficulty in perceiving the L2 /æ – ɛ/ contrast, supporting previous work on the impact of lexical processing requirements on even early bilinguals' ability to perceive L2 phonemic contrasts (Sebastián-Gallés and Baus, 2005). These results suggest quite strongly that, although in a superficial sense the L1 Dutch – L2 English learners were capable of perceiving a contrast between these two L2 phonemes, their representations within their mental L2 grammars were not native-like, being instead based on other factors, as predicted by the SLM (see Flege, 1995:239). Whilst not a test of the SLM or the NLM-e, the finding that difficulty in perceiving L2 phonemic contrasts may vary as a function of the degree of linguistic processing required has interesting implications for crosslinguistic influence in NNL usage, but remain under-tested in the L3 context. Furthermore, although the potential for increased linguistic processing requirements on phonological CLI in L3 production has been approached on a small scale (Hammarberg and Hammarberg, 2005), larger scale studies are required to evaluate this phenomenon.

Many other studies in L2 phonology in both perception and production have also shown evidence of CLI from the L1 and supported the hypotheses of the NLM-e and the SLM. Other studies in the perception of L2 vowels have found difficulty for L1 English learners of L2 French in perceiving the L2 contrast /y – u/ and /œ – ɔ/ in an ABX vowel categorisation test, which was attributed to the lack of front rounded vowels in English leading to perception of front rounded vowels being merged with existing L1 categories for back rounded vowels of similar height (Darcy et al., 2012). The difficulties of acquiring L2 speech sounds which are similar, but not identical, to L1 sounds have also been shown to influence perception of consonants (Flege and Hillenbrand, 1987) and it has been argued that even early learners' (L2A onset around 4 – 5 years of age) ability to distinguish L2 phonemic contrasts does not reach the same standards as that of monolinguals, with phonetic category assimilation impacting on the L2 phonological system (Hojen and Flege, 2006). The link between perception and production hypothesised by the SLM (see above) has also been demonstrated to influence acquisition of L2 phonology (see Aoyama et al., 2004), however some studies do suggest that the influence on production may be overcome, at least to some extent (Flege and Eefting, 1987; Fowler et al., 2008).

This section briefly reviewed the study of phonology in second language acquisition, presenting an influential model of L2 phonological processes, demonstrating the compatibility of the Native Language Magnet model of first language phonological development (Kuhl et al., 2008) with the hypotheses of the Speech Learning Model in second language phonology (Flege, 1995). Empirical evidence suggests that the phonetic categories established during L1A impact substantially on the ability to acquire new phonemic contrasts in the L2 which are similar to L1 categories. These L2 studies have also demonstrated a link between the perception and production of non-native phonological structures, with the suggestion that consistently accurate production of a NNL phoneme must be preceded by acquisition of the ability to perceive the relevant phoneme in contrast with similar L1 and L2 speech sounds. Despite this seemingly necessary progression from accurate perception to target-like production, evidence from studies of L2 production highlights that, at least at the surface level, the influence of the L1 phonology can be overcome in order to produce target-like non-native phonological patterns.

2.8. Studies in L3 Phonology

This section reviews several studies of phonological CLI processes in third language acquisition. It evaluates the results observed from empirical study of L3 phonologies and the implications of these for the role of CLI in the formation of L3 grammars, notably in terms of the predictions about the source of CLI and the factors which condition the selection of said source, within the context of the predictions of the models of L3A discussed in Section 2.3. Discussions of methodological concerns in the study of L3 phonological CLI are also presented.

Despite some recent growth in interest in the field, studies in L3 phonology remain rare and methodologies for research into phonetic and phonological CLI are somewhat disparate, leading to difficulty in equating results from different studies and thus a lack of consistency and generalisability of findings. Furthermore, results from the relatively small pool of studies conducted have varied widely in their determination of the source of phonological CLI on the L3. Several studies of L3 phonology are discussed in this section all of which, given the noted dearth of perception studies (Cabrelli Amaro, 2012), focus on identifying which background language(s) may become the source of phonetic or phonological crosslinguistic influence in L3 production. Whilst some studies have proposed a privileged role for the L1 (Wunder, 2011), others have claimed to primarily support the L2 Status Factor (Hammarberg and Hammarberg, 2005; Wrembel, 2010; Gut, 2010; Llama et al., 2010), and some have supported the TPM and the notion of CLI conditioned by crosslinguistic similarity (Wrembel, 2012).

Wunder (2011) studied VOT in the production of Spanish voiceless plosives by a group of eight L1 German – L2 English – L3 Spanish learners performing a 'read-on-your-own' task aloud from a text. Her results found little direct evidence of crosslinguistic influence from L2 English, as values for VOT in the L3 fell between native-like Spanish and English and thus closer to native-like German values, leading Wunder (2011) to conclude in favour of L1 CLI.

However, several methodological issues in this study lead to questions surrounding the interpretations of the data. The participants were treated as a relatively homogeneous group, despite substantial L3 proficiency differences (two advanced, six beginner to post-beginner) which will have altered the observable CLI effects due to the independent development of the L3 IL beyond the initial state that will have occurred for the advanced and post-beginner level participants. Furthermore, the participants were recorded reading a nonsense text in L2 English and a (somewhat adapted) natural text in the L3, with native speaker controls used for comparison of German VOT values, despite suggestions in other research that multilinguals' phonological production can differ from monolingual 'norms' (see Caramazza et al., 1973;

MacLeod and Stoel-Gammon, 2005; Fowler et al., 2008). Finally, the language combination chosen in this study and the lack of a mirror experimental group (i.e. L1 English – L2 German – L3 Spanish) makes it unclear whether the observed L3 VOT values were due to L1 influence, an interlanguage form, or a compromise L2 – L3 value and, were this CLI from the L1, whether this was due to a privileged status for the L1 in L3 phonology or due to Spanish VOT being closer to German than to English. It could be argued that these issues serve to highlight the importance for studies in L3 phonology to test all participants in all three languages for the properties studied, as additionally discussed by Rothman (2015), and for studies to maintain consistency in the requirement of tasks performed for experimental purposes in order to produce robust data.

Llama, Cardoso, and Collins (2010) also studied VOT in L3 Spanish production by two experimental groups: one L1 English – L2 advanced French, and the other L1 French – L2 advanced English. All were late beginner to lower intermediate proficiency in the L3 and all were tested in the L2 and L3, with stimuli for oral production presented as individual words on a computer screen, shown one at a time, to be read aloud. In order to achieve priming of both L1 and L2 prior to the L3 production task, the researchers conducted greetings and small talk with each subject in their L1, followed by the L2 production task, followed by the L3 task (see Rothman, 2015 for a contrasting discussion of task order and priming in L3 studies). Llama et al.'s (2010) results did not demonstrate any significant CLI from the L1 nor L2 when compared to native speaker norms, however comparison of the L2 and L3 data revealed that for both experimental groups L2 and L3 VOT was a compromise value, lying between monolingual norms of Romance languages (unaspirated) and English (aspirated, long lag VOT) fortis plosives, demonstrating a case of compound CLI (see de Angelis, 2007 for discussion), where crosslinguistic influence may come from the L2 which itself is influenced by L1 transfer.[3] The authors concluded that it was the L2 status factor model of L3A which best accounted for these observed CLI effects, however the lack of L1 data from this study's participants and reliance on established monolingual 'norms' does somewhat weaken the findings. Additionally, the post-beginner level and thus likely post-initial status of the subjects and the lack of a longitudinal element to this study may mean that the potential for the observed VOT values to be merely interlanguage forms developed independently from the L1 and L2 has not been

[3] Note that the L1 of the subjects in Llama et al.'s (2010) study was not tested; L1 VOT values were assumed to be the same as those previously established as standard monolingual norms.

eliminated as a possible explanation of these data. See also Cabrelli Amaro (2016) for discussion of the utility of (semi-)longitudinal elements in L3 studies as a means of eliminating the need for comparison to external native-speaker norms.

Tentative support for the L2 status factor in conditioning phonological CLI in L3 beginners' oral production was proposed by Wrembel (2010) in her study of general accentedness in L1 Polish – L2 German – L3 English subjects. Her research found that beginner-level learners were more frequently identified as being German by independent judges, whilst intermediate learners were significantly more likely to be identified as Polish. These results thus suggested that, in accordance with findings in earlier studies (Hammarberg and Williams, 1993; Hammarberg and Hammarberg, 2005) the L2 status factor conditions phonological CLI at the initial state, with L1 features becoming more prominent as proficiency increases. In later research however, Wrembel (2012) concludes that CLI effects seen were better accounted for by the predictions of the TPM (Rothman, 2010, 2011, 2013, 2015). This study examined foreign accentedness in nine learners of L3 English with L1 Polish and L2 advanced French, asking judges to assess short recordings of the subjects as well as one native English and one native French control performing 'read-on-your-own' tasks and spontaneous speech in English. In this study, judges rated each recording for several factors including degree of foreign accent and intelligibility, and identified the speaker's L1 by choosing a nationality from a predetermined list. Results from this study showed that speakers were identified as L1 Polish 63% of the time, significantly higher than any other L1 identification including French (16%), thus suggesting a notable degree of L1 influence against the predictions of the L2 status factor model. Whilst the TPM's predictions may not seem initially relevant given the greater degree of typological relatedness between English and French compared to English and Polish, Wrembel (2012) notes that, phonologically, English and Polish share many features in common such as prosody and some phonemic structures and thus concludes that her study does support exclusive transfer driven by structural similarity. However, the degree of morpholexical similarity between French and English may call into question the strength of Rothman's proposed hierarchy for judgement of crosslinguistic similarity (Rothman, 2015), since a lexically driven decision for exclusive influence of one linguistic system on the L3 should have led to French being chosen over English in the case of Wrembel's (2012) subjects. Taken together, Wrembel's two studies (2010, 2012) suggest support for the Typological Primacy model, demonstrating exclusive transfer of the phonological features of the perceived closest language at the initial state.

Whilst studies of general accentedness in L3 production can provide some degree of insight into phonological CLI processes in L3A, and whilst the methodology does address the issue of

CLI on a macro scale in a way in which more narrow studies of crosslinguistic influence on the scale of individual phonemes cannot, it has been recognised that finer phonetic analyses provide a “more reliable measure” (Wrembel, 2012:307) of CLI and a better understanding of the complex phenomenon that is L3 phonology. Moreover, there are several key issues associated with the underlying methodological practices for measuring general accentedness, including firstly an assumption that transfer will occur on a macro scale; the lack of any separation of the wide variety of phonological features in language (e.g. speech rhythm, vowel reduction, VOT, vowel quality and length, i.a.) renders the detection of partial or selective CLI impossible, and thus the method cannot be used to truly test for CLI source language within the framework of the models of L3A discussed above. Secondly, asking judges to choose the L1 of a speaker from a predefined, finite list may introduce a degree of bias, since it may be clear that one of the offered answers is ‘correct’, and (at least) one other is a key part of the experiment, rendering the use of an ‘other’ option of dubious relevance. Completely free choice, whilst creating more complex data analysis procedures, would allow for more robust data and a more true representation of the judges’ intuitions. Additionally, in asking the judges to identify the L1 of a speaker, it is assumed that they do not believe the subject to be a simultaneous bilingual. This also assumes that they believe either that this is an L2 production study and therefore only one background language could be the possible source of CLI, or that the L1 will always be the dominant source of phonological CLI in NNL production. Furthermore, the highly subjective nature of judge’s decisions may be problematic for general accentedness methodologies, as demonstrated by L1 judgements of the controls used in Wrembel’s (2012) study. The L1 of the native French control was correctly identified 65% of the time, implying that judges were not consistently able to detect French phonological features in English, whilst the native English control was identified correctly 90% of the time, implying that 10% of the judges either were unable to differentiate between native and advanced non-native speech, or were unwilling to accept evidence of native-like production.

This section reviewed studies in the field of L3 phonology, which has to date approached the question of which background language or languages may or may not become the source of phonological crosslinguistic influence in L3 production. Overall, studies in L3 phonology have revealed that either the L1(s) or L2(s) may influence the L3, however it is often noted that due to residual L1 influence in the L2 phonological system, evidence of L2 CLI may occur in terms of combined or compound crosslinguistic influence (Llama et al., 2010; Gut, 2010), thus demonstrating the importance of testing all L3 research subjects in their L1, L2 and L3. Nonetheless, studies in L3 phonology have not examined the factors which may condition CLI on the L3, beyond the notions of a privileged status for L1 or L2, or of typological or structural similarity at a macro level, nor have they adequately employed methodologies of sufficient sophistication to examine beyond the assumption of exclusive transfer. Considering the unified nature of native and non-native perceptual phonological space (as discussed in Section 2.7), the notion of phonological CLI occurring exclusively from a single language and to the exclusion of all other linguistic properties must be questioned, as is proposed by the scalpel model of L3A (Slabakova, 2015, 2017) for other elements of linguistic structure.

Despite this assumption of exclusive CLI and custom of considering crosslinguistic structural similarity at the level of the entire linguistic systems, the potential for similarity in one element of linguistic structure to influence CLI in another element of structure remains unexplored. Whilst it has been proposed that crosslinguistic influence may occur on a selective basis according to similarity at the property level (Slabakova, 2015, 2017), or may occur on an exclusive basis driven by overall lexical similarity (Rothman, 2015), these hypotheses have not been thoroughly tested, nor have they been applied to the development of L3 phonology. Links between lexical similarity and phonological CLI in production, as well as the nature of CLI on the L3 as either exclusive or selective may be examined through crosslinguistic cognates, discussed in section 2.5 above. The following section presents a contrastive analysis of the properties of English, French, Spanish and Portuguese phonology relevant to this study.

2.9. Phonologies of English, French, Spanish, and Portuguese

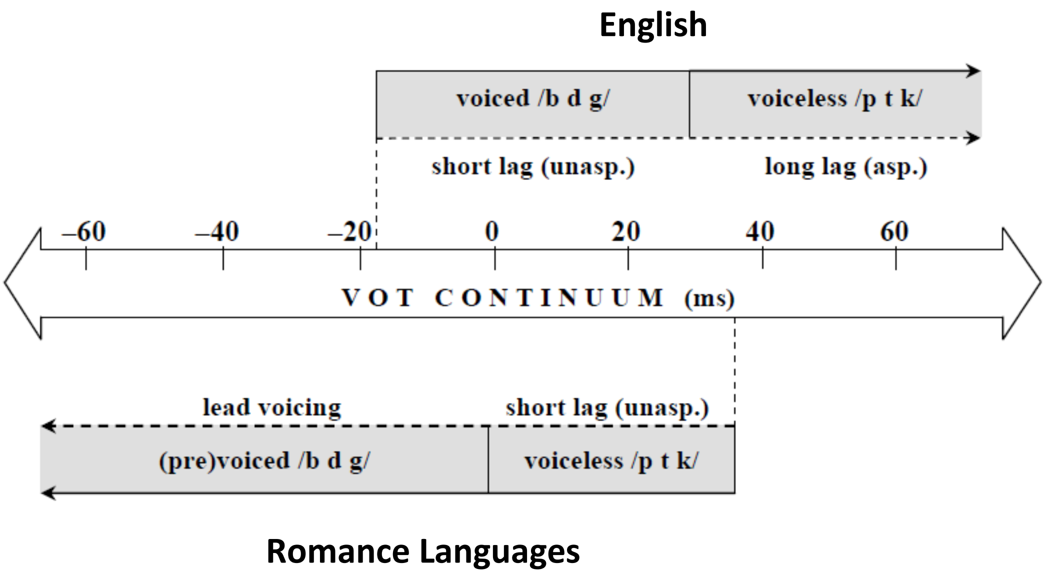
Several aspects of the phonologies of French, Spanish, European Portuguese, and British English are now discussed, focussing on the properties of plosives, pre-palatal consonants, and a selection of vowels which occur word-finally in Spanish and Portuguese. Notable similarities and differences exist across these languages in these areas, hence they represent a viable opportunity to study phonological CLI in L3 production. Furthermore, where differences across these languages lie, the influence of acquired languages on the ability to perceive relevant contrasts can also be tested.

The research questions of this study will be answered through testing of learners of L3 European Portuguese, with L1 English and L2 Spanish or French. The phonological properties of European Portuguese, as the key language under study, is the primary focus of this section, with subsequent comparison to Spanish, French and English. Due to the high degree of morphological and orthographic similarity associated with these properties that exists between standard Spanish and European Portuguese, properties of these two languages are discussed in closer detail where relevant.

2.9.1. Voice Onset Time

As defined by Lisker and Abramson (1964) voice onset time (VOT) is the measurable period of time between the audible release of a plosive and the beginning of quasi-periodic pulsing created by voicing in the following vowel. VOT varies across languages, with both negative and positive values occurring. Negative VOT values occur where voicing begins prior to the release to the plosive and is referred to as 'lead' voicing, whilst positive VOT values occur when voicing begins after the release of the plosive, referred to as 'lag'. Long lag VOT is characterised by the presence of aspiration, akin to the voiceless glottal fricative /h/; short lag VOT yields unaspirated plosives. Figure 6, adapted from Llama et al. (2010), demonstrates this continuum and the portion of it which characterises plosives in English and the Romance Languages.

Figure 6: The VOT Continuum



VOT continuum: Adapted from Llama, Cardoso and Collins (2010)

Hence, the VOT of plosives may be considered to fall along a spectrum with three key subsections: prevoiced, short lag, and long lag[4]. Spanish, French, and Portuguese voiced stops /b, d, g/ are prevoiced, whilst in English these stops are partially voiced. Romance voiceless stops /p, t, k/ have short lag VOT in contrast with the long lag VOT which generally occurs in

[4] Note that some research into VOT in Japanese (cf. Riney et al., 2007) suggests that an intermediate lag, 'moderately aspirated' may exist for Japanese fortis plosives. However, this intermediate lag does not feature in the languages studied in this work.

English voiceless stops.[5] There exists therefore, a notable degree of crossover between the VOT values of English voiced and Romance voiceless plosives. Plosive VOT varies as a function of place of articulation (Ladefoged, 2001). In the languages relevant to this study, bilabial plosives exhibit the shortest VOT, dental and alveolar plosives exhibit slightly longer VOT, and velar plosives have the longest VOT. These variations in VOT, as described by Yavas and Wildermuth (2006), arise because during plosive production the lips separate from one another faster than the tongue separates from the teeth, alveolar ridge, or velum, thus the change in pressure within the oral cavity is more abrupt in the release of bilabial stops than it is in dental, alveolar and velar stops. Faster pressure release allows for the air pressure within the oral cavity to more quickly reach the level at which voicing of the following vowel may begin.

Voice onset time in Romance language voiced plosives typically range from -40 to 0 milliseconds (ms), whereas English voiced stops range from -20 to +20ms (Llama, Cardoso and Collins, 2010). Typical VOT values for English voiceless stops range from 60–70ms for /p/, 70–80ms for /t/ and 80–100ms for /k/, whilst Romance plosives exhibit typical VOT ranges of 0–15ms for /p/, 15–20ms for /t/ and 20–30ms for /k/ (Hualde, 2005; Wunder, 2011). Thus, as mentioned above, and as seen in Figure 6, there is a clear overlap in the voice onset times of English voiced plosives and Romance voiceless plosives. However, whilst relative differences between the three English voiced plosives are similar to those between the three Romance voiceless plosives, and the higher VOT range for English voiced plosives coincides with the lower range for Romance voiceless plosives, absolute VOT values for the voiced plosives tend to be lower than the unaspirated voiceless plosives of the same place of articulation. Therefore, these two sets of plosives are distinguished by differing voice onset time values in addition to differences in articulatory force, however their VOT values are relatively substantially more similar to one another than to those of English aspirated voiceless plosives.

2.9.2. Pre-palatal Affricate – Fricative Contrast in English

In English, the pre-palatal fricative /ʃ/ and the pre-palatal affricate /ʧ/ exist in phonemic contrast, whereas the phonemic inventories of French and European Portuguese contain only

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[5] It should be noted that the terms ‘lenis’ and ‘fortis’ are often used in place of ‘voiced’ and ‘voiceless’ respectively to describe English stops. However, this work will use both terms. See Roach (2010:28) and Lisker & Abramson (1969:385-388) for discussion.

the fricative /ʃ/[6] and standard Spanish phonology utilises only the affricate /ʧ/. Hence, whilst native English speakers are exposed to /ʃ/ and /ʧ/ in phonemic contrast during L1 acquisition and, under normal circumstances, therefore establish separate categories for the two speech sounds for both perception and production, native speakers of French, Spanish, and Portuguese would not be exposed to, and thus may not acquire, this contrast during their L1 acquisition.

Orthographically, Standard French and European Portuguese represent the fricative /ʃ/ with the digraph <ch> in contrast to English and Spanish orthographies in which <ch> generally maps to the affricate /ʧ/; the fricative /ʃ/ is mapped in the English orthographical system to the digraph <sh>. In French and English these pre-palatal consonants may occur word-initially, word internally, and word-finally, whilst in Spanish and Portuguese these consonants may occur word-initially or word-internally, but not word-finally.[7]

2.9.3. Word Final Vowels in Spanish and European Portuguese

Both Spanish and European Portuguese use the graphemes <a> and <o> in word-final position, frequently representing inflectional morphemes encoding grammatical gender in nouns and adjectives or as a marker of person, tense and aspect in verbs. However, despite the orthographical and often functional similarity of these graphemes, the phonological representations of these vowels differ in Spanish and European Portuguese, with the phonemes /a/ and /o/ in Spanish and /ɐ/ and /u/ in European Portuguese occurring in word-final position, mapping to orthographic word-final <-a> and <-o> respectively. By contrast, word final <-a> and <-o> are comparatively rare in English and French and are not generally representative of inflectional morphemes. Within the phonemic inventory of British English, the low front vowel /æ/ and back vowel /ɒ/ may be deemed the closest equivalents of Spanish /a/ and /o/ respectively[8]. The British English front vowel is higher than the Spanish /a/, whilst

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[6] Note that exceptions to this are present in certain loan words, such as French *chat* /ʧat/ and Portuguese *tchau* /ʧau/.

[7] The only exception in Portuguese is in cases of reduction of word-final /ə/ to /Ø/ during rapid speech, such as *ache* [aʃə > aʃØ].

[8] Note that although the vowel /o/ may be considered to occur in many varieties of British English as part of the diphthong /oʊ/, I consider that, as the Spanish vowel occurs as a monophthong, /ɒ/ is a closer British English monophthong.

the British English /ɒ/ is lower than Spanish /o/. British English's closest equivalent to the Portuguese low-mid central vowel /ɐ/ may be considered to be /ɜ/, however as /ɐ/ only occurs in European Portuguese in unstressed, word-final position, it may in fact be assessed as relatively closer to the British English central vowel /ə/. The phonemic inventory of French contains the low, front vowel /a/, and the high-mid back vowel /o/, similar to the Spanish vowels (Lodge et al., 1997), however, French also utilises the mid-low back vowel /ɔ/. In general, the vowel /o/ is mapped to word-final, stressed orthographic trigraphs such as <-aut, -aud, - eau>, whereas orthographic <o> is primarily mapped to /ɔ/. Similar to English and Portuguese, French also contains the unstressed central vowel /ə/, although this is frequently reduced to /Ø/ during connected speech, with the exception of production of French clitic pronouns (Fagyal, Kibbee and Jenkins, 2006).

Both Spanish and Portuguese also share the frequent use of orthographic <-e> in word-final position, however with differing phonological representations. Spanish maps <-e> to the mid-high front vowel /e/ and Portuguese maps word-final <-e> to the unstressed central vowel /ə/[9] with potential raising to /ɨ/ (Mateus, 1982; Mateus and d'Andrade, 2000). British English and French phonologies both contain the schwa /ə/, which occurs word-finally often in English, though less frequently in French (see above). In comparison to Spanish, French and English also both have front, central vowels, however the phonemic inventory of British English contains only /ɛ/, slightly lower than the Spanish /e/, whilst French has both /e/ and /ɛ/, with the higher vowel occurring in 'open' CV syllables (e.g. *fait* /fe/) and the lower vowel occurring in 'closed' CVC syllables (e.g. *fête* /fɛt/) (Fagyal, Kibbee and Jenkins, 2006). Thus, the high-mid front vowel /e/ occurs frequently in stressed, word final position in French.

This section provided a contrastive analysis of the properties of voiced and voiceless plosives in British English, French, Spanish, and European Portuguese, as well as a comparison of Spanish and European Portuguese vowels both to each other, and further to vowels of similar qualities in French and British English. As evidenced through the above comparisons, these four languages have a range of areas of similarities and differences in their phonological properties, allowing for effects of crosslinguistic influence from French, Spanish, and British English on

[9] Note that in some varieties of Cape Verdean Portuguese word final <-e> may be pronounced as /e/. However, the subjects of this study have not had any exposure to this variety and therefore it is not considered to be of relevance to this case.

Portuguese during L3 Portuguese production to be observed through analysis of L3 learner speech.

2.10. Conclusion

As mentioned in Chapter 1, the purpose of the present study is to assess whether localised crosslinguistic similarity in morpholexical structure can influence the selection of source language for phonological crosslinguistic influence in L3 production. In the above review of relevant literature, it was recognised that studies in L3 phonology remain limited in number and scope, and that several areas of third language acquisition have not been fully tested, including:

1. The potential for the CLI source language to change over time with increased L3 proficiency
2. The nature of CLI of background language structures as either exclusive or selective
3. The factor(s) which drive(s) the selection of source language(s) for CLI on the L3
4. The full role of learners' perceptions of language distance or proximity in conditioning selection of source language for CLI.
5. Which aspect(s) of linguistic structure are and are not prominent in determining learners' perceptions of language distance
6. The potential for crosslinguistic similarity in one aspect of linguistic structure to influence CLI from properties in another aspect of structure.

Addressing all of these identified gaps would require a study of very large scope. Therefore, this study addresses points 2 and 6, whilst touching on points 3 and 4. The core focus of this study is to assess the potential for localised, structural similarity at the lexical level to influence phonological CLI in L3 production and to observe whether CLI in L3A can occur selectively from multiple background languages, or is restricted to occurring exclusively from a single L1 or L2. The study seeks to fulfil this focus by answering the following Research Questions:

1. Can phonological CLI on L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?
3. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects are neutral?
4. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects exist with both L1 and L2?

This chapter has criticised previous studies in third language acquisition for failing to actively address the role of learner perceptions of crosslinguistic similarity in conditioning CLI in L3A, relying instead on a priori assumptions or abstract, post-hoc deductions of learner perceptions. It has also raised concerns with studies in L3 phonology for testing only production despite the well-documented perception-production link in language acquisition. It was additionally argued in this chapter that research in L3 phonology has rarely employed methodologies which allow for testing of newer, more salient questions regarding the nature of CLI as selective or exclusive, and the complex factors which drive the selection of CLI source. As such, this study addresses its research questions by testing perception and production in L3 European Portuguese at the beginner level. It further analyses the results of these tests with the additional context of data regarding learners' perceptions of language distance, based on the concepts of psychotypology (Kellerman, 1977, 1979), and learners' desire to suppress or encourage crosslinguistic influence in L3 production.

Through these methods, this study will test the following hypotheses:

1. CLI from the L2 will be dominant; overall, the L3 VOT will be L2-like.
2. CLI will cause VOT in the L3 to be L2-like under the non-cognate condition, the L2 cognate condition, and the L1-L2 cognate condition
3. CLI will cause VOT in the L3 to be L1-like under the L1 cognate condition
4. Frication will be transferred from L1 for those with L2 Spanish
5. The first formant of the L3 vowel /u/ will consistently be produced lower than that of L1 /ɒ/ and L2 /o/.
6. L3 /ɐ/ and schwa will not be consistently distinguished in production.
7. Under the L1 cognate condition, the L3 vowel /ɐ/ will not be distinguished from L1 schwa.
8. Under the L2 cognate condition, L3 vowels /ɐ/ and /ə/ will not be distinguished from L2 /a/ and /e/ respectively.

Testing these hypotheses explores the potential for CLI in L3A to be sourced from the L1 or the L2, and the nature of CLI as selective or exclusive. Thus, testing these hypotheses also tests the predictions of the models of L3A discussed in Section 2.3 above. The use of cognates as localised sources of heightened crosslinguistic morpholexical similarity will allow for this study to address the gaps in the L3 literature identified above regarding the potential for crosslinguistic similarity at the lexical level to influence transfer of phonological properties. As was noted in Section 2.5, the interconnected nature of the multilingual lexicon leads to coactivation of multiple languages when accessing lexical items where root or affix morphemes share phonological or orthographic representations. These hypotheses therefore claim that where coactivation of the L3 with single background language occurs this will lead to phonological CLI from said background language. They also predict that where coactivation of neither background language or both background languages occurs the L2 will be selected as the source of phonological CLI in L3 production.

This chapter has presented a review of the literature and the theoretical framework within which this study is set. In accordance with the identified gaps in this literature, this study advances knowledge in the field of third language acquisition in two principle ways. Firstly, it will test the selective vs. exclusive CLI dichotomy that separates prominent L3A models. Secondly, it addresses the previously unexplored potential for localised crosslinguistic similarity in one aspect of language structure to alter processes crosslinguistic influence in another aspect of language structure. The following chapter details this study's methodology, including its participants, and the instruments and procedures of the data collection.

Chapter 3 **Methodology**

This chapter details the processes employed during this study of phonological CLI in L3 acquisition, including the participants, the instruments used in data collection, and the purpose of and reasoning for each element of the experiments. The chapter ends with reiterating this study's Research Questions and the set of hypotheses to be tested through the experimental procedure detailed here.

University students acquiring Portuguese as an L3 participated in a series of experiments which were conducted at three different times over the course of one academic year in order to create a study with both cross-sectional and (semi-)longitudinal elements. At each of these times, each participant performed several tasks involving their L1, their L2, and their L3, testing both aural perception and oral production, in addition to completing a language questionnaire at the beginning of the year. Data analysis later revealed that variation in L3 production over time in this study was essentially negligible, therefore this was not studied as a separate phenomenon.

3.1. Participants

Initially a pool of 22 Portuguese learners volunteered to take part in the study, of whom 1 left the study for personal reasons, 2 were eliminated due to not having an appropriate intermediate level L2, and a further 7 were eliminated due to timetabling incompatibilities. This left a final group of 12 participants (3 male, 9 female).

Table 3.1.1: Gender and Languages of Participants

Participant no.	Gender	L1 (native)	L2 (intermediate)	L3 (beginner)
A	Male	English	Spanish	Portuguese
B	Female	English	French	Portuguese
C	Female	English	Spanish	Portuguese
D	Female	English	Spanish	Portuguese
E	Male	English	Spanish	Portuguese
F	Female	English	Spanish	Portuguese
G	Male	English	French	Portuguese
H	Female	English	French	Portuguese
I	Female	English	Spanish	Portuguese
J	Female	English	Spanish	Portuguese
K	Female	English	Spanish	Portuguese
L	Female	English	Spanish	Portuguese

All participants were adults studying for undergraduate degrees at a university in the United Kingdom and were enrolled on an ab initio level Portuguese language course. All were L1 speakers of English, with no other languages identified as having been acquired from infancy. All had either French or Spanish as an L2 at intermediate level which they were also studying at university. Those participants with both L2 French and L2 Spanish at intermediate level were classified as L2 Spanish; all L2 production tests for these participants were therefore conducted in Spanish.

Due to the larger degree of lexical similarity between French and English than between Spanish and English, L2 Spanish was chosen to be the default classification for participants with both French and Spanish as L2 in order to more strongly differentiate the L1 from the L2 for the majority of participants. Nonetheless, the morphosyntactic similarities between French and Portuguese, as well as the properties of the phonological structures analysed in the present work, render French adequate for use as the L2 in this study. Individual variation between participants is accounted for in this study through the use of normalisation procedures for VOT length and vowel formant frequencies, as well as the use of Generalised Linear Mixed Models (see Chapter 4 for a full review). Differences in cognate condition for L3 target words due to the difference in target L2 are accounted for by categorising each L3 target word by cognate condition separately for each of the L2 groups. Table 3.1.1 briefly summarises the languages of each of the participants which were pertinent to this study; full language backgrounds of each participant can be seen in Appendix A.

3.2. Data Collection

Three elements of data collection were designed for this study and used to gather information and results from the study’s participants. The first element, a Language Questionnaire, was used to obtain participants’ linguistic background as well as their impressions of language distance, and their attitudes to language learning. The second element, an Aural Perception and Distinction Task (APDT), tested participants’ ability to distinguish key speech sounds in the L1, L2, and L3. The third element, an Oral Production Task (OPT), elicited L1, L2, or L3 words and sentences containing target phonemes. Each of these elements are described in greater detail below. All research instruments were created for the purpose of this project.

Each participant completed the Language Questionnaire once, at the beginning of the experiment participation process in mid-October, and the APDT and OPT were each conducted three times. Phase 1 was conducted in late October, Phase 2 in early March, and Phase 3 in late May, at the end of the academic year.

3.2.1. Language Questionnaire

The Language Questionnaire was administered to all participants at the beginning of the academic year (after approximately 8 hours of instruction in Portuguese). Participants were asked to complete the questionnaire whilst the researcher was present and were welcome to query any part of the form. No time limit was imposed on the completion of this task. The full questionnaire can be seen in Appendix B.

The Language Questionnaire consisted of three sections: The first requested information on participants' linguistic background, including which languages they know, their proficiency level in each language, whether or not they still study or regularly use the language, and, if no longer in use, when they stopped using the language. These data allow for a better understanding of participants' background in order to view the homogeneity of the group. A relatively simple approach to gathering language background information was taken, as the primary focus of the Language Questionnaire used in this study lies in section two of the questionnaire, addressing perceptions of language distance.

The second section comprised a questionnaire based on the concepts of psychotypology (Kellerman, 1977, 1979), to evaluate participants' perception of linguistic similarity and language distance of their L1 and L2(s) relative to their L3 (Portuguese). This section was further divided into three parts, asking participants to evaluate the morpholexical, phonological, and syntactic similarity between Portuguese and each of their background languages. Participants were asked to indicate the degree of similarity that they perceived on a 7-point Likert scale (where 1 represented "Extremely Different" and 7 represented "Extremely Similar"). It was made clear to all participants that these judgements were their own, personal perceptions.

The third section of the Language Questionnaire consisted of a set of seven statements related to language learning and to specifically the learning of Portuguese. In order to maintain consistency with section two, answers were again given on a 7-point Likert scale, with 1 representing "Strongly Disagree" and 7 representing "Strongly Agree" and it was again made clear to participants that these judgements should be based on their own perceptions. This section was designed to elicit information regarding:

- Participants' desire to achieve native-like pronunciation and the degree to which they believe acquisition of NNL phonology should be prioritised in NNLA.
- Participants' desire to avoid phonological CLI from the L1 and/or L2
- Participants' perception of potential positive CLI from the L1 and/or the L2 into the L3

- Participants’ perception of specifically potential positive phonological CLI from the L1 and/or the L2 into the L3.

The data from sections two and three were gathered in order to build a richer picture of each participant’s perceptions of crosslinguistic structural similarity and of their thoughts on the role of crosslinguistic influence in their L3 acquisition process. Whilst these data may prove useful in further contextualising data from the perception and production tasks also undertaken, the subjective nature of the Likert scale system employed and the relatively small participant pool means that the responses from each participant cannot be effectively compared to one another. It must further be noted that the responses from section two represent study participants’ conscious perceptions of structural similarity and language distance, and not the unconscious perceptions which, in the Typological Primacy Model (Rothman 2010, 2011, 2013, 2015) play an important role in the designation of a source language for CLI on the L3. Nonetheless, I suggest that measurements of conscious perceptions may prove revealing since learners’ unconscious perceptions cannot be accessed directly.

Data collected from section three of the Language Questionnaire represent conscious expressions by participants of their desire to suppress or encourage L1 and L2 CLI in L3 production, and their interpretations of the potential viability of their L1 and L2 as sources of positive CLI in their L3 acquisition processes. These data will be used to further contextualise data from section two on participant perceptions of language distance and assess whether learners who perceive background languages to be structurally similar to the L3 do also consider these languages as potential sources of positive CLI. It additionally allows for consideration of whether learners who consider their L1 or L2 to be similar to the L3 in some, but not all, aspects of linguistic structure also consider these languages to be viable potential sources of positive CLI, both generally and specifically for phonology. Finally, should phonological CLI be observed to occur from L1 or L2 in cases where participants express conscious desire to suppress phonological CLI but encourage lexical and morphosyntactic CLI, this will suggest that decisions regarding CLI source selection may be influenced by factors beyond simple, structural similarity at the level of direct property-to-property comparison. Such cases would suggest that perceptions of similarity in one aspects of linguistic structure (such as lexis) have a strong impact on selection of source language for crosslinguistic influence in other aspects (such as phonology), overriding some conscious perceptions of language distance.

Thus, data regarding participants' perceptions will be used to provide a backdrop against which to contextualise evidence of crosslinguistic influence in the Oral Production Tasks. Furthermore, although learners' perceptions of linguistic similarity or distance are frequently suggested to be a factor in conditioning CLI, previous works in the field have rarely attempted to measure subjects' perceptions of structural similarity. It is instead frequently assumed that learners' perceptions will be in line with objectively observable structural similarity (i.e. that which can be identified through contrastive analysis of relevant linguistic structures) or it is argued that evidence of CLI in L3 usage retrospectively suggests coinciding perceptions of similarity on the part of the subjects.

3.2.2. Aural Perception and Distinction Task

In order to assess participants' ability to distinguish between key phonemes in their L1, L2, and L3, an aural perception test for speech sound distinction was created. Participants undertook the test three times, once in each of the 3 phases, in order to measure any progress in perception and distinction that may occur with increasing proficiency in the L2 and L3 over the course of the experiment. This task took the form of an 'Odd-One-Out' discrimination task, as used by Pytlyk (2011) which is an adaptation of the frequently used AXB or ABX test. Participants are presented with a group of three sounds, two of which are the same and one of which is different, and asked to identify which of the three sounds is different. This method of delivery was chosen over the more common AXB test for two key reasons. Primarily, an 'Odd-One-Out' task allows for a greater variety of potential speech sound position settings and positions of the correct answer (i.e. three potential answers as opposed to the two offered in AXB). This has the additional advantage of reducing the effectiveness of participant guessing when they are unsure. Secondly, previous studies involving AXB and ABX tests have required extensive familiarisation periods for participants, as seen in Hojen and Flege (2006) in which some participants required up to 80 preliminary trials before being able to proceed to target test trials, whereas studies conducted with Odd-One-Out tasks required minimal participant training (cf. Pytlyk, 2011).

The task was designed to test participants' ability to distinguish between plosives with similar places of articulation but differing voice onset time (VOT) [p^h, p, b, ˬb], [t^h, t̪, d, ˬd̪] and [k^h, k, g, ˬg]; the affricate /ʧ/ against the fricative /ʃ/; and several key vowels that differ phonologically in English, Spanish, French and Portuguese despite orthographical similarities: front and central vowels [a, æ, ɐ, ə] and back vowels [ɒ, o, u]. This led to specific speech sound pairs to be tested, as seen in Table 3.2.1. It should be noted that several of these speech sound tests pairs exist in phonemic contrast in natural British English, and thus should be easily distinguishable for L1 English speakers. Other speech sound tests pairs do not exist as distinct phonemes in British English, and thus may prove difficult to distinguish unless the distinction has been acquired through the L2 or L3.

Sounds were collected from recordings of native speakers of British English (for /pʰ, tʰ, kʰ, b, d, g, ʧ, ʃ, æ, ə, ɒ/), Spanish (for /p, t̪, k, ˬb, ˬd̪, ˬg, ʧ, a, o/) and Portuguese (for / p, t̪, k, ˬb, ˬd̪, ˬg, ʃ, ɐ, ə, u/) producing real words in isolation. In total, four British English speakers (two male, two female), three native Spanish speakers (one male, two female), and two native European Portuguese speakers (one male, one female) were recorded. All consonants were produced in stressed, word-initial position followed by the vowel /i/; this vowel was chosen due to its being common to English, French, Spanish, and Portuguese and since neither perception nor production of this vowel were being tested elsewhere within the experimental procedure. Due to vowel reduction in unstressed syllables in British English, the vowels /æ, ɒ/ were taken from stressed syllables, whilst /ə/ was taken from word-final unstressed syllables. All examples of Spanish vowels /a/ and /o/ and Portuguese vowels /ɐ, ə, u/ were taken from unstressed, word-final position since these vowels represent a key element for analysis of the Oral Production Task data. Sounds were arranged into groups of three (two the same, one different, e.g. [di, di, ˬd̪i]; [ɒ, o, ɒ]) according to the pairings shown in Table 3.2.1, with each sound in each group being taken from recordings of a different speaker in order to eliminate speaker voice as a potential influence on participants' answers. The final test consisted of a total of 69 groups. The full order of the test procedure can be seen in Appendix B.

<u>Table 3.2.1: Speech Sound Test Pairs in Aural Perception and Distinction Task</u>

Bilabial plosive pairs	**Alveolar/Dental plosive pairs**	**Velar plosive pairs**	**Palatal consonant pairs**	**Vowel pairs**
• /pʰi/ vs. /pi/ • /pʰi/ vs. /bi/ • /pi/ vs /bi/ • /pi/ vs. /ˬbi/ • /bi/ vs. /ˬbi/	• /tʰi/ vs. / t̪i/ • /tʰi/ vs. /di/ • /t̪i/ vs. /di/ • /t̪i/ vs. /ˬd̪i/ • /di/ vs. /ˬd̪i/	• /kʰi/ vs. /ki/ • /kʰi/ vs. /gi/ • /ki/ vs. /gi/ • /ki/ vs. /ˬgi/ • /gi/ vs. /ˬgi/	• /ʧi/ vs. /ʃi/	• /a/ vs. /æ/ • /a/ vs. /ɐ/ • /æ/ vs. /ɐ/ • /ɐ/ vs. /ə/ • /o/ vs. /ɒ/ • /o/ vs. /u/ • /u/ vs. /ɒ/

Participants were tested in a quiet, isolated room with stimuli presented through headphones which each participant was able to individually adjust to a comfortable volume; answers were written on a paper answer sheet (see truncated version in Appendix B). Before beginning the test, participants were trained in the test procedure via three example sound groups. These groups were of contrasts existent in British English and which all participants were able to distinguish (e.g. [bi, bi, gi]). Once comfortable with the test procedure participants were permitted to continue with the main trials. All tests were conducted in the presence of the researcher.

Each group of sounds presented was preceded by a voice stating the group number corresponding to the group number on the answer sheet and was followed by a tone to indicate the end of the group. Inter-stimulus interval was set at 900ms and each group of sounds was delivered twice consecutively; a 1500ms period of silence was placed between the tone and the following group number. Participants were not able to pause or rewind the audio, however the test was administered in two separate audio files of approximately 11 minutes each, allowing a short break between group 35 and group 36.

3.2.3. Oral Production Task

The third element of data collection for the study consists of Oral Production Tasks (OPTs) completed by all participants during each of the three phases (October, March, and May). L1 oral production tasks were completed in Phase 1 only, whilst L2 and L3 oral production tasks were completed in Phase 1, 2, and 3. As described by Rothman (2015), testing of the L1 is necessary as it cannot be assumed that monolingual norms will apply to all multilingual speakers. Furthermore, work by Fowler et al. (2008) has suggested that VOT (relative) values in even consecutive bilinguals differ from those of monolinguals.

These tasks were designed to elicit words containing key phonemes, specifically voiceless plosives, the affricate /ʧ/ and the fricative /ʃ/, and the vowels [a, æ, ɐ, ə, e, ɒ, o, u] in order to analyse VOT, affrication, and vowel quality for evidence of phonological CLI in the L3. L1 stimuli also elicited tokens of [sibilant + plosive] clusters in order to attest participants' ability to produce unaspirated plosives in stressed, pre-vocalic position which exists as allophonic variation in English. All participants produced this allophonic variation as expected. The L2 and L3 stimuli were to elicit target words both in isolation as well as embedded in target language sentential contexts. This was done for potential future research to evaluate the any effects of morphosyntactic processing load on phonological processing. Sentence elicitation was not included in the L1 stimuli set as the data to be obtained from the L1 OPT was to be used to establish L1 baseline VOT values, use of the affricate – fricative contrast, and vowel qualities for each participant for comparison to L2 and L3 values.

All sentences used in the stimuli were natural, grammatical target language sentences. Some sentences contained more than one target word. Each target word appeared twice in its OPT stimuli set: once in isolation and once in sentence embedded context. Table 3.2.2 lists the final composition of each set of OPT stimuli. As mentioned in Section 1.3, in order to explore the role of cognates in conditioning phonological CLI on the L3, cognate and non-cognate words were included in the L3 stimuli.

Table 3.2.2: Item Number by Type in OPT Stimuli Sets

OPT Stimuli set	No. Isolated words	No. sentences	Total number of items
L1 English	68	0	68
L2 French	60	25	85
L2 Spanish	61	34	95
L3 Portuguese	83	57	140

3.2.3.1. Oral Production Task Stimuli

Word sets were created for English (L1), French (L2), Spanish (L2) and Portuguese (L3), containing words with target phonemes; all target words in the English, Spanish and Portuguese stimuli sets were disyllabic with the tonic syllable being in initial position. Due to the differing syllable stress pattern of French, the OPT stimuli set for French contained monosyllabic, disyllabic and some trisyllabic words. Full word lists can be seen in Appendix B.

Target consonants for the L1 OPT were aspirated voiceless plosives [p^h, t^h, k^h], the postalveolar affricate /ʧ/ and the postalveolar fricative /ʃ/, all of which occurred in stressed, syllable onset, word-initial position. Target vowels for the L1 OPT were /æ, ɒ, ə/; open vowels /æ, ɒ/ occurred in stressed, post-consonantal position, whilst all instances of /ə/ occurred in word-final, unstressed, post-consonantal position. The complete word list contained 68 items designed to yield a total of 105 tokens (see Table 3.2.3 for full delineation of token type).

Target consonant phonemes for the L2 French OPT were unaspirated voiceless plosives /p, t, k/ and the postalveolar fricative /ʃ/. All examples of the fricative /ʃ/ occurred in word-initial position; all target voiceless plosives occurred in stressed, syllable onset position. Due to the prosodic structure of French, the tonic syllable in polysyllabic words is rarely the first syllable, however since aspirated plosives in English occur only in stressed syllables, placing all target L2 French voiceless plosives in stressed syllable onset position allows for a more reliable comparison of L2 French VOT data to the L1 and L3 data sets. Target vowels for the L2 French OPT were /a, ɔ, e/; the vowels /a, ɔ/ always occurred in occurred in first syllable, post-consonantal position, whilst /e/ occurred in word-final, stressed position. The complete French item list comprised 60 isolated words and 25 sentences, yielding a total of 166 tokens (see Table 3.2.3).

Target consonant phonemes for the L2 Spanish OPT were unaspirated voiceless plosives /p, t, k/ and the postalveolar affricate /ʧ/, all of which occurred in stressed, word-initial position. Target vowels for the L2 Spanish OPT were /a, o, e/, all of which occurred in word-final, unstressed position to allow for effective comparison to word-final vowels in Portuguese which share orthographical but not phonological representation. The complete Spanish item list was composed of 61 isolated words and 34 sentences, yielding a total of 240 tokens (see Table 3.2.3).

Target consonant phonemes for the L3 Portuguese OPT were unaspirated voiceless plosives /p, t, k/ and the postalveolar fricative /ʃ/, all of which occurred in stressed, word-initial position. Target vowels for the L3 Portuguese OPT were /ɐ, u, ə/ all of which occurred in word-final, unstressed position to allow for effective comparison to orthographically identical word-final vowels <-a, -o, -e> in Spanish. The final Portuguese item list comprised 83 isolated words and 57 sentences, yielding a total of 314 tokens (see Table 3.2.3). Each target word from the L3 OPT stimuli was then classified by cognate status under the categories: Non-cognate, Cognate with L1 only, Cognate with L2 only, Cognate with both L1 and L2. For the L2 Spanish group, the target words comprised a total of 18 non-cognates, 14 L1 cognates, 23 L2 Spanish cognates, and 28 L1–L2 cognates; for the L2 French group, the target words comprised 31 non-cognates, 6 L1 cognates, 10 L2 French cognates, and 36 L1–L2 cognates.

3.2.3.2. Oral Production Task Procedure

Participants completed each oral production task individually in a quiet, isolated room in the presence of the researcher. In order to avoid L1 or L2 priming in research participants (as discussed in Rothman, 2015) the L3 OPT was always conducted first, the L2 OPT second and the L1 OPT third. Additionally the L3 OPT was always completed on a different day to the L2 and L1 tasks in order to reduce any potential priming of L3 influencing L2 production. Task sessions lasted between two and ten minutes.

Table 3.2.3: Token Type and Number: Oral Production Task Stimuli[10]

	Phoneme	L1 English		L2 French		L2 Spanish		L3 Portuguese	
		Isolated	Sentence	Isolated	Sentence	Isolated	Sentence	Isolated	Sentence
Plosives	Post-sibilant	10							
	Bilabial	17		12	12	16	16	29	29
	Alveolar/ Dental	13		15	15	15	15	19	19
	Velar	17		12	12	16	16	17	17
	/ʧ/	5				14	14		
	/ʃ/	3		15	15			19	19
Vowels	/a/			13	13	17	17		
	/æ/	13							
	/e/			8	8	18	18		
	/ə/	18						17	17
	/ɐ/							27	27
	/ɒ/	9							
	/o/					24	24		
	/ɔ/			8	8				
	/u/							29	29

During each oral production task participants were seated in front of a computer screen on which items (i.e. one isolated word or one sentence) were presented as written text one at a time. Items had been placed in random order by computer with the same, randomised order used for all participants. Participants were instructed to read the text on the screen aloud and were audio recorded via Audacity (version 2.0.5.0, Audacity team, 2008) using a ProSound A99JB Vocal Microphone; sampling rate was set at 44100Hz. The researcher sat to the side and moved the display from one item to the next using a wireless device so as to not intrude into

[10] Blank cells in this table represent zero tokens.

the participants' field of view. No time limit was given for completion of the task since the present project is not testing processing time or lexical access and retrieval speeds.

The use of pictorial stimuli was considered, however a pilot test revealed that for beginner level L3 learners with limited lexical knowledge in the target language, use of pictorial stimuli caused difficulty in lexical retrieval, leading to high degrees of non-target productions and lexical CLI. Furthermore, work on cross-language cognates and lexical activation in bilinguals[11] suggests that the presence of the orthographic form should further enhance cross-language activation in the lexicon for cognate (phonological and orthographical) items (Kroll, Gullifer and Rossi, 2013; Schwartz, Kroll and Diaz, 2007). Hence, use of orthographical representations leading to enhanced coactivation (when compared to phonological similarity only) may allow for any effect of cognates on phonological CLI to be more visible, whilst having no further impact on production if cognates do not play a role in conditioning phonological CLI. This was decided in spite of the fact that some research has suggested that orthographical forms may have some degree of influence on phonological processing (Simonet, 2014).

Data collected from the oral production tasks are used to analyse phonological crosslinguistic influence on L3 acquisition in this study. Analysis of VOT length in fortis plosives, affrication of frication of the graphemes <sh, ch>, and formant frequencies of the target vowels [a, æ, ɐ, ə, e, ɒ, o, u] is conducted to address the research questions and test the hypotheses of this study. Where these values converge across languages, it is possible that CLI has occurred, influencing the L3 property to be like an L1 or L2 counterpart.

3.3. Research Questions and Hypotheses

This study employs the instruments and methods described within this chapter in order to address its four research questions:

1. Can phonological CLI into L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?
3. Will L2 Spanish/French be the dominant source of phonological transfer into L3 Portuguese when cognate effects are neutral?

[11] Kroll, Gullifer & Rossi (2013) further propose that the coactivation effects observed in bilinguals would occur similarly in multilinguals.

4. Will L2 Spanish/French be the dominant source of phonological transfer into L3 Portuguese when cognate effects exist with both L1 and L2?

These questions are addressed by testing the following hypotheses:

1. CLI from the L2 will be dominant; overall, the L3 VOT will be L2-like.
2. CLI will cause VOT in the L3 to be L2-like under the non-cognate condition, the L2 cognate condition, and the L1-L2 cognate condition
3. CLI will cause VOT in the L3 to be L1-like under the L1 cognate condition
4. Frication will be transferred from L1 for those with L2 Spanish
5. The first formant of the L3 vowel /u/ will consistently be produced lower than that of L1 /ɒ/ and L2 /o/.
6. L3 /ɐ/ and schwa will not be consistently distinguished in production.
7. Under the L1 cognate condition, the L3 vowel /ɐ/ will not be distinguished from L1 schwa.
8. Under the L2 cognate condition, L3 vowels /ɐ/ and /ə/ will not be distinguished from L2 /a/ and /e/ respectively.

The methods outlined in this chapter are used to test these hypotheses and answer these research questions. In so doing, this study intends to address the above recognised gaps in the L3 literature regarding the nature of CLI in L3A as selective or exclusive, and the potential for structural similarity in morpholexis to condition CLI processes in phonology. Furthermore, the methods presented here intend to address the methodological concerns with previous L3 studies raised in Chapter 2, through actively considering learner perceptions of language distance and testing both perception and production in L3 phonology, and employing these results in answering the study's research questions. Additionally, it should be noted that answering these research questions will also test the predictions of prominent L3A models. Should phonological CLI be seen to be selective and shift its source between L1 and L2 depending on cognate condition status, this would contradict the predictions of the TPM and the L2SF. Should any such CLI effects lead to divergence from L3 target structure where positive CLI is available, this would contradict the predictions of the CEM. Finally, should there be no evidence of selective CLI this would present a challenge to the scalpel model, which would expect some changes in L3 production on a micro scale.

3.4. Conclusion

This chapter has established the participants, instruments, and research methods used in this study. It was shown that several data collection methods were employed on multiple occasions in order to build a rich data set to analyse the role of localised morpholexical similarity in conditioning phonological CLI in the acquisition of L3 Portuguese. Finally, the research questions and hypotheses that these methods test were reiterated.

Chapter 4 **Results**

This chapter reviews the data obtained through the three testing procedures. It begins by presenting the data from the Language Questionnaire, followed by the data of the Aural Perception Distinction Task, and finally the data obtained through the Oral Production Tasks. All tests were conducted in the presence of the researcher as detailed in Chapter 3.

4.1. Results: Language Questionnaire

As discussed in Section 3.2.1, all participants in this study completed a questionnaire prior to attending the aural perception and oral production tasks with the intention of providing both a broader, richer background to each participant, as well as to address suggestions that learners' perceptions of crosslinguistic similarity impact the processes of crosslinguistic influence from the L1 and/or L2 in L3 production. The questionnaire collected data in three sections: section one focussed on the participants' proficiency in their L2s, section two focussed on participants' perceptions of structural similarity between their L3 (Portuguese) and each of their background languages, whilst section three addressed participants' desire to imitate native speaker pronunciation and to avoid L1 or L2 CLI in L3 production, as well as their judgements on the degree to which their knowledge of L1 and L2 linguistic structures may be employed in order to contribute to success in both the L3A process and L3 production. Results from section one of the language questionnaire are shown in the Participant Details section found in Appendix A.

Although the subjective nature of the Likert scale used in sections two and three of the language questionnaire renders concrete and broad-reaching comparisons impractical, it does allow for some observations of trends as well as assessment of individual participants' perceptions of relative crosslinguistic distance and their judgements of the relative importance and usefulness of their background languages in L3 acquisition and production.

4.1.1. Results: Language Questionnaire Section Two

Results of section two of the language questionnaire, which assessed perceptions of crosslinguistic similarity, reveal some suggestions of patterns in participants' judgements. Data for the target L1 and L2s are shown in Table 4.1.1; additional data can be found in Appendix C.

Table 4.1.1: Participant English, French and Spanish Similarity Judgements

Participant	English			Spanish			French		
	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax
A	3	3	5	6	3	6	4	4	5
B	3	2	4				4	3	5
C	4	3	5	7	4	6	3	5	6
D	3	2	3	6	4.5	7			
E	4	3	3	7	5	7	5	4	5
F	2	2	5	6	3	6	5	3	5
G	4	3	5	6	5	7	5	6	6
H	1	1	4				2	1	3
I	3	2	5	4	3	6	6	3	4
J	2	1	3	5	2	4			
K	3	2	5	6	5	7			
L	2	1	4	7	4	5	4	5	5

All participants rate the morpholexical structures of their L3 Portuguese as more similar to their target L2 than the L1; furthermore all participants rate Portuguese as phonologically more or equally similar to their target L2 than their L1. In terms of syntax, only participant H rates Portuguese as less similar to their target L2 than the L1; all others rate their L2 as syntactically more similar than English to Portuguese

The data presented in Table 4.1.1 further show that no participant believes English to be similar (i.e. rank 5-7) to Portuguese in terms of lexis and phonology, with all participants specifically rating English as phonologically dissimilar (i.e. rating 1-3) to Portuguese. Of the 9 participants for whom the target L2 is Spanish, four rate their L2 as phonologically dissimilar to the L3 and three rate Spanish as somewhat similar to Portuguese. Lexical similarity between Spanish and Portuguese is generally rated highly amongst these participants, with Participant I giving the lowest rating of 4 (i.e. neither notably similar nor dissimilar). Of the three participants in the L2 French subgroup, two rate French as dissimilar to Portuguese in phonology, however Participant G perceives a substantial degree of phonological similarity between the L2 and L3. The data further suggest that the study's participants perceive a lesser degree of lexical similarity between French and Portuguese than that between Spanish and Portuguese; furthermore the answers provided by Participant H demonstrate that she finds very little similarity between Portuguese and either of her background languages in any of the three aspects addressed within section 2 of the Language Questionnaire.

Of the participants who speak both French and Spanish, all seven rank Spanish as equally or more similar to Portuguese in terms of syntax and only participant I ranks Spanish as lexically less similar than French to Portuguese. Meanwhile, both speakers of German rate all of their other known languages as greater or equal in similarity to Portuguese in morpholexis, phonology and syntax. Similarly, all three speakers of Italian rate Portuguese as equally or more similar to their other romance languages than to Italian in all three aspects.

In sum, the results from section 2 of the Language Questionnaire suggest that this study's participants perceive, at least on a conscious level, that their target L3 is more similar to their L2s than it is to their L1. Nonetheless, these data also reveal that the participants do not generally perceive the L2 and L3 to share high degrees of phonological similarity, despite perceived lexical and syntactic similarity.

4.1.2. Results: Language Questionnaire Section Three

Section 3 of the Language Questionnaire assessed participants' attitudes towards the importance of pronunciation in NNLA, their conscious desire to supress crosslinguistic influence in L3 production and the relevance of the linguistic structures of their L1 and L2 as sources of potential positive CLI in their L3 acquisition and production. Participants rated the following seven statements[12] on the 7 point Likert scale from 1 (strongly disagree) to 7 (strongly agree):

1. When learning a language, I think that closely imitating the pronunciation of native speakers is important.
2. When speaking Portuguese, I want to avoid using sounds from English.
3. When speaking Portuguese, I want to avoid using sounds from Spanish[13].
4. My knowledge of English is useful for learning Portuguese vocabulary, grammar, word order, and sentence structure.

[12] Numbers on each statement here correspond directly to the statement numbers in related tables.

[13] All references to Spanish in this section were replaced with "French" for the L2 French group.

5. My knowledge of Spanish is useful for learning Portuguese vocabulary, grammar, word order, and sentence structure.
6. My knowledge of English helps me learn how to pronounce Portuguese.
7. My knowledge of Spanish helps me learn how to pronounce Portuguese.

Table 4.1.2 shows the responses given by each participant to each of the seven statements.

Table 4.1.2: Participant Responses to Questionnaire Section Three Statements

Participant	**Statement number**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
A	7	7	7	5	7	2	4
B	6	6	4	4	5	3	5
C	7	6	5	4	7	3	5
D	7	5	3	4	7	3	5
E	7	7	7	4	7	3	5
F	7	7	7	5	6	3	4
G	7	6	6	7	5	5	4
H	7	5	4	5	5	2	2
I	5	6	5	4	7	2	5
J	5	6	6	4	5	3	4
K	5	6	3	4	6	3	4
L	6	7	3	2	5	2	3

As mentioned above, the subjective and individualistic nature of Likert scale based responses renders any precise comparison across participants problematic; nonetheless some suggestions of patterns in the recorded responses do emerge both within and across participants. Of particular note is the fact that all participants in the present study agree (i.e. a rating of 5 or greater) with statement numbers 1, 2 and 5, whilst all but Participant G disagree (i.e. a rating of 3 or lower) with statement number 6. No individual participant agrees more strongly with statement 3 than with statement 2, potentially suggesting that the participants are more inclined to consciously attempt to supress phonological CLI from the L1 than from the L2. However participants A, E, and F all responded to both statements 2 and 3 with a maximum rating of 7 and participants G and J agree with these two statements to an equal extent, with ratings of 6 for both. Most notably here, participants D, K, and L agree that they attempt avoid L1 phonological CLI in L3 production, but disagree that they attempt to avoid L2 phonological CLI.

Seven of the twelve participants neither agree nor disagree with statement 4, however it is noteworthy that all participants agree either more or equally strongly with this statement compared to statement 6.This suggests that the participants perceive L1 lexical and syntactic structures to be more useful in L3 production than L1 phonological structures. Furthermore, all participants agree more strongly with statement 5 than with statement 7, with the singular exception of participant B who agrees with both statements equally, suggesting that the participants also consider utilising L2 phonological structures to be less beneficial than employing L2 lexical and syntactic structures in L3 production.

Ten of the twelve participants agree more strongly with statement 5 than with statement 4, suggesting a perception that the L3 lexical and syntactic structures are more similar to the L2 than to the L1. Only Participant G rates the L1 as more useful in acquiring L3 lexis and syntax, whilst Participant H agrees with these two statements equally. Similarly, all participants except G and H agree more strongly with statement 7 than statement 6; participant G again agrees more strongly with L1 structures being useful in the L3 than L2 structures, whilst participant H disagrees with both statements equally.

Pearson's rank correlation tests revealed significant, positive correlations between statements 4 and 6 ($n=12$, $r=0.629$, $p=0.029$) and between statements 5 and 7 ($n=12$, $r=0.61$, $p=0.035$); correlation between statements 2 and 3 approaches, but does not reach, significance ($n=12$, $r=0.556$, $p=0.061$). These results potentially suggest that, although participants seemingly consider their background languages as more useful in the development of L3 lexis and syntax than in that of phonology, some degree of inter-relatedness may exist between the perception of the usefulness of syntax and morpholexis and that of the phonology of these participants' background languages in their L3 acquisition process.

As delineated in Section 3.2.1, the results garnered from the Language Questionnaire data are to provide a greater degree of context to observations on results obtained through the analysis of the APDT and OPTs. Whilst some degree of individual variation occurs amongst the responses given by the study's participants to sections 2 and 3, some evidence of wider trends across the participant pool are observed. Results from the Language Questionnaire suggest that the participants of the study generally perceive their L3 as being structurally more similar to their L2 than their L1, though it would appear that they perceive this similarity to exist more prominently within morpholexis and syntax than in phonological structures. Additionally, participants generally feel that their L2 linguistic knowledge would prove more beneficial than knowledge of their L1 in acquiring their L3. Furthermore, although all participants express a desire to avoid the use of the L1 and L2 phonologies in L3 production, very few disagree that

L2 knowledge is useful in their acquisition of L3 phonology and all participants agree that it would be useful in acquiring L3 lexical and syntactic structures.

This section detailed the data obtained through the language questionnaire portion of this study and identified trends both across and within participants. The following section presents an analysis of the Aural Perception and Distinction Task.

4.2. Results: Aural Perception and Distinction Task

All twelve participants completed the Aural Perception and Distinction Task in each of the three time phases of the study, demonstrating their ability to distinguish between speech sound pairs tested by marking which of the three sounds presented in each group they believed to be distinct from the others. Each test pair was tested three times, for a total of sixty nine responses per participant per phase; see Section 3.2.2 for a full delineation of the test procedure. Participants' responses to each group of sounds were coded as either correct or incorrect, then grouped by test pair in order to assess their ability to effectively distinguish the sounds as separate, thus suggesting acquisition of a contrast.

4.2.1. APDT Results: Consonants

Table 4.2.1 shows average proportions of correct responses to each consonant test pair across all participants. Whilst no test pair reaches 0% nor 100%, many of the pairs are correctly discriminated in less than 25% of cases and many others in more than 75% of cases; potential causes and implication of the lack of any absolute success or failure across all participants in distinction are discussed in greater detail in Chapter 5. Results for individual participants can be seen in Appendix C. Variation between time phases was seen to be small in most cases. Table 4.2.2 shows average correct responses to consonant test pairs aggregated across the three time phases.

Table 4.2.1: Consonants

Test pair		Average correct responses (percent)		
		Phase 1	Phase 2	Phase 3
Bilabial	[pʰ – p]	61.11	66.67	80.56
	[pʰ – b]	86.11	86.11	88.89
	[p – b]	38.89	30.56	33.33
	[p – b̬]	19.44	25.00	16.67
	[b – b̬]	50.00	52.78	38.89
	[tʰ – t̪]	77.78	72.22	80.56
	[tʰ – d]	86.11	94.44	91.67

Alveolar /Dental	[t̪ – d]	36.11	44.44	36.11
	[t̪ – d̪̬]	38.89	36.11	50.00
	[d – d̪̬]	66.67	80.56	72.22
Velar	[kʰ – k]	72.22	75.00	75.00
	[kʰ – g]	91.67	94.44	97.22
	[k – g]	27.78	44.44	50.00
	[k – g̬]	61.11	61.11	61.11
	[g – g̬]	47.22	58.33	52.78
	[ʧ – ʃ]	86.11	88.89	97.22

Table 4.2.2 Aggregated Consonants

Test pair		Average correct responses (percent)
		All Phases
Bilabial	[pʰ – p]	69.44
	[pʰ – b]	87.04
	[p – b]	34.26
	[p – b̬]	20.37
	[b – b̬]	47.22
Alveolar/Dental	[tʰ – t̪]	76.85
	[tʰ – d]	90.74
	[t̪ – d]	38.89
	[t̪ – d̪̬]	41.67
	[d – d̪̬]	73.15
Velar	[kʰ – k]	74.07
	[kʰ – g]	94.44
	[k – g]	40.74
	[k – g̬]	61.11
	[g – g̬]	52.78
	[ʧ – ʃ]	90.74

Of particular interest amongst the results presented in Tables 4.2.1 and 4.2.2 are the apparent presence of trends in the rates of successful distinction between similar speech sounds across the three different places of articulation. In each of the three places of articulation for plosives analysed here, participants have highest average successful distinction rates for aspirated, fortis plosives vs. short-lag VOT lenis plosives (i.e. [p^h – b], [t^h – d], [k^h – g]), followed by aspirated, fortis plosives vs. unaspirated, fortis plosives (i.e. [p^h – p], [t^h – t̪], [k^h – k]). High success rates for the former set of tests are to be expected, since these pairs exist in phonemic contrast in the participants' L1. Similarly, although the latter set do not exist in phonemic distinction as minimal pairs in the participants' L1, the differences in VOT between each speech sound pair in this set are very similar to those of the former set and therefore similar to the key acoustic cues used to distinguish between L1 fortis and lenis plosives. This similarity potentially aided the participants in distinguishing two speech sounds which do not exist directly in phonemic contrast in the L1, L2, or L3.

Across all three places of articulation, participants show difficulty in distinguishing between unaspirated fortis plosives and short-lag VOT lenis plosives (i.e. [p – b], [t̪ – d], [k – g]) which do not exist in phonemic contrast in the L1, L2, or L3. Despite differences in the articulatory force of the speech sounds in each pair, the fact that the VOT for each speech sound is similar in each test pair appears to limit listeners' ability to distinguish these pairs.

Finally, the participants of the present study also show limited success in distinguishing prevoiced, lenis plosives as distinct both from unaspirated, fortis plosives and from short-lag VOT lenis plosives, though it is noteworthy that success is highest in the velar test pairs and lowest in the bilabial test pairs, potentially due to the larger relative gap in VOT values of the velar plosives. This limited success occurs despite differences in the articulatory force in the former case and differences in the VOT in both cases. This would imply that the negative VOT of the prevoiced lenis plosives is not easily perceived by the participants, suggesting that VOT ranges outside of those naturally acquired during the L1 acquisition process may be unhelpful for distinction of speech sounds. Note that none of the pairs within these sets exist as contrasts in the L1 of the study's participants, and prevoiced lenis vs. short-lag VOT lenis plosive contrasts do not exist in any of the L1, L2, or L3 of the participants. However, as evidenced by the participants' high success rate in distinguishing between aspirated and unaspirated fortis plosives, it would appear that the ability to distinguish between two speech sounds is not precluded by the lack of their existence as minimal pair phonemic contrasts in previously acquired languages, and that VOT differences previously acquired as acoustic cues to distinguish between speech sounds can be transferred and applied to novel speech sound pairings.

The results presented in Tables 4.2.1 and 4.2.2 may suggest that the participants rely more on differences in VOT and acoustic cues to place of articulation acquired through the L1 in order to distinguish between plosives than on differences in articulatory force. Whilst the data show that average rates of successful distinction were generally a little higher for aspirated fortis plosive vs. short lag VOT lenis plosives ([pʰ – b], [tʰ – d], [kʰ – g]) than they were for aspirated fortis plosives vs. unaspirated fortis plosives ([pʰ – p], [tʰ – t̪], [kʰ – k]), this pattern does not recur consistently in the comparison of unaspirated, fortis plosives vs. prevoiced lenis plosives ([p –ˬb], [t̪ –ˬd̪], [k –ˬg]) against short-lag VOT lenis plosives vs. prevoiced lenis plosives ([b –ˬb], [d –ˬd̪], [g –ˬg]). This may imply that whilst articulatory force can play a role in aural perception and distinction of plosives, other factors such as VOT and formant transitions play a more substantial role.

4.2.2. APDT Results: Vowels

As with the plosive test pairs used in the aural perception task, some vowel test pairs represent phonemic contrasts that exist in the participants' L1, L2, or L3, whilst other pairs do not exist in phonemic contrast in any of the participants' tested languages. Of the vowel test pairs used in this study, one exists in phonemic contrast in the participants' L1 (/u – ɒ/), one exists in both the tested L2 and L3 of the participants (/o – u/) and two exist in the L3 (/ɐ – ə/ and /a – ɐ/). The three other test pairs (/a – æ/, /æ – ɐ/ and /o – ɒ/) do not exist as phonemic contrasts in any of the languages examined within this study.

Table 4.2.3: Vowels

Test pair	**Average correct responses (percent)**		
	Phase 1	**Phase 2**	**Phase 3**
[a – æ]	58.33	66.67	69.44
[a – ɐ]	72.22	77.78	75.00
[æ – ɐ]	83.33	86.11	77.78
[ɐ – ə]	41.67	55.56	38.89
[o – ɒ]	75.00	63.89	66.67
[o – u]	52.78	63.89	63.89
[u – ɒ]	88.89	94.44	80.56

Table 4.2.3 shows the average rates of successful distinction of vowel pairs tested in the APDT across all participants. As was seen in consonant tests, variation across time phases was

relatively minimal. Table 4.2.4 aggregates the APDT vowel results across the three time phases.

Table 4.2.4: Aggregated Vowels

Test pair	Average correct responses (percent)
	All phases
[a – æ]	64.81
[a – ɐ]	75.00
[æ – ɐ]	82.41
[ɐ – ə]	45.37
[o – ɒ]	68.52
[o – u]	60.19
[u – ɒ]	87.96

Highest rates of successful distinction are seen in the [u – ɒ] test pair, whilst lowest rates of successful distinction are found in [ɐ – ə]. The [u – ɒ] test pair average is impacted by a seemingly anomalous result from Participant G, who shows very poor ability to identify the correct answer; removing this participant's data, the aggregated success rates rise to 92.83%. The [æ – ɐ] and [a – ɐ] test pairs also show relatively high distinction success rates, whilst the [a – æ], [o – ɒ] and [o – u] tests show moderate success rates. Although [u – ɒ] exists in contrast in the participants' L1, the other pairs examined here do not; successful distinction of [u – ɒ] is therefore to be expected, whilst success or failure in other distinctions requires deeper analysis. This is discussed in Chapter 5.

Individual variation in distinction of the vowel test pairs is greater than that seen in the consonant test pairs, most notably in the [a – æ], [o – ɒ], and participant D consistently distinguishes vowel test pairs that do not exist in any of the target languages studied here. Nonetheless, most results of the APDT are unsurprising in the framework of phonology models laid out in Chapter 2. Causations and implications of these data and their relation to the literature of the wider field are discussed in Chapter 5.This section has presented the results of the Aural Perception and Distinction Task. The following sections present the results of the Oral Production Tasks.

4.3. Results: Oral Production Task

This section presents the results of the Oral Production Tasks. All twelve participants performed multiple Oral Production Tasks during the three testing phases, however Participant E was unfortunately unable to attend testing during phase 2 for personal reasons. All other OPTs were completed during the appropriate time periods. As detailed in Chapter 3, these tasks were conducted in the L1, L2 and L3 during Phase 1 and in only the L2 and L3 during Phases 2 and 3, collecting data on formant frequencies of vowels, the voice onset time of fortis plosives and the use of affrication and frication in L1, L2 and L3 production. The data obtained through the OPTs is detailed below and subjected to statistical analyses.

All tokens were analysed using the Praat (Boersma and Weenik, 2016) acoustic analysis software programme in order to determine the frequencies of the first and second formants for each vowel token, the voice onset time of each plosive token, and the presence of affrication or frication. Vowel formant and plosive VOT variables were subjected to statistical analysis, the results of which are detailed below. Due to the simple, bimodal nature of the affricate-fricative data, these OPT responses were coded as either affrication or frication and are analysed below in terms of modal averages.

This section first presents results regarding affrication and frication, followed by an analysis of VOT in fortis plosives, and finally reviews the production of vowels in the target L1, L2 and L3.

4.4. OPT Results: Pre-Palatal Affricate and Fricative

A full delineation of rates of successful production of affrication and frication by all participants can be seen in Appendix C. In both the L1 and the L2 results show that all participants are consistently successful in producing target-like affrication and frication. In the full dataset without division by cognate condition some variation is seen across participants in their production of L3 /ʃ/.

Participants E, F, and K show substantial negative CLI in their L3 production, frequently producing the digraph <ch> as the affricate /ʧ/. Participant L shows a degree of negative influence on production of this speech sound in Phase 1, however in later time phases this participant generally produces target-like frication in the L3. All of the participants who show this negative CLI are from the L2 Spanish group.

Overall, these results suggest that the participants of this study are generally successfully able to produce the L3 frication in a target-like manner. Given the presence of the pre-palatal fricative /ʃ/ in the L1 of these participants, it is possible that positive CLI from the L1 may have made this possible. Whilst it is not possible to specifically separate this result as being either due to L1 CLI or due to general language learning, it does show that for most participants potential negative CLI from L2 /ʧ/ was blocked. The presence of /ʧ/ in the L3 production of some participants nonetheless suggests that negative CLI is possible in this context, though not ubiquitous.

Some variation is seen in participants' production of the L3 fricative under cognate condition effects compared to the full dataset. Some participants who consistently produce target-like L3 frication were unaffected by cognate condition effects. However, where cognate condition effects were observed some trends are visible in participant behaviour.

Performance in the L3 under the L2 cognate condition is very similar to that in the full, undivided dataset. However, participants appear to produce a greater degree of non-target-like affrication in their L3 under the L1 cognate condition and the L1-L2 cognate condition. The highest rate of target-like L3 frication is seen under the non-cognate condition.

To conclude, although affrication and frication in English, Spanish, French and Portuguese form a small part of this study's core dataset, some potentially noteworthy CLI effects do occur in the production of these speech sounds. The full dataset implies that participants of this study were generally able to either utilise positive CLI from their L1 or otherwise suppress negative CLI from their L2 in order to produce target-like L3 structures. Nonetheless, some individual variation occurs. Cognate condition effects appear to have had some impact on the production of the pre-palatal L3 fricative. Most notably the reduced morpholexical processing load of the non-cognate condition allowed for more effective suppression of negative CLI, whilst the highly increased processing requirements under the L1–L2 cognate condition appear to cause a greater degree of negative CLI for many participants.

This section has analysed and briefly discussed the results of the affricate and fricative tests in the Oral Production Tasks. The following section examines the production of fortis plosives, focussing on the key property of voice onset time.

4.5. Results: Oral Production Task Plosives

All plosive tokens were analysed for their Voice Onset Time, measured as the time (in milliseconds) between the release of the plosive and the beginning of the following vowel. This section begins with a brief overview of the data, followed by results of statistical tests conducted in order to determine the distance between the VOT lengths of L1, L2, and L3 fortis plosives in oral production as a measure of phonological CLI. Comparison of VOT on plosives on L3 words with differing cognate relations is also conducted in order to evaluate the influence of lexical similarity on phonological CLI in L3 production. Average VOT values for all plosives are shown in Appendix C.

A large degree of variation between tokens, leading to a broad range of VOT values, was observed amongst the data. Speech rate has been seen to cause substantial individual variation in VOT duration (Beckman et al., 2011), therefore all VOT measurements were normalised in order to account for the influence of syllable length on the duration of VOT within the plosive segment. Since all fortis plosive tokens were arranged in stressed, pre-vocalic positions within words (i.e. /'pV, 'tV, 'kV/), this normalisation was achieved by measuring the portion of the C+V cluster which is filled by the voice onset time; average normalised VOT (n-VOT) values for each participant are shown in Appendix C. All further testing of VOT in oral production within this study was conducted using these normalised values in order to allow for more accurate comparison of aspiration in fortis plosives across the three target languages studied here.

4.5.1. Results: Normalised Voice Onset Time in Fortis Plosives

Generalised linear mixed models (GLMM) were constructed to analyse the plosive data from the OPTs. These models were then further analysed with ANOVAs in order to determine the degree of variance in n-VOT. This allows for comparison of n-VOT in fortis plosives across the L1, L2, and L3 as well as analysis of the effects of cognate condition on n-VOT in the L3. This section describes the results of these statistical tests conducted on the voice onset time in fortis plosives. The section analyses variation within the n-VOT of fortis plosives across the L1, L2, and L3 of the participants of this study and the impact of cognate condition on L3 fortis plosive production.

Differences in n-VOT between fortis plosives in the L1, the L2, and the L3 were analysed with a GLMM. Variation in n-VOT values were analysed in the GLMM with the fixed effect of language (L1, L2, L3), with random effects of participant and consonant to account for natural individual variation.

Table 4.5.1: GLMM normalised voice onset time by language

Fixed factors			Random Factors		
Language	Intercept	Std. Error	Factor	Variance	σ
L1	35.5227	2.3076	Participant	28.923	5.378
L2	-12.1171	0.3784	Consonant	8.381	2.895
L3	-10.7734	0.3687	Residual	68.291	8.264

The variance due to plosive place of articulation is seen to be relatively minor however individual variation amongst participants is relatively high. An ANOVA of this model was conducted to further evaluate the variance observed in n-VOT values across the L1, L2 and L3. This (n = 8420, df = 2, F = 516.74). This is significant in a two-tailed test at the 95% confidence interval (critical F value for $F_{2,\ 1000}$ = 3.7). Tukey-adjusted post-hoc tests show that the difference between n-VOT is significant between the L1 and the L2 (df = 8404, t = 32.024, p<0.0001), between the L1 and the L3 (df = 8404, t = 29.218, p<0.0001), and between the L2 and the L3 (df = 8404, t = -7.015, p<0.0001). Actual values of L3 n-VOT fall between those of the L1 and the L2; participants in this study generally produce longer VOT in the L3 than in the L2, but shorter VOT in the L3 than in the L1. Implications of this are discussed below.

In order to measure the impact of cognate condition on n-VOT in fortis plosives in L3 Portuguese, a GLMM was constructed to measure variation in L3 fortis plosive n-VOT by cognate condition. Variation due to participant and plosive type (/p, t, k/) were accounted for through aggregated analysis by including these as random factors in the model.

Table 4.5.2: GLMM L3 normalised voice onset time by cognate condition

Fixed factors			Random Factors		
Cognate condition	Intercept	Std. Error	Factor	Variance	σ
Non-cognate	23.3360	2.2720	Participant	37.508	6.124
L1 cognate	2.9071	0.4072	Consonant	5.919	2.433
L2 cognate	0.2621	0.3543	Residual	66.809	8.174
L1-L2 cognate	2.3299	0.3136			

This suggests that changes in cognate condition also lead to changes in length of voice onset time in L3 plosives. As seen in the cross-language comparison GLMM, a substantial degree of variance occurs between participants, however variance caused by consonant type (/p, t, k/) is relatively small. Average L3 n-VOT values are generally lower in the non-cognate condition and the L2 cognate condition than they are in the L1 cognate condition and the L1-L2 cognate condition.

An ANOVA of this model reveals that the variation in n-VOT due to cognate condition is significant in a two-tailed test at the 95% confidence interval (n = 4727, df = 3, F = 33.284; critical F for $F_{3, 1000}$ = 3.13). Tukey-adjusted post-hoc tests showed that the difference between L3 n-VOT is significant between the Non-cognate condition and the L1 cognate condition (df = 4711, t = -7.14, p<0.0001), between the non-cognate condition and the L1-L2 cognate condition (df = 4711, t = -0.74, p<0.0001), as well as between the L1 cognate condition and the L2 cognate condition (df = 4710, t = 6.602, p<0.0001), and the L2 cognate condition and the L1-L2 cognate condition (df = 4712, t = -6.588, p<0.0001). Differences between the non-cognate and the L2 cognate conditions were not significant, nor were differences between the L1 cognate and the L1-L2 cognate conditions. This suggests a clear dichotomy in n-VOT between cognate conditions.

A GLMM to analyse the impact of cognate condition by language proved unstable, therefore separate models were created for L3 data from each cognate condition in order to compare these against the n-VOT values of fortis plosives in the L1 and L2. Results of the four models are presented in Tables 4.5.3 to 4.5.6.

Table 4.5.3: GLMM n-VOT non-cognate condition by language

Fixed factors			**Random Factors**		
Language	**Intercept**	**Std. error**	**Factor**	**Variance**	**σ**
L1	35.2122	2.2956	Participant	22.182	4.7098
L2	-11.8018	0.3941	Consonant	9.752	3.1228
L3	-12.1375	0.4415	Time phase	0.1057	0.3251
			Residual	64.3368	8.021

Table 4.5.4: GLMM n-VOT L1 cognate condition by language

Fixed factors			Random Factors		
Language	**Intercept**	**Std. error**	**Factor**	**Variance**	**σ**
L1	35.0806	2.4097	Participant	24.7876	4.9787
L2	-11.6616	0.4111	Consonant	10.5981	3.2555
L3	-8.5768	0.5010	Time phase	0.1803	0.4246
			Residual	67.9402	8.2426

Table 4.5.5: GLMM n-VOT L2 cognate condition by language

Fixed factors			Random Factors		
Language	**Intercept**	**Std. error**	**Factor**	**Variance**	**σ**
L1	35.2256	2.4997	Participant	25.10706	5.017
L2	-11.8034	0.3931	Consonant	11.96793	3.4595
L3	-11.3073	0.4373	Time phase	0.09715	0.3117
			Residual	64.2802	8.0175

Table 4.5.6: GLMM n-VOT L1-L2 cognate condition by language

Fixed factors			Random Factors		
Language	**Intercept**	**Std. error**	**Factor**	**Variance**	**σ**
L1	35.0208	2.4973	Participant	25.062	5.0206
L2	-11.6198	0.4042	Consonant	11.744	3.427
L3	-9.2275	0.424	Time phase	0.2366	0.4864
			Residual	67.3434	8.2063

As with other models, variance between participants was relatively high, though lower than that seen in the full dataset. Variance due to time phase was seen to be minimal whilst variance between the consonant types is low, though higher than in the model of all L3 data. An ANOVA shows that variation between n-VOT in the L1, the L2, and the L3 under each cognate condition is significant in a two-tailed test at the 95% confidence interval (critical F for $F_{2, 1000} = 3.7$); table 4.5.7 shows results from each of the four ANOVA tests.

Table 4.5.7: ANOVA results L3 n-VOT by language

Cognate condition	n	df	F
Non-cognate	4799	2	472.44
L1 cognate	4352	2	412.65
L2 cognate	4837	2	458.43
L1-L2 cognate	5511	2	419.32

The ANOVA results demonstrate that participants do retain some distinctions between their n-VOT in the L3 and that of their other languages under each of the four cognate conditions. Tukey-adjusted post-hoc tests show that participant behaviour is not the same under all cognate conditions.

Table 4.5.8: Post-hoc Tukey tests L3 n-VOT by language

Cognate condition	Languages	df	t	p
Non-cognate	L1 vs L3	851	27.49	<0.0001
	L2 vs L3	4783	1.171	0.47
L1 cognate	L1 vs L3	1453	17.121	<0.0001
	L2 vs L3	4334	-8.708	<0.0001
L2 cognate	L1 vs L3	774	25.86	<0.0001
	L2 vs L3	4820	-1.782	0.1758
L1-L2 cognate	L1 vs L3	2540	21.763	<0.0001
	L2 vs L3	5494	-9.759	<0.0001

The post-hoc tests reveal that the study's participants consistently maintain a distinction between the n-VOT of their fortis plosives in the L1 and the L3 across all cognate conditions.

However, the results of these GLMMs and post-hoc tests also show that n-VOT of the L3 approximates to that of the L2 under the non-cognate condition and the L2 cognate condition. A clear dichotomy emerges between the non-cognate condition and L2 cognate condition against the L1 cognate condition and L1-L2 condition; this reflects the comparison of L3 fortis plosives under each cognate condition seen above. Implications of this in terms of CLI effects is discussed in greater detail below.

This section has detailed the results of statistical tests conducted on the plosives from the OPTs of this study. The results of these tests show that these participants' L3 VOT is generally produced as a compromise value between the L1 and the L2. The results suggest that the presence of cognates has influenced the production of fortis plosives in the L3. They have shown in particular that the length of VOT in the L2 and L3 is closely aligned when the L3 is produced under the non-cognate condition and under the L2 cognate condition, but that they are distinct when the L3 is produced under the L1 cognate condition and the L1-L2 cognate condition. The following section discusses these findings and relates them to the wider field. It also tests the hypotheses of this study that are relevant to plosive production.

4.6. Discussion: OPT Plosives

This section analyses and discusses the results of the tests conducted on normalised voice onset time values of fortis plosives produced by participants in this study. It begins by briefly summarising the findings in the context of the field of L3 phonology, before examining the implications of these results for the four prominent models of L3A discussed in Chapter 2. It then employs these results to test this study's hypotheses relevant to the production of fortis plosives. Discussion of the interactions between the three data collection methods of this study: Language Questionnaire, Aural Distinction and Perception Task, and Oral Production Task, can be found in Chapter 5.

4.6.1. OPT Plosives: Results summary

Results from the production of fortis plosives presented above demonstrate several noteworthy interactions between VOT in the L1 English, the L2 Spanish/French, and the L3 Portuguese of the participants of this study. The GLMMs show that variance due to time phase is minimal, whilst variance due to individual differences between participants is relatively large. When analysing L3 fortis plosive data as a single whole, differences between n-VOT production in the L1, the L2, and the L3 are significant with L1 VOT being the longest, L2 VOT being the shortest, and L3 values generally falling between the L1 and L2. Mean n-VOT values of the L1, L2, and L3 show that L3 fortis plosives are consistently produced with shorter n-VOT than their L1 counterparts; a general trend is also seen in L3 fortis plosives being produced with longer n-VOT than their L2 counterparts, however this is slightly less consistent across all participants and plosives than in the comparison of L1 vs. L3. These compromise VOT values have been seen in several previous studies, in which it is deemed to evidence either combined CLI from both L1 and L2 on the L3 (cf. Llama et al., 2010), or CLI from the background language whose phonological norm is closest to that produced in the L3 (cf. Wunder, 2010). In the case of these participants, I agree with Llama et al. (2010) that this is the product of combined crosslinguistic influence from both L1 English and L2 French/Spanish on L3 Portuguese production.

When analysing the VOT of L3 fortis plosives under varying cognate condition effects, it is seen that there is a significant effect of cognate condition on the length of VOT in L3 fortis plosive production. Most notably, however, is that a clear divide emerges between two pairs of cognate conditions: The non-cognate condition and L2 cognate condition are not significantly different from each other, but both are significantly different from the L1 cognate and the L1-L2 cognate conditions; similarly the L1 cognate condition and L1-L2 cognate condition are not significantly different from each other. I interpret this as a divide between conditions in which the L3 is produced with and without influence of heightened L1 activation.

Further comparison of L3 VOT under each cognate condition shows that the n-VOT of the L3 is significantly different from that of the L1 in all cognate conditions. This shows that although a variation due to cognate condition occurs, it is not a large enough variation to lengthen the L3 VOT to be consistently equivalent to that of the L1. However, n-VOT in L2 fortis plosives only differs significantly from that in L3 fortis plosives in the L1 cognate condition and the L1-L2 cognate condition; in the non-cognate condition and the L2 cognate condition, the n-VOT of fortis plosives in the L2 and L3 do not differ. This further highlights the impact of cognate condition on L3 fortis plosives, with a clear divide between cognate conditions in which the L1 is highly activated and those in which it is not. An initial, superficial observation may suggest that this is a product of one (or more) of the following:

1. L2 CLI is more intense under the non-cognate condition and the L2 cognate condition
2. L1 CLI is more intense under cognate conditions in which the L1 is highly activated
3. L1 CLI is reduced under cognate conditions in which the L1 is not activated.

Given the lack of evident amalgamation of L1 and L3 values under any cognate condition, I suggest that the results seen in this study are caused by either point 1 or point 3. Further study involving contrasting language pairings would be required to investigate this.

4.6.2. OPT Plosives: Implications for L3 acquisition Models

This section applies the results regarding the production of fortis plosives in the OPT to test the four models of third language acquisition detailed in Chapter 2, assessing which models' predictions are and are not supported by the data of this study. As shown in Table 2.3.1, each of these four models shows varying strengths and caveats and makes testable predictions on the nature of crosslinguistic influence in L3A. As was reiterated above, these models are divided by their predictions of which background languages may become the source of CLI into the L3, of the potential for CLI to be positive or negative, and of the possibility for CLI to occur on a highly selective, property-by-property basis.

The results presented in Section 4.5 demonstrate that VOT in the L3 is not generally L2-like, despite the fact that employing CLI only from the L2 would have led to more target-like L3 structures. Furthermore, the results of VOT in L3 fortis plosives suggest that this property has been influenced by the phonological structures of both the L1 and the L2 by varying degrees, suggesting that CLI may have occurred from the L1 and the L2. The compromise VOT values seen in L3 VOT is also seen in previous studies of L3 VOT in Romance languages (cf. Llama et al,, 2010; Wrembel, 2012 i.a.), in which is suggested that this demonstrates a partial influence of one or both pertinent background languages on the L3.

The Cumulative Enhancement Model (Flynn et al., 2004) accounts for the presence of both L1 and L2 influence on the L3, however this model's predictions do not effectively account for the evidence of negative CLI causing the L3 to diverge from target despite potential for positive CLI from the L2. In the case of VOT in fortis plosives, the CEM predicts that CLI would come from the L2, however compromise values between L1 and L2 occur, thus evidencing negative CLI from the L1 and disputing the CEM. Similarly, this suggestion of L1 CLI strongly disputes the L2SF (Bardel and Falk, 2007; Falk and Bardel, 2011). The change in VOT seen under differing cognate conditions may be argued to somewhat support the L2SF's claim that the L2 and L3 share a degree of linkage due to their non-native status however, as I argue above, this VOT change appears to stem not from an increase in CLI from the L2, but rather as a decrease in CLI from the L1 under conditions where the L1 is not active; whilst L1 CLI is decreased in the non-cognate condition leading to more L2-like phonological structures in the L3, the fact that L2 influence does not similarly override L1 influence in the L1-L2 cognate condition suggests that this 'association of foreignness' is not as strong a link as the L2 Status Factor model predicts. Overall, the presence of some L2 CLI does support some predictions of the L2SF, but nonetheless this model is unable to account for the compromise VOT values seen in place of the sole CLI from L2 VOT values that the L2SF predicts.

Both the Typological Primacy Model (Rothman, 2010, 2011, 2013, 2015) and the scalpel model (Slabakova, 2017) account for the presence of negative CLI, in contrast to the CEM, and allow for the observed potential L1 influence in contrast to the L2SF. However these models crucially differ in that the TPM predicts that CLI would occur exclusively from only one of the two background languages, in this case from the L2, due to the high degree of lexical and morphosyntactic similarity. However, whilst there is evidence of L2 CLI, it is clear that in VOT production, this influence is not absolute as the TPM predicts. Evidence of compromise VOT values strongly suggests the presence of combined CLI from the L1 and L2 in the formation of the L3 phonology. Of note is that where cognate condition effects occur, they may be argued to somewhat support the TPM's prediction of lexical similarity as a highly prominent factor in determining the selection of source language for CLI in the L3, however it would appear that CLI occurs on a more fine-detailed level than that predicted by the TPM.

The data from the production of fortis plosives in the OPT most strongly support the scalpel model of L3 acquisition. The scalpel model's predictions account for the presence of both L1 and L2 CLI and for the occurrence of selective CLI on a property-by-property basis. Cognate condition effects may be accounted for within the scalpel model, with CLI source selection being influenced by sites of heightened lexical similarity, although it is unclear precisely how the scalpel model accounts for the presence of compromise VOT values seen consistently in the production of L3 fortis plosives. Nonetheless it is also true that the CEM, L2SF, and TPM are equally unable to adequately explain such data.

As argued by Cabrelli Amaro and Wrembel (2016), models of L1 and L2 phonology are based on perception, and models of morphosyntax are most aptly tested by perception (e.g. grammaticality judgement tasks). I therefore propose that the presence of compromise VOT values may be accounted for through extending the predictions of Native Language Magnet-expanded model of perception in order to apply the impact of perception onto production. Differences between VOT in L1 and L2 fortis plosives were seen to be well established across participants in this study, strongly suggesting that participants had acquired the ability to distinguish these speech sounds in their L1 and L2 production; this is further supported by the consistency with which participants successfully distinguish aspirated and unaspirated fortis plosives in the APDT. Formation of magnets for each of these fortis plosive VOT settings is suggested to have occurred, thus when acquiring a third language under the potential influence of both L1 and L2 settings, both the L1 aspirated fortis plosive magnets and the L2 unaspirated fortis plosive magnets will have acted on the ability to perceive and subsequently produce a new, L3 plosive setting during the earliest phases of L3 acquisition. Whilst additional input would have caused the nascent L3 setting to gravitate and eventually merge with the L2 magnet, the distortion effect and the 'magnetic pull' of both the L1 and the L2 settings may have influenced the formation of the L3 magnet, drawing it into a compromise value between the two.

4.6.3. OPT Plosives: Testing Hypotheses

This section applies the results of the production of VOT in fortis plosives from the OPTs to test the hypotheses of this study. Hypothesis 1, Hypothesis 2, and Hypothesis 3 all relate directly to CLI in L3 plosives, and so these hypotheses are tested here. I argue throughout that where VOT values of the L3 converge with those of the L1 or L2, this is suggestive of the presence of CLI from the relevant background language on the L3; similarly I argue that where values are divergent this suggests a lack of influence from L1/L2 on the L3. This stance is taken in line with a considerable body of literature in the field of phonology in third language acquisition (see Pyun, 2005; Hammarberg and Hammarberg, 2005; Gut, 2010, Llama et al., 2010; Wrembel, 2010, 2012; Wunder, 2011, i.a.).

Hypothesis 1 predicts that CLI from the L2 will be dominant and that VOT in the L3 will be L2-like. This hypothesis is not supported by the data. When examined without division for cognate condition, L3 n-VOT values are clearly distinct from the L2, being produced as a compromise value between the L1 and the L2 VOT. Statistical modelling and tests further demonstrate that the differences between n-VOT values in the L1, the L2, and the L3 are significant, suggesting that neither background language is dominant as the source of CLI on L3 fortis plosive production.

Hypothesis 2 predicts that VOT in the L3 will be L2-like when fortis plosives are produced under the non-cognate, the L2 cognate, and the L1-L2 cognate conditions. This hypothesis is partially supported by the data. Tests show that n-VOT in the L3 is L2-like under the non-cognate condition and the L2 cognate condition; however L3 n-VOT is distant from the L2 under the L1-L2 cognate condition. This shows that L3 VOT does vary by cognate condition and that it is produced closer to the L2 VOT under some cognate conditions, however it is not produced with L2-like values in all of the cognate conditions predicted by this hypothesis.

Hypothesis 3 predicts that VOT in the L3 will be L1-like when fortis plosives are produced under the L1 cognate condition. This hypothesis is not supported by the data. L3 fortis plosives in the L1 cognate condition are significantly different from those of L1 fortis plosives; they are produced with compromise VOT values, between those of the L1 and L2, as is the general trend when observing the L3 fortis plosive data without division by cognate condition.

Differences in L3 VOT were observed between the non-cognate and L2 cognate conditions versus the L1 cognate and L1-L2 cognate conditions which may suggest an increase in CLI on the L3 from the L1 under the cognate conditions in which the L1 is more highly activated. However, in no cognate condition was the L3 n-VOT found to be L1-like therefore Hypothesis 3 is not supported.

4.6.4. OPT Plosives: Conclusion

This section has discussed the plosive results of the OPTs of this study. It was argued that these results contradict the CEM, the L2SF, and the TPM, but may support the scalpel model of L3 acquisition. It was also argued that a model of L3 phonology may be built through combining the tenets of the NLM-e for aural perception with the predictions of the scalpel model for CLI in L3A. Finally, Hypotheses 1, 2, and 3 were tested and it was demonstrated that Hypotheses 1 and 3 are not supported by the data, whilst Hypothesis 2 is partially supported. The following section presents the results of the OPTs relating to the production of vowels in L1 English, L2 Spanish/French, and L3 Portuguese.

4.7. Results: Oral Production Task Vowels

This section presents the results relating to the target vowels elicited in the oral production tasks of this study. A full description of the vowels chosen for this study can be found in Chapter 3, whilst a contrastive analysis of pertinent phonological properties of this study's target languages can be seen in Section 2.9. The frequencies of the first and second formant of all relevant vowels were taken for all OPTs conducted in the study. These elements of vowel quality were subjected to statistical analysis in order to ascertain where CLI effects have caused similar vowels across languages to converge or diverge.

In order to reduce variation in vowel formant frequency measurements due to the physiological and anatomical differences between participants, F1 and F2 values were transformed through the Gerstman normalisation procedure. This procedure was chosen for two reasons: firstly it is simple to apply to any dataset, and secondly a thorough evaluation of multiple vowel formant normalisation methods (Flynn, 2011) found it to be highly effective in normalising vowel data across speakers. Flynn (2011) argues that of the 20 methods of formant normalisation tested, the most effective is Bigham's (2008) quadrilateral centroid normalisation procedure, followed by Gerstman's (1968) procedure, then equally by Lobanov's (1971) procedure and Watt and Fabricius' (2002) triangle centroid. Whilst Flynn's work suggests that Bigham's method would be more effective in normalising vowel formant data across participants, it requires data from four cardinal vowels and was thus not a viable method for normalising the data of the three vowels from each language collected within this study.

An ANOVA was conducted on the F1 and F2 values of each vowel in each language to analyse the variance between participants' vowel formants, as well as on Gerstman and Lobanov normalisations of these values, in order to assess the effectiveness of the normalisation processes. Means of the variance statistics of each normalisation method showed that the degree of vowel formant variance between participants was lower for the Gerstman procedure ($\mu F = 17.04906$) than for the Lobanov procedure ($\mu F = 32.73078$), and for the non-normalised data ($\mu F = 31.99756$). A further ANOVA assessing the variance of the F value obtained from each of these previous tests showed that the difference between the normalisation methods approached but did not reach significance ($df = 2$, $F = 2.982$, $p = 0.06$). Post-Hoc Tukey HSD tests further showed that none of the three methods (no normalisation, Gerstman normalisation, Lobanov normalisation) differed significantly from each other.

Nonetheless, the reduction in the degree of variance seen by employing the Gerstman normalisation procedure is noteworthy and therefore all further data analysis is conducted using these normalised values in order to allow for the participant group to be analysed as a more coherent whole.

4.7.1. Results: Gerstman-normalised Vowels

Several generalised linear mixed models were created to measure the variation in the Gerstman normalised frequencies of the first and second formants of the vowels produced in the OPTs. Combined with ANOVA and Tukey-adjusted post-hoc tests, these are used to analyse where differences between the L1, L2, and L3 occur as well as where variation in L3 vowel quality has been influenced by cognate condition. Tables 4.7.1 and 4.7.2 show the results of modelling F1 and F2 respectively of related L1, L2, and L3 vowels. Specifically these compare:

- L1 /æ/ vs L2 /a/
- L1 /ɒ/ vs. L2 /o, ɔ/
- L1 /ə/ vs. L2 /e/
- L1 /æ/ vs. L3 /ɐ/
- L1 /ɒ/ vs. L3 /u/
- L1 /ə/ vs. L3 /ə/
- L2 /a/ vs. L3 /ɐ/
- L2 /o, ɔ/ vs. L3 /u/
- L2 /e/ vs. L3 /ə/

These vowels were grouped based on a combination of similarities of orthographic representation and of phonological properties. The vowels /æ, a, ɐ/ fall under <a>, vowels /ɒ, o, ɔ, u/ fall under <o>, and vowels /ə, e/ fall under <e>.

Table 4.7.1: GLMM Vowel F1 by language

Fixed factors			Random Factors		
Language	**Intercept**	**σ**	**Factor**	**Variance**	**σ**
L1	485.651	99.304	Participant	1277	35.74
L2	-48.086	9.356	Vowel	28436.4	168.63
L3	-92.062	9.255	Time phase	594.4	24.38
			Residual	33485.1	182.99

Table 4.7.2: GLMM Vowel F2 by language

Fixed factors			Random Factors		
Language	**Intercept**	**σ**	**Factor**	**Variance**	**σ**
L1	592.475	131.064	Participant	1381.6	37.17
L2	-128.937	8.881	Vowel	50008.9	223.63
L3	-102.427	8.785	Time phase	968.2	31.12
			Residual	30150.1	173.64

For F1 values, an ANOVA shows that variation between Gerstman-normalised F1 values of the L1, L2, and L3 is significant in a two-tailed test at the 95% confidence interval (n =8920, df = 2, F = 89.06; critical $F_{2, 1000}$ = 3.7). Tukey-adjusted post-hoc tests reveal that differences are significant between the L1 and L2 (df = 8827, t = 5.140, p<0.0001), between the L1 and L3 (df = 8827, t = 9.948, p<0.0001), and between the L2 and L3 (df = 8910, t = 10.687, p<0.0001). For F2 values, an ANOVA shows that variation between Gerstman-normalised F2 values of the L1, L2, and L3 is significant in a two-tailed test at the 95% confidence interval (n = 8920, df = 2, F = 110.97; critical $F_{2, 1000}$ =3.7). Tukey-adjusted post-hoc tests reveal that the differences are significant between the L1 and L2 (df = 8887, t = 14.518, p<0.0001), the L1 and L3 (df = 8886, t

= 11.66, p<0.0001), and the L2 and L3 (df = 8909, t = -6.789, p<0.0001). These results suggest that the participants distinguish both the first and second formants of these vowels.

Variance due to participant is noteworthy in these models, as it was in GLMMs for OPT fortis plosives. However, in contrast to the results seen for plosives in Section 4.5, variance due to vowel type is very large. This renders the model of limited use comparing similar vowels across the target L1, L2, and L3 of this study's participants. Attempting to include vowel type as a fixed factor led to highly unstable models. Hence, separate GLMMs were constructed for each vowel to allow for more effective comparison and for the potential to identify CLI effects in L3 vowel production. Table 4.7.3 shows results of the GLMMs for each vowel.

Table 4.7.3: GLMM Vowels by Language

Vowel	Formant	Fixed factors			Random Factors		
		Language	**Intercept**	**Std. Error**	**Factor**	**Variance**	**σ**
<a>	F1	L1	771.25	29.05	Participant	2415.8	49.15
		L2	-142.94	18.79	Time phase	985.7	31.4
		L3	-184.7	18.29	Residual	44733.2	211.5
	F2	L1	753.91	29.98	Participant	2166	46.54
		L2	-326.19	12.8	Time phase	1541	39.26
		L3	-315.02	12.46	Residual	20702	143.88
<o>	F1	L1	364.686	26.628	Participant	2631.8	51.3
		L2	-3.431	16.047	Time phase	750.7	27.4
		L3	-60.692	15.833	Residual	24170.3	155.5
	F2	L1	215.74	27.69	Participant	3561.7	59.68
		L2	19.31	18.3	Time phase	475.8	21.81

		L3	94.58	18.05	Residual	31471.4	177.4
<e>	F1	L1	316.7072	26.0367	Participant	2030	45.05
		L2	-0.2563	13.0289	Time phase	1090	33.02
		L3	-20.2875	13.1984	Residual	25840	160.75
	F2	L1	777.64	26.56	Participant	1342	36.63
		L2	-41.21	14.5	Time phase	1240	35.21
		L3	-77.64	14.69	Residual	32044	179.01

ANOVAs of these models showed that variation between Gerstman-normalised formant frequencies of the L1, L2, and L3 is significant in a two-tailed test at the 95% confidence interval for both formants of each vowel set ($F>3.7$; critical $F_{2, 1000} = 3.7$). These results are summarised in Table 4.7.4

Table 4.7.4: ANOVA Tests Vowel formant Variance by Language

Vowel	Formant	n	df	F
<a>	F1	3289	2	58.162
	F2	3289	2	337.58
<o>	F1	3522	2	56.796
	F2	3522	2	78.041
<e>	F1	2109	2	3.7885
	F2	2109	2	17.976

Tukey-adjusted post-hoc tests show that the differences are not significant for all formants between all languages; see Table 4.7.5 for details. Most notably, these results show that L1 and L2 back vowels are not distinguished by this study's participants in oral production. Furthermore, they suggest that L3 /ɐ/ appears to be fronted (as measured by the frequency of the second formant), and that L3 /ə/ is more similar to L2 /e/ than to L1 /ə/.

Table 4.7.5: Tukey-adjusted Post-hoc tests: Vowel formants

Vowel pair	Formant	df	t	p
L1 /æ/ vs L2 /a/	F1	3241	7.606	<0.0001
	F2	3274	25.486	<0.0001
L1 /ɒ/ vs. L2 /o, ɔ/	F1	3505	0.214	0.9751
	F2	3479	-1.056	0.5419
L1 /ə/ vs. L2 /e/	F1	2056	0.02	0.9998
	F2	2049	2.842	0.0126
L1 /æ/ vs. L3 /ɐ/	F1	3237	10.097	<0.0001
	F2	3274	25.286	<0.0001
L1 /ɒ/ vs. L3 /u/	F1	3503	3.833	0.0004
	F2	3476	-5.239	<0.0001
L1 /ə/ vs. L3 /ə/	F1	2066	1.537	0.2738
	F2	2060	5.285	<0.0001
L2 /a/ vs. L3 /ɐ/	F1	3274	5.2871	<0.0001
	F2	2374	2.077	0.0948
L2 /o, ɔ/ vs. L3 /u/	F1	3513	10.372	<0.0001
	F2	3513	-11.947	<0.0001
L2 /e/ vs. L3 /ə/	F1	2101	2.647	0.0223
	F2	2104	4.327	<0.0001

Additional tests were run to compare the production of central vowels. These compared L3 /ɐ/ against L3 and L1 /ə/. Tables 4.7.6 and 4.7.7 show results of ANOVA and post-hoc Tukey tests respectively.

Table 4.7.6: L1 and L3 Central Vowels ANOVA Tests

Vowel pair	Formant	n	df	F
L3 /ɐ/ vs. L3 /ə/	F1	4889	2	1584.6
	F2	4889	2	1406
L3 /ɐ/ vs. L1 /ə/	F1	2236	1	195.05
	F2	2236	1	998.73

Table 4.7.7: L1 and L3 Central Vowels Tukey-adjusted Post-hoc Tests

Vowel pair	Formant	df	t	p
L3 /ɐ/ vs. L3 /ə/	F1	4876	40.047	<0.0001
	F2	4764	-36.156	<0.0001
L3 /ɐ/ vs. L1 /ə/	F1	2190	-13.966	<0.0001
	F2	2219	31.603	<0.0001

ANOVA results suggest that variance is significant for both formants in both cases (Critical $F_{1, 1000}$ = 5.04; Critical $F_{2, 1000}$ = 3.7), this is further confirmed by the results of the post-hoc tests. This demonstrates that participants of this study produce their L1 and L3 schwa as a vowel distinct from their L3 /ɐ/.

4.7.2. Results: Gerstman-normalised Vowels – Cognate Condition Effects

In order to analyse the impact of cognate condition effects on L3 vowel production, GLMMs were constructed for L3 data from each cognate condition and compared cross-language to relevant as described above. ANOVA and post-hoc Tukey tests were again used to further analyse where vowel formants converge and diverge. Tables 4.7.8 to 4.7.11 show the results of these models for each cognate condition.

Table 4.7.8: GLMM Vowels by Language Non-cognate Condition

Vowel	Formant	Fixed factors			Random Factors		
		Language	Intercept	Std. Error	Factor	Variance	σ
<a>	F1	L1	761.28	28.34	Participant	3690	60.75
		L2	-132.32	19.79	Time phase	435.2	20.86
		L3	-177.3	20.71	Residual	47524.9	218
	F2	L1	754.21	27.9	Participant	1048	32.37
		L2	-325.68	13.45	Time phase	1586	39.82
		L3	-308.88	14.05	Residual	21546	146.79
<o>	F1	L1	353.921	26.232	Participant	3167.1	56.28
		L2	3.023	16.031	Time phase	554.8	23.55
		L3	-53.35	16.578	Residual	23303.9	152.66
	F2	L1	214.87	24.77	Participant	2524.9	50.25
		L2	19.27	17.27	Time phase	376.5	19.4
		L3	131.36	17.87	Residual	24146.7	164.76
<e>	F1	L1	311.36955	28.85969	Participant	5202.1	72.13
		L2	0.07216	13.35555	Time phase	733.2	27.08
		L3	58.36214	25.38869	Residual	24816.3	157.33
	F2	L1	760.83	19.83	Participant	1121.6	33.49
		L2	-20.77	13.37	Time phase	433.5	20.82

		L3	-238.22	25.26	Residual	25224.8	158.82

Table 4.7.9: GLMM Vowels by Language L1 Cognate Condition

Vowel	Formant	Fixed factors			Random Factors		
		Language	Intercept	Std. Error	Factor	Variance	σ
<a>	F1	L1	748.24	27.09	Participant	3934.3	27.09
		L2	-118.82	20.4	Time phase	106.1	10.3
		L3	-149.56	28.41	Residual	51831.4	227.67
	F2	L1	741.24	23.13	Participant	1217.7	34.9
		L2	-310.89	12.9	Time phase	849.8	29.15
		L3	-249.05	17.58	Residual	18941.3	137.63
<o>	F1	L1	345.086	28.206	Participant	3472.6	58.93
		L2	6.134	16.079	Time phase	796.9	28.23
		L3	-31.045	18.042	Residual	22927.1	151.42
	F2	L1	213.09	22.21	Participant	1823.3	42.7
		L2	21.72	15.85	Time phase	323.8	17.99
		L3	91.23	17.8	Residual	22422.7	149.74
<e>	F1	L1	312.693	27.8241	Participant	4360.1	66.03
		L2	-0.2406	13.3643	Time phase	768.4	27.72
		L3	-51.1278	18.4335	Residual	25202.7	158.75
	F2	L1	754.45	18.45	Participant	1419.2	37.67

		L2	-13.76	12.79	Time phase	243.5	15.6
		L3	-22.56	17.75	Residual	23712.5	153.99

<u>Table 4.7.10: GLMM Vowels by Language L2 Cognate Condition</u>

Vowel	Formant	Fixed factors			Random Factors		
		Language	Intercept	Std. Error	Factor	Variance	σ
<a>	F1	L1	767.32	28.98	Participant	2843.2	53.32
		L2	-138.28	20.66	Time phase	661.1	25.71
		L3	-174.33	21.92	Residual	51264.4	226.42
	F2	L1	742.97	23.97	Participant	1405.6	37.49
		L2	-312.8	13.09	Time phase	911.5	30.19
		L3	-287.77	13.87	Residual	20336	142.6
<o>	F1	L1	352.2689	25.7896	Participant	2355	48.53
		L2	0.9339	16.3694	Time phase	659	25.67
		L3	-69.0353	17.125	Residual	24146	155.39
	F2	L1	216.39	23.3	Participant	1851.1	43.02
		L2	18.88	16.33	Time phase	420.8	20.51
		L3	86.57	17.09	Residual	24107	155.26
<e>	F1	L1	311.0522	27.502	Participant	3842.4	61.99
		L2	0.9628	13.3714	Time phase	844.6	29.06

		L3	-29.1764	16.4599	Residual	25569.8	159.91
	F2	L1	759.86	19.58	Participant	1219	34.92
		L2	-19.8	13.12	Time phase	399	19.97
		L3	-54.64	16.17	Residual	24967	158.01

Table 4.7.11: GLMM Vowels by Language L1-L2 Cognate Condition

Vowel	Formant	Fixed factors			Random Factors		
		Language	**Intercept**	**Std. Error**	**Factor**	**Variance**	**σ**
<a>	F1	L1	760.12	26.84	Participant	2645	51.43
		L2	-131.46	19.97	Time phase	430.5	20.75
		L3	-178.97	20.5	Residual	48732.9	220.76
	F2	L1	747.4	24.84	Participant	1052	32.43
		L2	-318.39	12.84	Time phase	1145	33.84
		L3	-329	13.17	Residual	19822	140.79
<o>	F1	L1	353.127	25.641	Participant	442.4	49.42
		L2	1.198	16.084	Time phase	639.5	25.29
		L3	-34.036	16.721	Residual	23374.1	152.89
	F2	L1	214.27	21.59	Participant	1451.6	38.1
		L2	21.93	15.73	Time phase	344.7	18.57
		L3	65.54	16.36	Residual	22436	149.79
<e>	F1	L1	312.246	27.153	Participant	3339.9	57.79

		L2	2.333	13.171	Time phase	928.1	30.46
		L3	-12.798	14.501	Residual	25350.4	159.22
	F2	L1	764.05	21.07	Participant	1009.5	31.77
		L2	-26.06	14.16	Time phase	561.8	23.7
		L3	-46.49	15.61	Residual	29576.1	171.98

ANOVA tests were conducted on each model to analyse the variance in Gerstman-adjusted vowel formant frequencies between the L1, L2, and L3.

Results show that variation is significant in a two-tailed test at the 95% confidence interval (Critical $F_{2, 1000}$ = 3.7; Critical $F_{2, \infty}$= 3.6889) for almost all vowel formants. Variance of F1 of <e> fails to reach significance in the non-cognate, L2 cognate, and L1-L2 cognate conditions; variance of F2 of <e> is not significant in the L1 cognate condition. Table 4.7.12 fully details the results of these tests.

Table 4.7.12: ANOVA Vowel formant Variance by Language and Cognate Condition

Cognate condition	Vowel	Formant	n	df	F
Non-cognate	<a>	F1	1886	2	37.233
		F2	1886	2	296.72
	<o>	F1	2124	2	28.227
		F2	2124	2	99.907
	<e>	F1	1342	2	3.203
		F2	1342	2	48.296
L1 cognate	<a>	F1	1388	2	18.973
		F2	1388	2	292.85
	<o>	F1	1748	2	6.5914
		F2	1748	2	25.954

	<e>	F1	1419	2	6.1894
		F2	1419	2	0.8779
L2 cognate	<a>	F1	1809	2	31.637
		F2	1809	2	286.17
	<o>	F1	2022	2	39.921
		F2	2022	2	39.631
	<e>	F1	1508	2	3.2747
		F2	1508	2	6.423
L1-L2 cognate	<a>	F1	2013	2	40.02
		F2	2013	2	331.54
	<o>	F1	2068	2	10.774
		F2	2068	2	19.571
	<e>	F1	1683	2	1.2854
		F2	1683	2	4.6798

Tukey-adjusted post-hoc tests were also conducted in order to determine where the formant frequencies of L3 vowels converged with L1 and L2 counterparts. Cognate effects appear to be somewhat erratic with vowel production, and the dichotomy seen in plosive production does not emerge with vowels. These results are summarised in tables 4.7.13 to 4.7.16. Of note however are the following comparisons:

- L3 /ɐ/ seems to converge somewhat with L2 /a/ under the non-cognate, L1 cognate, and L1-L2 cognate conditions.
- The first formant of L3 /u/ converges with that of L1 /ɒ/ in the L1 cognate and L1-L2 cognate condition.
- L3 /ə/ shows the greatest variation in its position relative to L2 /e/ and L1 /ə/ under cognate condition effects.
- F1 of L3 /ə/ is not significantly different to L1 /ə/ in the non-cognate, L2 cognate, and L1-L2 cognate conditions.
- F1 of L3 /ə/ is not significantly different to L2 /e/ under the L2 cognate and L1-L2 cognate conditions.
- F2 of L3 /ə/ is not significantly different to L1 /ə/ under the L1 cognate condition, and to L2 /e/ under the L1 cognate and L1-L2 cognate conditions.

Table 4.7.13: Tukey-adjusted Post-hoc tests: Vowel formants Non-cognate Condition

Vowel pair	Formant	df	t	p
L1 /æ/ vs. L3 /ɐ/	F1	1450	8.562	<0.0001
	F2	1871	21.98	<0.0001
L1 /ɒ/ vs. L3 /u/	F1	2082	3.218	0.0037
	F2	2020	-7.352	<0.0001
L1 /ə/ vs. L3 /ə/	F1	1323	-2.299	0.0563
	F2	1217	9.433	<0.0001
L2 /a/ vs. L3 /ɐ/	F1	1880	4.012	0.0002
	F2	1881	2.227	0.067
L2 /o, ɔ/ vs. L3 /u/	F1	2119	7.442	<0.0001
	F2	2119	-13.722	<0.0001
L2 /e/ vs. L3 /ə/	F1	1334	-2.513	0.0324
	F2	1114	9.474	<0.0001

Table 4.7.14: Tukey-adjusted Post-hoc tests: Vowel formants L1 Cognate Condition

Vowel pair	Formant	df	t	p
L1 /æ/ vs. L3 /ɐ/	F1	482	5.265	<0.0001
	F2	1364	14.164	<0.0001
L1 /ɒ/ vs. L3 /u/	F1	1721	1.721	0.1977
	F2	1641	-5.126	<0.0001
L1 /ə/ vs. L3 /ə/	F1	1377	2.744	0.0155
	F2	1161	1.271	0.4122
L2 /a/ vs. L3 /ɐ/	F1	1373	1.399	0.3419
	F2	1373	-4.655	<0.0001

L2 /o, ɔ/ vs. L3 /u/	F1	1737	3.631	0.008
	F2	1740	-6.869	<0.0001
L2 /e/ vs. L3 /ə/	F1	1407	3.383	0.0015
	F2	1411	0.621	0.8084

Table 4.7.15: Tukey-adjusted Post-hoc tests: Vowel formants L2 Cognate Condition

Vowel pair	Formant	df	t	p
L1 /æ/ vs. L3 /ɐ/	F1	551	7.954	<0.0001
	F2	1782	20.741	<0.0001
L1 /ɒ/ vs. L3 /u/	F1	1988	4.031	0.0002
	F2	1950	-5.065	<0.0001
L1 /ə/ vs. L3 /ə/	F1	1458	1.773	0.1792
	F2	1322	3.38	0.0022
L2 /a/ vs. L3 /ɐ/	F1	1803	2.995	0.0078
	F2	1802	-3.302	0.0028
L2 /o, ɔ/ vs. L3 /u/	F1	2008	8.851	<0.0001
	F2	2009	-8.57	<0.0001
L2 /e/ vs. L3 /ə/	F1	1497	2.539	0.0302
	F2	1503	2.976	0.0083

Table 4.7.16: Tukey-adjusted Post-hoc tests: Vowel formants L1-L2 Cognate Condition

Vowel pair	Formant	df	t	p
L1 /æ/ vs. L3 /ɐ/	F1	1546	8.279	<0.0001
	F2	1990	24.974	<0.0001
L1 /ɒ/ vs. L3 /u/	F1	2030	2.035	0.1041

	F2	1975	-4.007	0.0002
L1 /ə/ vs. L3 /ə/	F1	1614	0.883	0.6514
	F2	1466	2.978	0.0083
L2 /a/ vs. L3 /ɐ/	F1	1999	4.533	<0.0001
	F2	1999	1.586	0.2518
L2 /o, ɔ/ vs. L3 /u/	F1	2060	4.598	<0.0001
	F2	2062	-5.814	<0.0001
L2 /e/ vs. L3 /ə/	F1	1673	1.595	0.2482
	F2	1678	1.999	0.1128

Finally, additional models were constructed and tested for comparison of the L1 and L3 central vowels. Results of the ANOVA and post-hoc Tukey tests are presented in Tables 4.7.17 to 4.7.19. ANOVA tests for L3 /ɐ/ vs. L3 /ə/ tested variance across all L3 vowels by cognate condition, thus post-hoc Tukey tests are more reflective of comparing these two vowels within each cognate condition.

Table 4.7.17: ANOVA Tests L3 Vowels by Cognate Condition

Formant	**n**	**df**	**F**
F1	4889	6	3.0614
F2	4889	6	9.9973

Table 4.7.18: ANOVA Test L1 and L3 Central Vowels by Cognate Condition

Cognate condition	**Formant**	**n**	**df**	**F**
Non-cognate	F1	833	1	155.3
	F2	833	1	552.21
L1 cognate	F1	335	1	74.007
	F2	335	1	147.19

L2 cognate	F1	756	1	79.308
	F2	756	1	472.07
L1-L2 cognate	F1	960	1	149.54
	F2	960	1	763.97

Table 4.7.19: L1 and L3 Central Vowels Tukey-adjusted Post-hoc Tests by Cognate Condition

Cognate condition	**Vowel pair**	**Formant**	**df**	**t**	**p**
Non-cognate	L3 /ɐ/ vs. L3 /ə/	F1	4870	14.153	<0.0001
		F2	4868	-6.101	<0.0001
	L3 /ɐ/ vs. L1 /ə/	F1	601	-12.462	<0.0001
		F2	803	23.499	<0.0001
L1 cognate	L3 /ɐ/ vs. L3 /ə/	F1	4865	13.871	<0.0001
		F2	4865	-11.065	<0.0001
	L3 /ɐ/ vs. L1 /ə/	F1	88.2	-8.603	<0.0001
		F2	15.6	12.132	<0.0001
L2 cognate	L3 /ɐ/ vs. L3 /ə/	F1	4865	19.859	<0.0001
		F2	4865	-17.976	<0.0001
	L3 /ɐ/ vs. L1 /ə/	F1	638	-8.905	<0.0001
		F2	512	21.727	<0.0001
L1-L2 cognate	L3 /ɐ/ vs. L3 /ə/	F1	4865	26.702	<0.0001
		F2	4864	-27.636	<0.0001
	L3 /ɐ/ vs. L1 /ə/	F1	679	-12.229	<0.0001
		F2	886	27.640	<0.0001

The results shown in Table 4.7.18 clearly show that the participants of this study distinguish their L1 and L3 central vowels consistently across all cognate conditions. It appears clear that morpholexical processing has not impacted CLI processes for these L3 learners in their production of L3 Portuguese /ɐ/ and /ə/.

4.8. Discussion: OPT Vowels

This section analyses and discusses the results of the statistical tests conducted on the Gerstman-normalised formant frequencies of L1 English, L2 Spanish/French, and L3 Portuguese vowels produced by this study's participants. It begins by briefly summarising the findings of the results presented in Section 4.7, before evaluating the implications of these data for the models of third language acquisition presented in Section 2.3. It then employs these results to test hypotheses of this study that are relevant to L3 Portuguese vowel production.

4.8.1. OPT Vowels: Results Summary

This section offers a brief summary of the results of the statistical tests conducted on the vowels produced by this study's participants in the Oral Production Tasks. The vowels focussed on in this study are L1 /æ, ɒ, ə/, L2 /a, o, ɔ, e/ and L3 /ɐ, u, ə/, comparing L3 vowels to their L1 and L2 counterparts as well as comparing L3 /ɐ/ to L3 /ə/, and L3 /ɐ/ to L1 /ə/ in order to investigate L1 and L2 CLI effects on the first and second formants of L3 vowels. CLI effects are not highly visible within the OPT vowel data, with most vowel formants being significantly different from their cross-language counterparts. Several results analysing differences in vowel formants between the L1 and L2 are noteworthy, however very few CLI effects surface in the comparison of L3 vowels to L1 and L2. The effects of cognate condition on L3 vowel production are seen to be minimal.

Firstly, the first and second formants of L1 and L2 <o> do not differ significantly. Whilst a similar F2 is to be expected, the fact that these vowels are produced with similar height suggests a strong influence of L1 /ɒ/ on the production of L2 /o/. Secondly, the L1 /æ/ and L2 /a/ are produced distinctly, with both first and second formants differing significantly. Given the difficulty in distinguishing these vowels in the APDT, it is surprising that participants appear to have separate categories for them in their oral production. Finally, the second formant of <e> is not significantly different between the L1 and L2 despite the expectation that L2 /e/ would be produced substantially more fronted than L1 /ə/.

When analysed without cognate condition effects, cross language comparison of vowels does not suggest obvious CLI effects, with L3 vowels differing significantly in their first and second formant frequencies in almost all cases. Height (measured by F1 frequency) of L1 and L3 /ə/ do not differ significantly, whilst frontness (measured by F2 frequency) of L2 /a/ and /e/ does not differ significantly from L3 /ɐ/ and /ə/ respectively. All other formants were found to be distinct, suggesting no direct overlap of any L3 vowels with any L1 or L2 vowels. Comparison of central vowels without cognate condition effects reveal that L3 /ɐ/ is produced distinctly from L1 and L3 /ə/.

Cross-language comparison of rounded back vowels under cognate condition effects suggests that some lowering of L3 /u/ may have occurred in the L1 cognate and the L1-L2 cognate condition with the first formant of L1 /ɒ/ and L3 /u/ seemingly converging. This may suggest some increase in L1 CLI under conditions of increased L1 activation, however results are somewhat unclear. Some changes are also seen under the L1 cognate condition in the comparison of L1 and L3 /ə/, where the vowel height differs significantly, but frontness does not. Cognate condition effects may have minor impact on L2 CLI into L3 vowel production, with F1 of /a/ and /ɐ/ converging under the L1 cognate condition, however the F2 of these vowels diverge under the L1 cognate and the L2 cognate conditions. Additionally, the F2 of L2 /e/ and L3 /ə/ diverge under the non-cognate and the L2 cognate conditions, whilst the F1 of these vowels converges under the L1 cognate condition. Finally, cognate condition changes had no additional impact on the comparison of L3 /ɐ/ against L1 and L3 /ə/, which continue to be produced distinctly under all cognate conditions. As above, these results may suggest some minor CLI effects, however the lack of full overlap of any vowels within the participants' oral production renders any such connections tenuous at best.

4.8.2. OPT Vowels: Implications for L3 Acquisition Models

Due to the highly complex nature of the vowel data, the implications of CLI effects observed in this study for the four prominent models of L3 acquisition examined here are less robust than those discussed above regarding VOT in fortis plosives. CLI is difficult to see in the data, especially since, of the formant frequencies studied, very few vowels showed substantial similarity between languages. Nonetheless, some commentary on the ability of the CEM, the L2SF, the TPM, and the scalpel model to account for the data of L3 vowel production analysed in this study are presented here.

Some suggestion of negative CLI is seen in the production of L3 vowels, as well as suggestions of both L1 and L2 influence on formant frequencies of the first and second formants of L3 /ɐ/, /ə/ and /u/. As seen with plosives, the Cumulative Enhancement Model is unable to account for negative CLI and therefore it is not supported by the data. The CEM predicts that all CLI that does occur is positive; any background language properties that would not lead to target-like L3 production remain neutral, having no influence on L3 development. This appears to have not been the case, with the second formant of L3 <a> and <e> being L2-like, not target-like, where the CEM would predict that L1-like schwa properties would influence the formation of L3 schwa, and other properties would remain neutral in order to allow the L3 to develop independently towards target.

The L2 Status Factor Model (Bardel and Falk, 2007; Falk and Bardel, 2011) predicts that all linguistic properties of the L3 begin as those of the L2. The consistent differences between several L3 vowels and their L2 counterparts cannot be accounted for by the L2SF, most notably in the first formants of L3 central vowels /ɐ, ə/. The vowel /ɐ/ is seen to consistently differ in height from the L2 /a/; no Spanish vowel exists that should be close enough to L3 /ɐ/ to lead to substantial CLI effects to be observed. Furthermore, there appears to be potential L1 influence in the production of L3 /ə/, with the first formants of these vowels not differing significantly. Nonetheless, given that evidence of L1 CLI in the vowel data is difficult to identify, the L2SF is not entirely dismissed by these data.

The Typological Primacy Model (Rothman, 2010, 2011, 2012, 2015) struggles to adequately account for the CLI seen in the L3 vowel data of this study. Given the high degree of morpholexical similarity between the L2 and L3, the TPM should predict that the L2 will be the dominant source of all CLI on the L3. However, the fact that L3 <a> and <e> show relatively consistent differences between L2 and L3 suggests that L2 influence is not absolute and that the formation of the L3 phonology is more complex than the TPM assumes. The scalpel model allows for a highly complex, intricate CLI process in L3A however it is unclear if it is able to adequately predict the L3 vowel production results seen in this study. As mentioned above, CLI processes that may have occurred in the L3 vowels are difficult to pinpoint within the data, and where similarities in vowel quality to arise, it is not always possible to definitively show that this is a result of influence from the L1 or L2.

In conclusion, none of the four models (CEM, L2SF, TPM, and scalpel model) seem to be able to account for the highly complicated, unclear picture presented by the vowel data of this study. Some suggestions of both L1 and L2 CLI as well as some negative CLI in L3 vowel production somewhat counter the predictions of the CEM, the L2SF and the TPM; the scalpel model may be able to account for the degree of complexity and intricacy that appears to occur with the L3 vowel production data, but this is not entirely clear. Efforts to model CLI in L3A in the context of the vowel formant frequency data of this study is hampered by the fact that CLI effects are not highly visible, rendering it difficult to adequately test these four models.

4.8.3. OPT Vowels: Testing Hypotheses

This section applies the results of the production of key L1, L2, and L3 vowels from the OPTs to test the hypotheses of this study. Hypotheses 5, 6, 7 and 8 relate to CLI in the production of vowels, and so these hypotheses are tested here. The results of testing these hypotheses are subsequently applied to contribute towards answering this study's research questions in Chapter 5.

Hypothesis 5 predicts that the L3 high, back, rounded vowel /u/ will be consistently produced with a lower first formant frequency (i.e. produced higher in the oral cavity) than L1 /ɒ/ and L2 /o/. This hypothesis is supported by the data. In all cognate conditions, as well as when examining the full dataset without accounting for cognate condition effects, a consistent, strong trend is seen towards L3 /u/ being produced higher than the L1 and L2 back rounded vowels studied in the OPTs. Statistical modelling and tests further demonstrate that the difference in F1 frequency is significant between L1 /ɒ/ and the L3 /u/, and between L2 /o/ and L3 /u/ when examined without cognate condition effects. The L2 and L3 also differ significantly in this formant frequency under all cognate conditions, whilst the L1 and L3 are different under the non-cognate condition and the L2 cognate condition, but not under the L1 cognate condition nor the L1-L2 cognate condition.

This neither proves nor disproves the presence of CLI on the production of L3 /u/ since this successful distinction of rounded back vowels could be due to positive CLI of L1 or L2 /u/, universal language development, or general acquisition of the L3 phone. However, it does demonstrate a lack of negative CLI from orthographically similar L1 and L2 vowels and suggests that L3 word final <o> has not been heavily influenced by the morphemic similarity of L2 Spanish <o>, even under conditions in which the L2 is highly activated (i.e. the L2 cognate condition).

Hypothesis 6 predicts that L3 /ɐ/ and L3 /ə/ will not be distinguished in production. This hypothesis is not supported by the data. Tests conducted clearly demonstrated that these two L3 vowels were produced distinctly in all cognate conditions as well as when all L3 data is analysed as a single whole, without cognate condition effects. However, deeper analysis of the data suggests that the reason for this distinction is not due to successful acquisition of target-like L3 /ɐ/ and /ə/ settings but rather due to influence of the L2 /a/ and /e/ moving these L3 vowels away from a centralised position. A simple understanding of the NLM-e applied to the production of these two L3 central vowels would predict heavy influence from the previously acquired L1 schwa since no other previously acquired vowel should occupy the central vowel space. However, in production, this does not seem to be the case.

Hypothesis 7 predicts that, when produced under the L1 cognate condition, the L3 /ɐ/ formant frequencies will not be distinguished from those of L1 /ə/. This hypothesis is not supported by the data. Tests revealed that the frequencies of both the first and second formants of these vowels differed significantly under all cognate conditions. In fact, very little variation due to cognate condition is seen in the F1 and F2 of L3 /ɐ/, with differences between cognate conditions only being significant in the comparison of the second formant in the L1 cognate condition against that in the L1-L2 cognate condition ($n = 4889$, df, $= 4864$, $t = 3.416$, $p = 0.0314$). This lack of convergence of the L1 and L3 central vowels appears, as seen with the difference between L3 /ɐ/ and /ə/, to be due not to an independent, target-like development of an L3 /ɐ/ category, but rather due to CLI from the L2 causing this L3 vowel to converge towards L2 /a/. This is further supported by the lack of significant difference between the first formants of L2 /a/ and L3 /ɐ/ under the L1 cognate condition.

Hypothesis 8 predicts that under the L2 cognate condition, the L3 vowels /ɐ/ will not be distinguished from L2 /a/, and L3 /ə/ will not be distinguished from L2 /e/. This hypothesis is not supported by the data. Tests conducted show that when produced in the L2 cognate condition, the first and second formants of L3 /ɐ/ are significantly different from those of L2 /a/; the first and second formants of L3 /ə/ are also different from those of L2 /e/. It is further noteworthy that these differences are also seen in the non-cognate condition, presenting a stark contrast to the dichotomy seen in the VOT in fortis plosives, where the L2 appeared to have greater influence in these cognate conditions than in the L1 cognate and the L1-L2 cognate conditions. The reasons for this difference are difficult to precisely ascertain from the data of this study, however they do suggest that there may be a difference in the development of L3 vowels and that of L3 plosives. Given their experience with at least one intermediate level L2, the L3 learners of this study may be expected to have a highly complex, multilingual vowel space. This, as would be predicted by the NLM-e and the SLM, will lead to a large number of potential influences acting simultaneously on each newly forming vowel in the L3 acquisition process, potentially leading to L3 vowels which are not target like whilst also being distinct from L1 and L2. I thus speculate that just as compromise VOT values are frequently seen in the production of L3 fortis plosives due to combined CLI, vowel quality may also be subject to combined CLI leading to L3 vowels which are neither L1-like, nor L2-like whilst also being non-target-like. Nonetheless, the data of this study is insufficient to test such a hypothesis, and a more precise study with the explicit intention of examining such phenomena is required to do so.

4.8.4. OPT Vowels: Conclusion

This section has discussed the results of the OPT vowel data gathered from the participants of this study. It was argued that none of the four prominent models of L3A discussed in this work are truly able to adequately predict these data, though it is proposed that the scalpel model is the only one of sufficient complexity and flexibility to be viable on any level. Hypotheses 5, 6, 7, and 8 were tested and it was found that Hypothesis 5 is supported, whilst Hypotheses 6, 7, and 8 are not supported by these data. It was nonetheless conceded that the data of this study may not be sufficient to show clear CLI effects in action.

4.9. Results: Conclusion

This chapter has presented the results of the Language Questionnaire, the Aural Perception and Distinction Task, and the Oral Production Tasks. Additional discussion of the OPTs was also made in order to evaluate evidence of CLI in L3 Portuguese production. The following Chapter presents additional discussion. It examines interactions between the OPTs and other two task types conducted in the study, and brings together the datasets to address the research questions posed by this work.

Chapter 5 Discussion

This chapter presents additional discussion of the data collected for this study of crosslinguistic influence in third language acquisition. It examines the significance of the Language Questionnaire and the Aural Perception and Distinction Task in this study to the wider literature in L3 phonology and reviews interactions between the Language Questionnaire, the APDT and the OPT. It additionally draws on the results and discussion to address the four research questions posed in this work:

1. Can phonological CLI on L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?
3. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects are neutral?
4. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects exist with both L1 and L2?

This chapter first discusses the results from the Language Questionnaire, followed by the results of the Aural Perception and Distinction Task, and finally the interaction between these and the Oral Production Task. Through relating the results presented throughout Chapter 4, the discussion within this chapter aims to address the above research questions. Relation of this discussion to the literature and theoretical framework laid out in Chapter 2 will lead to addressing the above research questions and determine the impact of localised cross-language morpholexical similarity on phonological processing and crosslinguistic influence processes in L3 production.

5.1. Discussion: Questionnaire

This section discusses the results from the language questionnaire given to all of the participants of this study. It first reiterates a summary of the results detailed more fully in Chapter 4, before discussing how these data are employed in further discussion of the results of other tests conducted. Finally, the data from the questionnaire are related to the wider literature within the field of third language acquisition, both theoretical and empirical.

5.1.1. Data Summary

The Language Questionnaire acquired data from all participants of the study in three distinct sections. Section 1 gathered data on participants' linguistic backgrounds and does not require additional analysis here. Section 2 related to participants' perceptions of similarity between the L3 and their background languages, whilst section 3 asked participants to evaluate their perceptions of the importance of pronunciation in NNLA as well as their desire to supress or actively employ crosslinguistic influence from their L1 and L2 in their L3 production.

Sections 2 and 3 of the Language Questionnaire reveal several patterns suggesting perceptions of language similarity and desire to supress or utilise CLI that correlate with evidence of CLI in L3A seen in previous studies. All participants consider the L3 to be more similar to their target L2 than the L1 in terms of morpholexical structures whilst all but participant H rate their L3 as syntactically more similar to their target L2 than to the L1. All participants rate the L1 as phonologically distant from the L3, however less consistency was seen across participants in their evaluation of phonological proximity between the L3 and their target L2. In the L2 Spanish group, no participants rate Spanish as extremely similar to Portuguese phonologically, however participants D, E, and K rate their L2 as more similar than dissimilar (ratings over 4) to the L3, with all but one participant choosing a similarity rating between 3 and 5 on the 7-point Likert scale. In the L2 French group, participant G rates their L2 French as being very similar to the L3 in phonology, whilst participants B and H rate their target L2 as phonologically distant from the L3; see Appendix C for details.

In section 3 all participants agree with the statement that pronunciation is important, as well as expressing a desire to supress L1 phonological CLI in their L3 production. A greater degree of variation is seen in participants' response to the desire to supress phonological structures of L2 in L3 production, with participants D, K and L disagreeing with the statement and participants B and H neither agreeing nor disagreeing. All participants consider there to be potential for positive morpholexical and syntactic CLI from the L2 on the L3, and only participant L disagrees that the L1 may provide a useful source of CLI in these elements of L3 grammar; four participants agree, one very strongly, however the majority of participants neither agree nor disagree. All participants agree that their L2 presents a potential source of positive CLI for morpholexical and syntactic L3 structures. Participant H expresses that the L1 is more useful than the L2 in acquiring L3 morpholexical and syntactic structures, whilst participant G rates the L1 and L2 as equally useful in this regard; participant G is also the only participant in the study to agree that L1 phonological structures may provide potential positive CLI in L3 production. Finally, five of the twelve participants agree somewhat that their L2 phonological structures may be useful in acquiring L3 phonology, five neither agree nor disagree and two (participants H and L) disagree.

5.1.2. Questionnaire Data Analysis

Analysis of the data from sections 2 and 3 of the language questionnaire reveal some noteworthy interactions between related statements within section 3 as well as between the responses to the statements in section 3 and the similarity rating judgements made in section 2. Some discrepancies arise within participants' responses to the statements in section 3 of the language questionnaire due to the interrelated nature of statements 2 and 6, and statements 3 and 7. Statements 2 and 3 asked participants to consider their desire to suppress L1 and L2 phonology respectively in their production of the L3, whilst statements 6 and 7 asked participants to consider their desire to utilise L1 and L2 phonology respectively in their L3 production.

Participants A, E, F, and L all very strongly agree with suppressing both L1 and L2 phonology in their L3 production as well as disagreeing that L1 phonological structures are useful in their L3 acquisition, however only participant L also disagrees that their L2 phonology is useful in the L3A process. Participant E agrees with statement 7, whilst participants A and F neither agree nor disagree with the statement. Similarly, participants B, C, and I all agree that they wish to suppress L2 phonological CLI but also agree that L2 phonology is useful in acquiring the L3 phonology. Participant H neither agrees nor disagrees with the statement that they wish to avoid using L2 phonological structures in their L3 production, however they quite strongly disagree that their L2 phonology is useful in L3 Portuguese acquisition. Finally, participant G is the only participant in the present study to agree with the statement that their L1 phonology may be useful in their L3A process, however this participant also quite strongly agrees that they wish to suppress L2 phonological CLI in L3 production.

Despite the discrepancies, the majority of participants show relatively consistent behaviour in their responses to these two pairs of statements in section 3. Whilst it may be argued that the discrepancies observed here highlight the difficulties in accurately measuring subjective perceptions of language distance, it can also be argued that it shows that 'phonology' may be too broad a term by which to measure an aspect of linguistic structure. Whilst L3 learners may perceive a background language to be dissimilar to the L3 in terms of its overall phonology, they may still consider the phonology of one language to be useful in the L3A process. In the case of utilising L2 phonological structures, this may be due to a perception that knowledge of a non-native phonological system has granted the learner general language learning strategies, phonology-specific language learning strategies, and a generally wider phonological repertoire on which to draw in NNL production and acquisition. In the case of both L1 and L2 phonology this may be due to specific, isolated phonemic or phonetic properties that exist in common between the target L3 and the background languages.

5.1.2.1. Questionnaire: Cross-section Analysis

Whilst section 2 of the Language Questionnaire asked participants to consider the relative structural proximity of their background languages compared to their L3 Portuguese, section 3 asked them to respond to statements related to language learning processes and the utilisation or suppression of CLI from the L1 and L2 in their L3 acquisition and production. Some notable links of similarity occur across these two sections, whilst some discrepancies arise amongst others.

All participants agree with the statement that they attempt to suppress phonological CLI from the L1 in their L3 production, as well as rating their L1's phonology as quite distant from that of the L3. Additionally, as mentioned above, all participants with the exception of participant G further disagree that the phonological structures of the L1 may prove useful in their L3A process, reinforcing the assumed link between learners' perceptions of language distance and a desire to avoid CLI from background languages perceived to be dissimilar from the target language. This link is less prevalent in the case of the L2, however participants A, F, H, I and J all quite strongly agree that they wish to suppress their L2 phonological structures in L3 production and rate their L2 as distant from their L3 in this aspect. Participant C also agrees, though less strongly, with the desire to suppress L2 phonological CLI in L3 production whilst also rating the L2 as phonologically dissimilar.

Whilst no participants very strongly agree that the lexical and syntactic structures of their L1 are useful in their L3A process, participants A and F agree somewhat with this statement and rate L1 syntax as similar to that of the L3, however both rate L1 as dissimilar to the L3 in morpholexis. A greater proportion of participants agree that the morpholexical and syntactic structures of their L2 are useful in their acquisition of L3 Portuguese with participants A, C, D, E and F agreeing strongly with this statement and rating their L2 as similar to the L3 in both lexis and syntax. Participant I also agrees strongly with this statement and rates their L2 Spanish as very similar to Portuguese in syntax, although this participant considers their L2 lexis to be neither similar nor dissimilar to the L3. Participants B, G, J and L all agree, though less strongly as those previously mentioned, that the morpholexical and syntactic structures of their L2 are useful to them in their L3 Portuguese acquisition and also rate their L2 and L3 as similar in these aspects of linguistic structure.

As was seen in the case of phonology above, these connections between responses to the language questionnaire further suggest that L3 learners' perceptions of similarity across languages are frequently connected with a desire to encourage or suppress CLI in L3 acquisition and production processes.

Despite this, some participants also exhibit contradictory behaviour in their responses to the similarity judgements of section 2 and the statements in section 3. Participants E, G and K all consider their L2 to be phonologically somewhat similar to the L3, however these participants also agree with the statement that they intend to avoid using L2 phonological structures in their L3 production. By contrast, participant B agrees that the phonological structures of their L2 are useful in the acquisition of L3 Portuguese, but rates the two languages as dissimilar in phonology. Finally, participants C and L both rate their L2 as neither similar nor dissimilar to the L3 in phonological structures, however participant L very strongly agrees that they wish to supress L2 phonology in L3 production, whilst participant C agrees with both statements 3 and 7 in section 3 of the Language Questionnaire.

A small number of notable discrepancies also occur in participants' responses to questionnaire items relating to the comparison of the morphology, lexis and syntax of the background languages to those of the L3 and the potential to utilise these structures in L3 Portuguese acquisition and production. Participants A, F and H all agree with the statement that the lexical and morphosyntactic structures of their L1 may be useful in their acquisition of L3 Portuguese; these three participants also rate the L1 and L3 as dissimilar in terms of lexis, however participants A and F rate these two languages as syntactically somewhat similar whilst participant H judges their L1 and L3 to be neither similar nor dissimilar in syntax. Participant H additionally agrees that the L2 lexis and syntax may be useful in L3 Portuguese acquisition, however she considers her L2 to be very dissimilar to the L3 in all aspects.

Whilst few in number compared to the noteworthy links of similarity, these discrepancies in participant responses to related elements of the Language Questionnaire do highlight that data based on subjective judgements and conscious perceptions of language distance can garner seemingly contradictory responses. Nonetheless I argue, as above, that in the case of these apparent discrepancies in participant responses there may have been some influence of participants' subjective interpretation of the questions posed within the language questionnaire, as well as the scope of the statements on desire to utilise or suppress CLI in L3 acquisition and production. Several participants rate their background languages as dissimilar in lexical or morphosyntactic structure whilst also agreeing that these L1 and L2 linguistic structures are useful in their L3 Portuguese acquisition and production. They may consider that it is the general knowledge and understanding of language acquired through the language acquisition process that is useful in L3A, not similarity of specific structures across the two languages. Similarly, in the case of phonology, learners may consider their conscious awareness of phonological production processes from their L1 and L2(s) as useful in L3A and L3 production whilst simultaneously perceiving the majority of specific phonetic properties of the L3 and the background languages as dissimilar. The questionnaire asked participants in section 2 to rate their languages for similarity in terms of 'pronunciation', whilst in section 3 participants considered statements 2 and 3 referring to 'sounds from English' and 'sounds from Spanish'; meanwhile statements 6 and 7 stated that knowledge of the L1 and L2 aided in the acquisition of L3 Portuguese pronunciation. Despite the evident link between them, given the imperfect correlation between the terms used in these two sections I argue that participants' responses may have been subject to differences in interpretations of the scope of the statements presented in section 3 and of the terminology used in section 2. Whilst the term 'pronunciation' may be considered to encompass all segmental and suprasegmental features of the target language, the term 'sounds' may be interpreted as simply the segmental features or specific phonemes which language learners note as salient or unique within the L1 or L2.

The number of such discrepancies in participant responses to questions relating to their perceptions of language distance and the intention to suppress or utilise CLI from background languages in L3 acquisition and production was seen to be relatively small, however their presence warrants more detailed discussion. Whilst these discrepancies do highlight imperfections in the use of data based on subjective judgement, it nonetheless remains my assertion that in order for research in third language acquisition to consider the role of learners' perceptions of crosslinguistic similarity as a factor in conditioning CLI in L3A, it is necessary to attempt to assess such perceptions and not to simply assume them to be in accordance with objectively observable structural or typological similarity. Furthermore, as was argued in Chapter 2, such direct methods of obtaining data pertaining to L3 learners' perception of language distance have not been undertaken in previous studies prior to claiming influence of said perceptions on the L3A process. Hence, I propose that such methods continue to be used in future L3 research in order to access participants' knowledge of language distance, albeit on a conscious level.

The impact of L3 learners' perceptions of similarity and dissimilarity between the L3 and their background languages is highly relevant to the predictions of the TPM (Rothman, 2010, 2011, 2013, 2015) and the scalpel model (Slabakova, 2017) with regards to the selection of source language for crosslinguistic influence on the L3. The use of the Language Questionnaire in the present study also relates to earlier works in the field of L3 acquisition, being relevant to Williams and Hammarberg's (1998) proposal of typological proximity and L2 status as factors which influence the selection of source for CLI on the L3; as was discussed in Chapter 2, the L2 status factor proposed by Williams and Hammarberg (1998) was further expanded upon by Gessica de Angelis (2007) as an 'association of foreignness'. In both cases, these assertions on the nature of learners' perceptions of language distance assume that a cognitive association will occur without gathering data on participants' perceptions and associations of language distance. Finally, both Hufeisen's (2005) Factor Model of Language Acquisition and Herdina and Jessner's (2000, 2002) Dynamic Model of Multilingualism assert that L3 learners' perceptions of language distance will have a substantial impact on the development of the L3 interlanguage; I deduce that such impact is considered to occur through the selection of the source language for CLI in L3 acquisition and production.

In support of previous works in the field of L3A, in which the importance of learner perceptions of language distance was asserted but not overtly measured, the data from the Language Questionnaire suggest that languages of the same family are perceived as more similar to one another than languages of different families, in that typological factors appear to play a role in conditioning learner perceptions of language distance. However, the data further suggest that specific similarities on a property-by-property basis are important in learners' perceptions of language distance, as a strong trend was seen towards participants who have both L2 French and L2 Spanish rating their L3 as more similar to Spanish than to French in terms of lexis and morphosyntax, though less consistently so in terms of phonology. As was detailed in Section 2.9, European Portuguese and Spanish share a high degree of objectively observable structural similarity in their lexical and morphosyntactic structures, whilst their phonologies differ in some aspects but are similar in others. Furthermore some aspects in which Spanish and European Portuguese phonologies share commonalities, such as voice onset time in plosives, are also shared with French whilst other aspects of European Portuguese phonology, such as the use of nasal vowels and the voiceless palatal fricative /ʃ/, are entirely distinct from phonological structures in standard Spanish but highly salient in French.

By breaking down participants' perceptions of language distance into multiple aspects of linguistic structure, even into such broad terms as phonological, lexical, and morphosyntactic structures, it becomes clear that L3 learners' perceptions of language distance are not considered on a holistic, absolute or mono-lateral scale. Perceptions of cross linguistic similarity can be differentiated across different aspects of language, thus the assumption of similarity being perceived on a macro level is inadequate for the complexity of linguistic structure. Despite the fact that the data on learner perceptions of language distance collected through this Language Questionnaire represent conscious perceptions of similarity and not the purely subconscious crosslinguistic links made within language learners' minds, these data clearly demonstrate that learners are aware that similarity between languages may be considered in a more detailed fashion than the macro scale of perception presupposed by the L2SF model (Bardel and Falk, 2007; Falk and Bardel, 2011) and the TPM (Rothman, 2010, 2011, 2013, 2015).

This section has discussed the data collected through the Language Questionnaire and reiterated their relevance to this study as well as the importance of collecting such data in future examinations of CLI in L3A. It was argued that despite the limitations of data of this nature, the importance of assessing learner perception of language distance rather than simply assuming that learners' subjective perceptions of similarity are identical to objectively observable structural similarity renders them most relevant and necessary in L3A research concerning the selection of source language for crosslinguistic influence. Data gathered from the Language Questionnaire are further referred to in the following sections in order to contextualise and enrich data from the APDTs and the OPTs.

5.2. Discussion: Aural Perception and Distinction Task

This section analyses and discusses the results from the APDT presented in Section 4.2. It first briefly summarises some notable elements of the results, then discusses noted patterns in participant behaviour. Finally, this section addresses the previously established literature of speech sound discrimination in L1, L2 and L3 acquisition and demonstrates how the results of the present study relate to models and theoretical and empirical works in the fields of first, second, and third language acquisition.

5.2.1. APDT: Data Summary

In the cases of both vowels and consonants, the APDT tested participants' ability to distinguish paired speech sounds. Four consonant pairs and one vowel pair exist in contrast within the participants' L1, three consonant pairs and two vowel pairs exist in contrast in the L2 or L3, and nine consonant pairs and four vowel pairs do not exist as phonemic contrasts within any of the participants' target languages. The results across participants presented in Section 4.2 reveal that participants are generally very successful at distinguishing the pre-palatal affricate and fricative test pair [ʧ – ʃ], the three unaspirated fortis plosive vs. voiced lenis plosive pairs [p^h – b], [t^h – d], [k^h – g] and the high, back rounded vowel vs. low back rounded vowel test pair

/u – ɒ/, all of which exist in phonemic contrast within the participants’ L1 and were therefore expected to be distinguished with high rates of success. In the affricate-fricative tests only participant F does not show clear consistent success, correctly identifying the appropriate response in only one of three cases in Phase 1, however in Phases 2 and 3 this participant shows the expected ability to distinguish /ʧ/ vs /ʃ/. This suggests that the apparent discrepancy seen in Phase 1 may have been due to a test effect and a period of acclimatisation to the manner of testing rather than a true inability on this participant’s part to perceive and distinguish the two speech sounds. The APDT contained five plosive test pairs for each of the three places of articulation examined in this study. One of these exists in phonemic contrast in the participants’ L1, one exists in phonemic contrast in the participants’ L2 and L3, and three do not exist in phonemic contrast in any of the target languages. All participants show a strong trend of consistently, successfully distinguishing the L1 contrast of aspirated, fortis plosives vs. voiced, lenis plosives. Conversely, participants show poor ability to distinguish the unaspirated fortis plosive vs. prevoiced lenis plosive pairs, which exist in phonemic contrast in the L2 and L3. Participants are especially poor at distinguishing the bilabial [p – ̬b] pair, however several participants appear relatively strong in distinguishing the velar [k – ̬g] pair.

Of the test pairs which do not exist in phonemic distinction in the participants’ target languages, participants are generally very strong at distinguishing the unaspirated fortis vs. aspirated fortis plosive pairs, but poor in the others. Distinction of voiced lenis plosives vs. prevoiced lenis plosives was generally poor for bilabial and velar plosives, but good for the alveolar/dental test pair [d – ̬d̪]. The final non-TL contrast, unaspirated fortis plosives vs. voiced lenis plosives, proved extremely difficult for the participants to distinguish, especially in the bilabial and alveolar/dental test pairs. However, several participants show strength in distinguishing the velar [k – g] pair.

Of the seven vowel test pairs used in the APDT, one pair exists in phonemic contrast in the L1, two exist in phonemic contrast in the L3 only and one other exists as a phonemic contrast in both the L2 and the L3. The three remaining vowel test pairs do not occur as minimal pairs in any of the participants’ target languages. In the distinction of L1 rounded back vowels /u – ɒ/ most participants, as expected, consistently show the ability to correctly distinguish this pair. The L3 [a – ɐ] contrast also proved to be reasonably easily distinguished by the participants of the present study. Results regarding participant distinction of the similar, non-target language speech sound pair /æ – ɐ/ were of an extremely similar pattern, with all participants showing strong ability to distinguish these speech sounds.

Distinction of the non-target language back rounded vowel [o – ɒ] test pair was generally strong across most participants. This test pair was not expected to prove highly difficult to distinguish for the participants, however participants B, D, and I specifically struggled in distinguishing this pair. The final non-target language test pair in the APDT is that of the two low, front, unrounded vowels [a – æ]. As expected, participants are consistently poor at distinguishing these two vowels, however some individual variation was seen. The high back rounded vowel pair [o – u], which exists in the participants' L2 and L3, was generally distinguished successfully, although participants B, D, and J found this more difficult than their peers. Finally, the pair [ɐ – ə], which exists as an L3 phonemic contrast, was expected to pose difficulty to the participants of the present study since it is not a contrast to which they had been exposed prior to their initial contact with L3 European Portuguese. Participants were very poor in discriminating these two vowels.

5.2.2. APDT: Implications for NNL Perception Models

Many of the difficulties and successes encountered by the participants within the study strongly support previously discussed literature. Both the Speech Learning Model (SLM: Flege 1995) and the Native Language Magnet – enhanced model (NLM-e: Kuhl et al., 2008) predict that listeners will be capable of distinguishing speech sounds as potentially discrete phonemes where sounds are sufficiently distinct from previously acquired exemplars deemed to exist in phonemic contrast in a previously acquired linguistic system. Participants in this study are generally excellent in distinguishing the affricate-fricative contrast [ʧ – ʃ], as predicted by both the SLM and NLM-e due to the presence of these speech sounds as distinct phonemes in the L1. The role of participants' L1 in their ability to distinguish these speech sounds as a phonemic contrast is certain, since although both /ʧ/ and /ʃ/ exist within the target L2 and L3 of the participants of the present study, they do not exist in phonemic contrast in either of these languages.

Distinction of the tested plosive pairs within the APDT also strongly support the predictions of the NLM-e and the SLM. From the L1A process that occurred during infancy, all participants in the present study will have established discrete categories for each of the three unaspirated fortis plosives and voiced lenis plosives [p^h, t^h, k^h, b, d, g] that exist in phonemic contrast in English and that these will influence learners' ability to perceive similar speech sounds that share acoustic properties with these established categories. The NLM-e would further predict that a magnet will have formed as a prototypical exemplar of each of these phonemes, and as such any speech sound whose acoustic properties approximate elements of these established exemplars will be distorted and perceived as being minor allophonic variations of those phonemes.

Participants are generally consistently strong in distinguishing aspirated fortis plosives and voiced lenis plosives, as these speech sounds exist in phonemic contrast within the L1 and thus prototypical exemplars of these speech sounds were established through L1A in infancy and the acoustic cues that distinguish them were easily identified by the participants. A similarly consistently strong ability to distinguish aspirated and unaspirated fortis plosives was also seen, despite these speech sounds not existing in phonemic contrast in the L1, L2, nor L3 of the study's participants. Nonetheless, the predictions of the NLM-e are supported strongly by these data, as the acoustic cues of the VOT difference which distinguishes these speech sounds correspond very closely to VOT differences that distinguish the L1 fortis and lenis plosives. Thus, it can be asserted that perception of [p, t, k] may have been perceived as variations of previously established phonemic categories representing L1 voiced lenis plosives /b, d, g/ and thus are successfully distinguished from the aspirated fortis plosives. These data suggest that participants' ability to distinguish plosives is based on differences in voice onset time as the primary acoustic cue; it further suggests that articulatory force is not a key, relevant factor in the perception of phonemic differences. In English plosives are distinguished by aspiration whilst in Romance languages they are distinguished by voicing (Wrembel, 2015); this further suggests that CLI has occurred from the L1.

Participants perform similarly poorly in the tests to distinguish unaspirated fortis plosives from prevoiced lenis plosives, to distinguish unaspirated fortis plosives from voiced lenis plosives, and to distinguish voiced lenis plosives from prevoiced lenis plosives, suggesting that both the prevoiced lenis and the unaspirated fortis plosives were assimilated to the category established for L1 voiced lenis plosives. These results present evidence that although distinction between aspirated fortis plosives and both unaspirated fortis plosives and voiced lenis plosives is based on a difference in VOT, no category had been created for plosives with VOT lower than that which exists in L1 plosives. This strongly supports the magnet effects proposed by the NLM-e and is evidence against a simple, computational account in which relative VOT differences may be simply measured as a means of determining phonemic distinction. Furthermore, the lack of notable difference between the participants' ability to distinguish these test pairs whether they were of two lenis plosives, or of one fortis and one lenis plosive further supports the above assertion that articulatory force does not play a substantial role in phonemic distinction. Whilst the terms fortis and lenis are of use for delineating differences in plosives as a tool for linguistic description, it appears that their relevance in language acquisition for purposes of perception is highly limited and that the perceptual categories or prototypical exemplar magnets formed for plosives as part of the language acquisition are formed above all on the basis of the lag of voice onset time.

Of further note is the fact that participants appear to show a small tendency towards a greater rate of success in distinguishing difficult plosive test pairs in the cases of [t̪ –ˬd̪] and [d –ˬd̪] than their bilabial and velar counterparts. Despite the test pairs of bilabial [p –ˬb] and [b –ˬb], and velar [k –ˬg] and [g –ˬg] being similar in VOT differences and contrast or non-contrast of articulatory force, the additional difference in place of articulation for the pairs involving one alveolar and one dental plosive may have provided acoustic phonetic cues to some participants that were not available as tools for distinction in the bilabial and velar pairs. Although dental plosives do not exist in phonemic contrast with alveolar plosives in any of the participants' target languages, the participants' L1 does differentiate dental and alveolar fricatives and thus some elements of the native grammar utilised to distinguish such speech sounds may have been utilised in order to distinguish speech sounds of a different manner of articulation, but which varied in place of articulation in the same way. It may be argued that this effect is explained by models such as the Perceptual Assimilation Model (Best, 1995) however, as argued in Section 2.6, although the PAM may be used to retroactively to explain observations of language data, the model is not generally able to make predictions of behaviour. This caveat is not shared with the SLM (Flege, 1995) and the NLM-e (Kuhl et al., 2008), in which phonemic categories or prototypical exemplar phoneme magnets defining differences in consonants can be anticipated to include information on the frequency variances caused by changes in place of articulation.

In the distinction of vowel test pairs, participants showed reasonably consistent success in distinguishing several of the tested contrasts, with more consistent success seen in test pairs that more closely approximated speech sounds which exist in phonemic contrast within the L1. Consistent difficulty was seen in distinguishing the [ə – ɐ] pair, suggesting that the influence of L1 /ə/ distorted participants' ability to perceive /ɐ/ as a distinct, separate vowel as it was likened to the L1 schwa. This is further supported by the fact that a majority of participants are able to distinguish the [æ– ɐ] pair, which does not exist as a minimal pair in any of the participants' target languages, and the [a – ɐ] pair, which contrasts only in the L3. A similar rate of success was seen in distinguishing these two test pairs, which may have potentially implied the formation of a separate category for the L2 and L3 front vowel /a/ in contrast with an unrounded central vowel category, however the generally low success rate in distinguishing the [a – æ] test pair suggests that the apparent ability to distinguish /a/ from /ɐ/ is due not to the acquisition of a category for either of these NNL vowels, but rather an influence of the L1 /æ – ə/ contrast.

Back vowels [u, o, ɒ] are distinguished with moderate success, with participants generally showing a consistent ability to distinguish the L1 /u – ɒ/ contrast as expected. Although the tests pairs [o – u] and [o – ɒ] show similar degrees of successful distinction across participants, this average was seen to be influenced by a small number of participants for whom these pairs are not distinguished at all and, with these anomalies accounted for, a slightly greater degree of success is seen within the [o – ɒ] test pair than in that of the two higher vowels [o – u]. These results again adhere to the predictions postulated by both the SLM and the NLM-e; whilst British English does not incorporate the vowel /o/ as a monophthong in phonemic contrast with either of these vowels, it does occur to some degree in most varieties of modern British English within the diphthong /oʊ/, thus allowing for prediction of a greater, though imperfect, degree of success in distinction of this vowel from /u/ and /ɒ/ than may be expected through simple contrastive analysis of minimal pairs. The greater degree of success for distinction of [o – ɒ] than of [o – u] may be argued as additional support for the models of speech perception most discussed within this work, the SLM and the NLM-e. The presence of both /u/ and /ɔ/ in the L1 provide magnets within the perceptual vowel space; perceptual assimilation to either of these L1 phonemes would assist in distinction of /o/ from /ɒ/, however it would not facilitate distinction of the two higher rounded back vowels. Nonetheless, given that several participants demonstrate a moderate ability to consistently distinguish /o/ from /u/, the support for the SLM and NLM-e from these data is somewhat limited.

Participants' success rate in distinguishing the difficult test pairs, in both vowels and consonants, does not appear to change substantially over time, despite continued input and progress in other elements of their L2 and L3 interlanguage and some change seen in production. This strongly implies that NNL phonemic distinction acquisition processes may occur more slowly than might be suggested by NNL production, emphasising the importance of analysing both perception and production in studies of language acquisition. As revealed in Section 2.6, acquisition of L1 contrasts in infancy appear to take up to 12 months to develop in monolinguals, with periods of divergence from TL norms seen in bilingual infants to continue for lengthier periods before expected native-like proficiency is finalised (Kuhl et al., 2008; Bosch and Sebastián-Gallés, 2003; Sebastián-Gallés and Bosch, 2009).

In conclusion, the results of the APDT demonstrate strong support for the SLM (Flege, 1995) and the NLM-e (Kuhl et al., 2008). Where patterns in participant behaviour emerge, they are accounted for very effectively by the tenets of both of these models of perceptual phonetic processing, with logical predictions made by these models being realised within the test results.

5.2.3. APDT: Implications for L3 Acquisition Models

Several models of L3 acquisition were detailed in Section 2.3. This section applies the data of the APDT in order to test these models and determine which models' predictions are supported and which are not. Both the L2SF (Bardel and Falk, 2007; Falk and Bardel, 2011) and the TPM (Rothman, 2010, 2011, 2013, 2015) assert that CLI occurs exclusively from a single background language, whilst the CEM (Flynn et al., 2004) and the scalpel model (Slabakova, 2017) both assert that selective CLI is possible. The L2SF contends that CLI in L3A may only occur from an L2, whilst the three other models allow for CLI to occur from any background language, with factors for selection being based primarily on similarity of relevant structures. See Section 2.3 for a fuller account.

In the perception and distinction of the consonant test pairs, the results of the APDT may be argued to strongly dispute the predictions of models asserting exclusive CLI or L2-only CLI. In the case of vowels, a large degree of L1 influence was seen, most notably in the perception of front vowels and the rounded back vowel /o/. Influence of Romance L2 phonology was seemingly blocked, in contrast to the assertions of the L2 Status Factor Model and the TPM. As discussed above, the apparent assimilation of /a/ and /o/, phonemes present in the L2 and L3, with L1 /æ/ and /u, ɔ/ respectively demonstrates that L2 influence in perception has not been effective in facilitating distinction of sounds, being instead overridden by more deeply rooted L1 structures. In consonants, participants are seen to easily distinguish the L1 affricate-fricative contrast and aspirated fortis plosive against voiced lenis plosive contrasts despite these not existing in the L2 or L3. Of more interest, however, is that test pairs which do not exist as contrasts in any language, notably those of aspirated and unaspirated fortis plosives, are easily distinguished by participants, as well as the above noted variance in success seen where small differences in place of articulation occur (i.e. dental and alveolar plosives). These instances demonstrate strong support for the scalpel model in that specific, minute properties of speech sounds have been extracted and the acoustic phonetic cues that they provide have been applied in order to distinguish speech sounds which do not otherwise occur in phonemic contrast in any of the participants' known languages. In the case of the aspirated and unaspirated fortis plosives, positive CLI has occurred not from the phoneme as a unit, but from the VOT as a property of the phoneme. In the case of the alveolar and dental plosive pairs, the properties acquired to distinguish phonemic contrasts which exist with similar places of articulation but different manners of acquisition have been utilised to distinguish contrasts which could not have been acquired purely through isolated L1, L2, or L3 input.

In conclusion, although data is limited, the results of the Aural Perception and Distinction Task suggest that the ability to distinguish speech sounds does not occur with discrete perceptual spaces created for different languages, and thus CLI cannot occur on an exclusive basis from one linguistic perceptual space in creating another. This contrasts with the predictions of the TPM and the L2SF, however it supports the predictions of the scalpel model. The predictions of the CEM are not supported by these data, since a large degree of negative CLI occurs, leading to participants' inability to perceive distinctions that could have been acquired through L2 input, due to negative CLI from previously formed L1 phonemic categories or magnets.

5.2.4. APDT: Interactions with Questionnaire Results

In the Language Questionnaire, all participants agree that pronunciation is important in non-native language acquisition, though some variation occurs in participants' responses to the potential for applying L1 and L2 linguistic knowledge to the L3A process. However, all participants show substantial influence from the L1 in their perception of the speech sound test pairs. Results from the APDT do not reveal a consistent, substantial difference in the way in which the participants perform in their distinction of the speech sound test pairs in this study.

Since the Language Questionnaire relates primarily to learners' conscious understanding of L3 production, it may be argued to be somewhat unsurprising that the results from the questionnaire appear to have little bearing on participants' passive ability to perceive distinctions in speech sounds. Deeper research into the roles of active listening and specific language learning listening strategies may reveal some synergy between participant perceptions of language distance and their conscious desire to utilise CLI, and learners' ability to perceive non-native phonemic contrasts in spite of L1 influence. Such discussion and research lies beyond the scope of this work.

5.2.5. APDT: Addressing Hypotheses and Research Questions

The research questions and hypotheses proposed in the present work relate primarily to the production of L3 phonological structures. Cognate condition effects are not present in the APDT and therefore tests of distinction can be considered to have occurred in a neutral, or non-cognate condition and thus can be applied to hypotheses and research questions relating to CLI under conditions of no cognate effects. The APDT touches upon the predictions of Hypotheses 1 and 4, and on Research Questions 1 and 3.

A trend was seen towards strong influence of L1 phonemic categories on perception of L2 and L3 phonemes and contrasts in both vowel and consonant test pairs, suggesting that under conditions in which cognate effects do not apply the primary source of crosslinguistic influence for aural perception and distinction comes from the L1. This touches on Hypothesis 1, which is not supported by the data of the APDT since influence on perception of VOT was influenced by the phonemic categories established in the L1. By contrast, the APDT data may be argued to support Hypothesis 4 since all participants were able to consistently distinguish /ʃ/ and /ʧ/.

The APDT thus contributes to answering Research Question 1 in that it shows that influence in perception occurs seemingly exclusively from the L1. There is no suggestion amongst the participants of this study that the L2 has had any meaningful impact on aural perception, however the small sample and lack of contrasting or control group mean that these data do not definitively rule out the possibility of CLI occurring selectively in perception. Similarly, the APDT contributes to answering Research Question 3 in that influence from the L2 is not dominant. In the case of perception with participants of an intermediate level L2, the L1 remains the dominant source of CLI on all aural perception.

5.2.6. Conclusion

This section has analysed the data of the APDT and discussed how these relate to the theoretical framework established throughout Chapter 2, addressing models of perception of aural linguistic input and models of third language acquisition. It was demonstrated that the L1 maintains a prominent role in influencing perception throughout this study, opposing the assertion of Hypothesis 1, and supporting the assertion of Hypothesis 4. It was additionally demonstrated that these data may be argued to contradict the L2 Status Factor Model (Bardel and Falk, 2007; Falk and Bardel, 2011), the Typological Primacy Model (Rothman, 2010, 2011, 2013, 2015) and the Cumulative Enhancement Model (Flynn et al., 2004), but support the scalpel model (Slabakova, 2017). Furthermore, the role of articulatory force as a tool in phonemic distinction was disputed, with established L1 categories for voice onset time and place of articulation taking prominence as the method of distinguishing plosives.

5.3. Discussion: Task Interactions

This section analyses and discusses the results from the Oral Production Task presented in Sections 4.3 to 4.8 and relates these to the results of the APDT and the Language Questionnaire.

5.3.1. OPT: Interactions with Aural Perception and Distinction Task

This section analyses results of both the Aural Perception and Distinction Task and the Oral Production Task and examines where evidence of crosslinguistic influence in the APDT relates to that observed in the OPT. It demonstrates that whilst there are notable links between participants' ability to perceive and to produce speech sounds in contrast, perception and production in L3 phonology appear to develop at different rates and may be subject to different influences. In the distinction of plosives in the APDT, several tests were focussed on speech sound pairs involving lenis plosives which were not examined within the OPT, however fortis plosives was tested across both tasks. Vowel test pairs in the APDT show clear, simple relations to vowels tested in the OPT, with cross-language comparisons revealing noteworthy interactions between vowels.

In the APDT, participants are generally very successful in distinguishing aspirated from unaspirated fortis plosives, and voiced lenis plosives from aspirated fortis plosives, which share similar differences in VOT. In the OPT, it is seen that L1 (aspirated) and L2 (unaspirated) fortis plosives are consistently distinguished successfully, as in the APDT, however results also suggest that L3 VOT values are not target-like and are frequently seen to be compromise values between those of the L1 and L2, despite the fact that target L3 fortis plosives should exhibit the same short-lag VOT as their L2 counterparts. This strongly suggests that, despite having acquired the ability to perceive and distinguish L1 and L3 fortis plosives, the ability to produce L3 fortis plosives continues to be influenced by CLI from the L1. As argued in Section 5.2, it appears that the learners tested in this study are able to utilise the VOT values of their L1 lenis plosives in order to aid in perception of unaspirated fortis plosives, but are not as successful in applying this process to L3 production. This may suggest that although articulatory force has seemingly minimal impact in perception, its impact on the processes of production may be relevant as a factor in conditioning the source language for crosslinguistic influence.

Participants are very strong in distinguishing the [ɒ – u], [æ – ɐ] and [a – ɐ] test pairs in the APDT. In the OPT, these vowels are also successfully produced in contrast with consistency. In both cases, this result may have been influenced by CLI from L1 phonology, due to the existence of /ɒ, u, æ/ in phonemic contrast in British English, and to the influence of L1 /æ/ on L2 /a/ and L1 /ə/ on L3 /ɐ/. Conversely, participants perform very poorly in distinguishing the [ə – ɐ] test pair in the APDT, whilst in the OPT vowel quality frequently differs significantly between L3 /ə/ and /ɐ/. As was argued above, this ability to distinguish the two similar vowels in production may have been strongly influenced by the L2, further supported by the lack of significant differences between L3 /ə/ compared to L2 /e/ and L3 /ɐ/ compared to L2 /a/, as well as the consistent distinction between the L1 /ə/ and the two L3 central vowels. The apparently successful distinction of the L1 and L2 low front vowels [æ – a] within the OPT is also not reflected in the APDT results, with trends towards participants showing significantly different first formants for these two vowels. These results may suggest that the influence of phonological structures of background languages in L3A is stronger in production than it is in perception; this may be due to morpholexical and morphosyntactic processing effects in the oral production task, which were not present in the APDT on any level, leading to increased activation of L1 and L2 structures during L3 production, and thus increased influence of L1 and L2 phonology.

In the distinction of the [o, ɔ – u] and [o, ɔ – ɒ] back vowels, the results of the OPT appear to somewhat reflect those of the APDT. Participants are generally more successful in distinguishing the [o – u] vowel pair than [o – ɒ] in both perception and production, though neither of these contrasts are distinguished with the same degree of high success as the L1 [ɒ – u] contrast in either of the two tasks. In production, participants show generally poor ability to produce the L2 mid back vowels /o, ɔ/ distinctly from the L1 low back vowel /ɒ/, suggesting a strong influence of the L1 on the L2. This is highly likely to have caused further impact on results comparing these L2 mid back vowels, drawing the L2 vowel to a lower position than a target-like production would produce. This may be seen in the fact that participants are more successful in producing significantly different formant frequencies for the /o, ɔ – u/ vowel pair than the /o, ɔ – ɒ/. Negative CLI of L1 /ɒ/ on the L2 vowel, combined with the positive CLI of L1 /u/ on the L3 may have widened the settings for production of these two vowels allowing for a greater degree of success in their distinction. Nonetheless it is clear that the influence of L1 /ɒ/ on the production of L2 /o, ɔ/ is not absolute, given that the distinction of the L1 /ɒ – u/ contrast is more consistently successful than that of /o, ɔ – u/, and that participants do show some significant contrast in their production of the L2 /o, ɔ/ vowels against the L1 /ɒ/, despite not doing so consistently.

On some level, it is possible to argue that the observed contrasts in behaviour in perception and production lend credibility to the notion that storage and retrieval of linguistic information in NNL production may occur in a more sequential, language-by-language, manner, leading to specific transfer of singular phonetic structures attached to morpholexical structures, whilst for perception all NL and NNL speech sounds are stored in a single perceptual space and consistently influence one another in parallel, with strongly established phonemic categories or magnets warping perception of similar phones (Kuhl et al., 2008). However, such a notion is countered by data from this study which evidence an impact of cognate condition on production. This suggests that lexical processing is conducted by searching through all relevant lexemes in parallel, leading to influence of L1 and L2 phonology in L3 production due to the simultaneous activation and retrieval of multiple relevant lexemes. This latter reasoning is further supported by the presence of compromise VOT values in L3 fortis plosives, which suggest simultaneous activation of L1 and L2 properties in L3 production leading to combined crosslinguistic influence.

This section has evaluated the results of the Oral Production Task and related them to the results of the Aural Perception and Distinction Task. In the APDT, a strong influence of L1 phonology occurs, with participants performing well in distinguishing speech sounds in which application of L1 phonology provided positive CLI. In the OPTs participants also successfully distinguish these contrasts however in L3 production a combined influence of L1 and L2 occurs more frequently, most notably in fortis plosives. Moderate success is seen in both the APDT and the OPT in contrasts involving L2 phones, whilst the contrast of L3 central vowels poses great difficulty in the APDT, but is frequently produced distinctly in the OPT. It was argued that although OPT data suggest that L3 learners are more capable of distinguishing expected difficult contrasts in production than in perception, this appears to have been due to negative CLI from both L1 and L2 causing the L3 production to diverge from target, and not due to successful acquisition of these L3 phonemes.

5.3.2. OPT: Interactions with Questionnaire Results

This section analyses and discusses the results of the Oral Production Task and evaluate their relation to the results of the Language Questionnaire. As was detailed in Section 4.1, strong trends are seen across participants in their responses to section 2 and section 3 of the Language Questionnaire, with all participants stating that they perceive the L1 as phonologically distant from the L3 and none rating the L1 as lexically similar to the L3. Ratings of similarity between L2 and L3 are slightly less consistent than those between L1 and L3, however all participants consistently consider the L3 as more similar to the L2 than to the L1. Only participant H states that they perceive their L2 (French) as distant from the L3 in terms of morphosyntax; this is the only example across all twelve participants and all three aspects of language (lexis, phonology, syntax) of the L1 being rated as more similar than the L2 to the L3. Despite this individual variation seen in the Language Questionnaire, participant H does not demonstrate a notably greater degree of L1 influence in the OPT than other participants. Nonetheless this participant does rate the L2 as lexically and phonologically more similar than the L1 to the L3 as do all other participants and therefore may be expected to exhibit similar trends of CLI in L3 production.

In section 3 of the Language Questionnaire, very little variation occurs across participants in their responses to the statements relating to the importance of phonology in NNLA and the desire to suppress or utilise CLI from background languages in L3 Portuguese acquisition. Participants generally agree that they seek to suppress L1 and L2 phonology in L3 production and that the L2 is more useful than the L1 in L3 acquisition. The strong trends seen across participants towards viewing the L2 as a more viable source of positive CLI than the L1 appear to be reflected within the OPT data, in which CLI from the L2 is more prominent than from the L1 in many cases, such as in the influence of L2 /a/ and /e/ in the production of L3 /ɐ/and /ə/ and in the ability of participants to produce significantly shorter voice onset time in L3 fortis plosives than in their L1 counterparts. Nonetheless, L1 influence is also seen in several areas, despite participants rating the L1 as distant from the L3 and asserting that they seek to suppress L1 phonology in L3 Portuguese production. This leads to positive CLI in the case of participants of the L2 Spanish groups' use of the L1 fricative /ʃ/ in L3 Portuguese and, to some extent, in participants' ability to distinguish the rounded back vowels, but negative CLI is seen in the evidence of the compromise values seen for VOT in L3 fortis plosives and in the influence of L1 /ɒ/ on L2 /o, ɔ/.

This section has related the results of the Language Questionnaire to the results of the Oral Production Task. Whilst individual variation across participants seen in the Language Questionnaire is not generally reflected in the results of the OPT, the small sample size of this study may have limited the opportunity for such occurrences. Nonetheless, it remains my argument that in order to assert that learners' perceptions of crosslinguistic similarity drive processes of crosslinguistic influence in L3A, it is necessary to measure these perceptions. Subconscious perceptions of similarity by their nature are not directly measurable, however future studies may measure conscious perceptions or employ other means of accessing learner perceptions of language distance. The results of this study show a relatively strong correlation between participants perceiving the L2 as structurally similar to the L3 and a potential source of positive CLI, and their employing L2 phonological structures in L3 production, although it does not appear to be the case that participants who rate the L1 or L2 as more or less similar to the L3 or useful in L3A are influenced by their background languages to a greater or lesser degree. Furthermore, it was seen that although L2 phonology is not frequently rated as highly similar to L3 phonology, L2 morpholexical and syntactic structures are generally considered similar to those of the L3. This correlates with a slightly stronger influence of L2 phonology observed within the L2 cognate and the L1–L2 cognate conditions than that seen in the L1 cognate condition and in the full, undivided data set. Nonetheless, these links remain somewhat limited in scope and further research with broader language pairings is necessary in order to further evaluate the impact of learner perceptions of language distance on crosslinguistic influence in L3 production.

5.4. Discussion: Addressing Research Questions

This study asks four research questions, which are reiterated here:

1. Can phonological CLI into L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?
3. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects are neutral?
4. Will L2 Spanish/French be the dominant source of phonological CLI on L3 Portuguese when cognate effects exist with both L1 and L2?

In answer to Research Question 1, the data of this study suggest that yes, phonological CLI can occur selectively from the L1 and L2 into the L3. This was seen heavily in the OPT in the presence of combined CLI on VOT of L3 fortis plosives, further reinforced by the shifting CLI patterns when L3 production was analysed under differing cognate conditions. Furthermore, the differences in influence on L3 central vowels /ɐ/ and /ə/ in the APDT (L1 CLI) compared to that seen in the OPT (L2 CLI) suggest that CLI on L3 Portuguese can occur from either L1 English or L2 French/Spanish.

In answer to Research Question 2, the data suggest that there may be increased L2 influence under the L2 cognate condition, however the presence of increased L1 influence under the L1 cognate condition is less clear; the falsification of Hypotheses 3 and 7 demonstrate that L1 influence is not obviously increased under the L1 cognate condition. In the production of fortis plosives, there was a suggestion that L2 influence may be increased, at least relative to the degree of L1 influence, under the L2 cognate condition.

In answer to Research Question 3, it appears that in the case of L3 fortis plosive VOT production, the L2 may be the dominant source of CLI when cognate effects are neutral, i.e. under the non-cognate condition. The partial support for Hypothesis 2 supports this position, where n-VOT of L3 fortis plosives was seen to be L2-like under the non-cognate condition. However the support for Hypothesis 4, in which a lack of L2 Spanish CLI was seen on the production of the pre-palatal fricative under this cognate condition, does not support the notion that L2 CLI is definitely increased when cognate effects are neutral. The data of this study suggest that whilst some phonological features such as VOT length may be subject to increased CLI from the structurally closest language in this context, other, more substantial features, such as the ability to produce an L3 speech sound which has been acquired as an L1 phoneme, are more resistant to negative CLI.

In answer to Research Question 4, it appears that L2 French/Spanish does not become the dominant source of CLI on L3 Portuguese when cognate effects exist with both L1 and L2, i.e. under the L1-L2 cognate condition. Testing of Hypothesis 2 suggested that L2 influence in the production of VOT in L3 fortis plosives was actually reduced under the L1-L2 cognate condition, with L3 n-VOT length being a compromise value between the L1 and L2. Some suggestions of increased negative CLI from the L2 was seen in the production of the L3 pre-palatal fricative by some participants under the L1-L2 cognate condition, however these results do not represent enough of a clear, strong pattern to definitively consider this cognate condition to be a cause of substantially increased L2 CLI on the L3.

5.5. Discussion: Conclusion

This chapter has evaluated and discussed the results of the Language Questionnaire, Aural Perception and Distinction Task, and Oral Production Task. Throughout Chapters 4 and 5, I have considered relations between the three task types employed in this study, and analysed the implications of the results of these tasks for phonological perception models and for models of third language acquisition reviewed in Chapter 2. Several arguments were also proposed linking the data of this study to the wider literature reviewed above, and this study's hypotheses were tested. It was argued that whilst Hypotheses 4 and 5 are supported by the data, Hypotheses 1, 3, 6, 7, and 8 are not. Hypothesis 2 is partially supported by the data.

Individual variation within the OPT and the APDT is substantial, but within the Language Questionnaire variation across participants in relatively minimal. Participants consistently rate their L2 as lexically similar to the L3 which is reflected to an extent in the L3 production data, most notably in the considerable L2 influence seen in fortis plosives. Comparison of the APDT and the OPT reveal some synergy across participants' behaviour across the two tasks. Several difficulties in distinction arising in the APDT are reflected in the OPT, such as L1 /ɒ/ against L2 /o/. Many cases are also seen of an apparent ability to distinguish vowels in production which participants consistently struggled to distinguish in perception, such as the L3 /ɐ - ə/ contrast and L1 /æ/ vs L2 /a/. In the case of the difficult L3 central vowel contrast, it was argued that the OPT data show that this distinction due not to successful acquisition of the L3 contrast, but to negative CLI from the L2. The lack of successful distinction in the APDT is attributed to CLI from the L1.

It was seen that whilst some elements of the Cumulative Enhancement Model, the L2 Status Factor model, and the Typological Primacy Model are supported by the results of the OPT, the presence of negative CLI and of selective CLI strongly contradict the predictions of these models. Although the scalpel model does not fully and explicitly account for the combined CLI seen in L3 fortis plosives, the data of the OPT most strongly support this model, with CLI seemingly able to occur on a property-by-property basis leading to both positive and negative crosslinguistic influence.

The data from the Language Questionnaire suggest that participants' perceptions of language proximity are not monolateral and thus that perceptions of language similarity and distance are more complex than assumed by models which predict exclusive transfer from only one background language such as the TPM (Rothman, 2010, 2011, 2013, 2015) and the L2SF (Bardel and Falk, 2007; Falk and Bardel 2011). Furthermore, the data from the APDT and the OPT suggest that participants' perception and production of L3 phonological structures are subject to crosslinguistic influence from both L1 and L2. Tests of perception strongly support the existence of a single, unified phonological perceptual space and thus support the predictions of the Native Language Magnet - expanded model (Kuhl et al., 2008) and the Speech Learning Model (Flege, 1995). Tests of L3 production strongly suggest the potential for CLI to be sourced from both background languages, either selectively from the L1 or L2, or as a combined CLI effect. These data support only the predictions of the scalpel model (Slabakova, 2017).

It was additionally argued that whilst the scalpel model is the only current L3 model whose predictions approach an adequate explanation of the results of the present study it does not fully account for the complex nature of L3 phonology, most notably in the presence of combined CLI. I thus suggest that an extension of models of phonological development, distinction and perception into L3 production may provide a more concrete basis on which to evaluate L3 phonology in combination with the predictions for the selection of CLI source of the scalpel model. I additionally argue that the data support interaction between morpholexical and phonological processing in L3 production, highlighting the interrelated nature of the storage and processing of lexical and phonological information. This supports some elements of an approach to language processing based in lexical phonology (Kiparsky, 1982).

The following chapter reviews and concludes this work, addressing limitations of the study and highlighting areas in which further research in the field of L3 phonology and its interaction with lexical processing is required.

Chapter 6 **Conclusion**

This chapter presents final conclusions to the present work. It briefly summarises and reiterates the rationale and the purpose behind study and the core of the theoretical framework within which the study is grounded, as well as the key arguments presented throughout earlier chapters of this work. It further evaluates the contribution that this work makes to the field of third language acquisition, identifies and recognises the limitations of this work, and proposes directions for future studies in the field.

6.1. Theoretical Framework

The understanding of crosslinguistic influence in NNLA forms a core of this work's theoretical framework. It was revealed that the nature of CLI has frequently been defined differently in different studies, and a need to clearly define CLI in the context of any study which examines this process was identified (as argued by Selinker, 1992). Nonetheless, Jarvis (2000) and Jarvis and Pavlenko (2008) argue that a consistent, field-wide approach to the study of CLI can be achieved by ensuring that studies are able to adequately account for intragroup similarity, intergroup differences, and crosslinguistic performance similarities. Building on several works (c.f. Odlin, 1989; Selinker, 1992; Jarvis, 2000; Jarvis and Pavlenko, 2008), I proposed a definition of CLI to be used for the purposes of this study as: "The use of previously acquired linguistic knowledge in the perception or production of another language, driven by learners' hypotheses on crosslinguistic similarities and differences". This definition, in line with Jarvis' (2000) and Jarvis and Pavlenko's (2008) arguments on consistency in CLI research, was used as the basis for evaluating the presence of CLI in the data of this study.

This study examined the potential for localised lexical similarity to condition phonological crosslinguistic influence in third language acquisition and production, drawing upon the fields of first, second, and third language acquisition, as well as structure and access of the multilingual lexicon. It was argued that in L1A, perception precedes production by necessity, whilst in NNLA production can occur prior to acquiring perception and can appear target-like, but true acquisition requires acquisition of perception. A prominent model of L1 phonological development, the Native Language Magnet-expanded model (Kuhl et al., 2008), was detailed in which it is postulated that L1 input in infancy leads to the formation of prototypical exemplars of L1 phones, which form 'magnets' within the mental phonemic perceptual space. These magnets then warp the perception of sounds which are similar in acoustic quality to the prototypes, leading speech sounds to be assimilated to the prototype L1 sound and be perceived as the similar L1 phones. This consequently reduces the ability to perceive and distinguish NNL speech sounds which are similar to, though not the same, as L1 phonemes. Previous work in the field of L1 phonological development also shows that although the ability to perceive and distinguish L1 phonemes in a native-like way appears to be complete by the age of 12 months, the acquisition of vowels appears to occur prior to the acquisition of consonants (Kuhl et al., 2008) and simultaneous bilinguals demonstrate a U-shaped developmental path (Bosch and Sebastián-Gallés, 2003; Sebastián-Gallés and Bosch, 2009), with a deviation from target norms seen as compared to monolinguals at 8 months, before again converging on target by 12 months.

In second language acquisition processes, it was seen that CLI of previously acquired linguistic properties (i.e. the grammar of the L1) consistently plays a substantial role in the formation of the L2 initial state, with the prominent Full Transfer/Full Access model (Schwartz and Sprouse, 1996) predicting that the initial state of the L2 is formed of the L1 transferred in its entirety, with subsequent development of the L2 interlanguage occurring according to L2 input and within the confines of UG (see Figure 3). Key models of L2 phonology were presented and it was argued that the Speech Learning Model (Flege, 1995), whose predictions are very similar to those of the NLM-e (Kuhl et al., 2008), most effectively makes clear, testable, and empirically supported predictions for the impact of L1 CLI in L2 phonology. It was argued that although in L2 it is accepted that the acquisition of perception precedes that of production (Aoyama et al., 2004), it is possible to produce seemingly target-like structures without having acquired the ability to perceive the contrast (Flege and Eefting, 1987; Fowler et al., 2008). It was additionally seen that L2 consonants appear to be more susceptible to L1 influence than vowels (Chan 2012) and that increased lexical processing requirements lead to increased L1 influence and consequently to greater difficulty in perceiving NNL contrasts (Díaz et al., 2012).

Work in the relatively young field of third language acquisition has demonstrated that the processes by which additional non-native languages are acquired beyond the L2 are not identical to those of the first non-native language. This is due primarily to the potential for the L3 initial state to be formed from either the L1, the L2, or both, with subsequent progression of the L3 interlanguage then proceeding according to input and within the confines of Universal Grammar (see Figures 4 and 5). A multitude of additional, extralinguistic factors in the L3A process which potentially differentiate it from L2A have been proposed (Hufeisen, 2005; Herdina and Jessner, 2000, 2002), however as argued by Jennifer Cabrelli Amaro (2012), these have not been empirically supported in the L3 literature. Four influential models of third language acquisition were presented: the CEM (Flynn et al., 2004), the L2 Status Factor Model (Bardel and Falk, 2007; Falk and Bardel 2011), the TPM (Rothman, 2010, 2011, 2013, 2015) and the scalpel model (Slabakova, 2017). It was observed that these models differ primarily in their predictions of which background language(s) may become the source of CLI on the L3 and whether CLI may occur exclusively from a single language or selectively from multiple languages; see Table 2.3.1 for a concise comparison of each model's predictions, strengths and caveats. Whilst these models were developed and tested primarily through work on L3 lexis and morphosyntax, it was argued to be relevant to apply them equally to L3 phonology, a field in which previous studies are limited in number and, it was argued, methods employed have often lacked consistency and depth. Concerns relating to methodologies and assumptions made in analysis of results were discussed in greater detail in Section 2.8. Furthermore, it was seen that previous studies in L3 phonology have principally addressed which background language can become the source of CLI and have frequently assumed that CLI will occur exclusively from a single language. Additionally, they have not addressed what conditions CLI source language selection beyond notions of L1 or L2 status, and observations of typological proximity and structural similarity on the scale of entire linguistic systems.

Consequently, a need for a different approach to the study of L3 phonology was identified, in agreement with the assertion of Wrembel (2012). The present study proposed the investigation of the impact of lexical processing on L3 and a fine-detailed analysis of phonological properties of L3 production in order to additionally address the potential for CLI relating to phonological properties to occur on a selective, property-by-property basis. Given the observed impact of lexical processing on NNL phonological processing (Díaz, 2012), the nature of the multilingual lexicon as a single, unified, space (Dijkstra, 2005; Kroll, Bob and Wodniecka 2006), and evidence that cognates cause increased cross-language coactivation (Linck, Kroll and Sunderman, 2009; Kroll, Gullifer and Rossi, 2013), it was asserted that cognates across the L1, L2, and L3 may lead to increased influence of phonological properties of L1 and L2 in L3 production due to coactivation of linguistic properties of background languages. The process of lexical decomposition, by which lexemes are stored within the mental lexicon as root morphemes with affixes stored separately proven by tests of lexical priming (de Diego Balaguer et al., 2005; Silva and Clahsen, 2008; Neubauer and Clahsen, 2009; Bowden et al., 2010; Feldman et al., 2010; Gor and Jackson, 2013) was utilised in the identification of cross-language cognates in this study. Although there are suggestions that L2 lexical units are not decomposed at the initial state as efficiently as the L1 (Ellis, 2001; Silva and Clahsen, 2008; Neubauer and Clahsen, 2009), it was argued that lexical decomposition can occur in later stages of development (Diependaele et al., 2011; Bowden et al., 2010; Feldman et al., 2010) though with some limitations (see Gor and Jackson, 2013; Bowden et al., 2010;

Basnight-Brown, 2007). In this study, participants' L2 was in an intermediate stage of IL development, thus well beyond the initial state, allowing for lexical decomposition to be performed in both the L1 and the L2.

6.2. Methodological Review

This study tested the role of cross-language cognates in conditioning phonological CLI in L3 production. Twelve participants were tested through three data collection procedures in three time phases over the course of an 8 month period: a Language Questionnaire was administered in Phase 1 only, and Aural Perception and Distinction Tasks and Oral Production Tasks were conducted in Phases 1, 2 and 3. The Language Questionnaire was employed in order to address the concern that whilst the importance of learner perceptions in conditioning selection of source language for crosslinguistic influence is frequently asserted, these perceptions are always assumed and never measured.

It was argued that studies of phonological acquisition should measure both perception and production where possible in order to assess and differentiate true acquisition of non-native phonological structures from superficially target-like structures in production and to further, better show effects of CLI and of combined or compound CLI in L3 production. Thus, the APDT was considered a necessary element of this study in order to assess language acquisition processes because perception and production in phonology are evidently interlinked as, logically, are the CLI processes which underlie them in NNLA.

The Oral production tasks tested participants' L1, L2, and L3 production. It was argued that, in agreement with Rothman (2015), testing of all background languages in the study of L3A is necessary, as native-like norms cannot be assumed to be unequivocally applicable to all NNL learners (see especially Fowler et al., 2008). In the case of phonology, this was considered especially pertinent due to the degree of individual variation that naturally occurs between speakers.

6.3. Research Questions

This study posed four research questions:

1. Can phonological CLI into L3 Portuguese occur selectively from both L1 English and L2 Spanish/French?
2. Do cognates cause increased phonological CLI from the same language as the source of the cognate?

3. Will L2 Spanish/French be the dominant source of phonological transfer into L3 Portuguese when cognate effects are neutral?
4. Will L2 Spanish/French be the dominant source of phonological transfer into L3 Portuguese when cognate effects exist with both L1 and L2?

These questions were addressed through the testing of the study's hypotheses:

1. CLI from the L2 will be dominant; overall, the L3 VOT will be L2-like.
2. CLI will cause VOT in the L3 to be L2-like under the non-cognate condition, the L2 cognate condition, and the L1-L2 cognate condition
3. CLI will cause VOT in the L3 to be L1-like under the L1 cognate condition
4. Frication will be transferred from L1 for those with L2 Spanish
5. The first formant of the L3 vowel /u/ will consistently be produced lower than that of L1 /ɒ/ and L2 /o/.
6. L3 /ɐ/ and schwa will not be consistently distinguished in production.
7. Under the L1 cognate condition, the L3 vowel /ɐ/ will not be distinguished from L1 schwa.
8. Under the L2 cognate condition, L3 vowels /ɐ/ and /ə/ will not be distinguished from L2 /a/ and /e/ respectively.

Analysis of the data showed that Hypotheses 4 and 5 were supported, whilst Hypothesis 2 was partially supported. Hypotheses 1, 3, 6, 7, and 8 were rejected. It was seen that, in answer to Research Question 1, either background language may become the source of crosslinguistic influence in production, though in perception the more deeply rooted L1 phonological settings appear to have greater influence. The impact of morpholexical processing, as addressed in Research Questions 2, 3, and 4, was seen to be subtle and highly complex. Where no cognate condition effects were present, and where L3 words were cognate with the L2, the data show that L3 plosives were L2-like. Where L3 words were cognate with the L1 and where they were cognate with both L1 and L2, L3 plosives were produced with compromise VOT values. It was argued that this suggests that L1 influence is greater under conditions where the L1 is more highly activated due to lexical retrieval processes. In answer to Research Question 2, it is argued that cognates may cause increased phonological CLI from the same source language as the source of the cognate. In answer to Research Question 3 it appears that L2 Spanish and French do become the dominant source of phonological CLI in L3 Portuguese production where lexical items produced are cognates with the L2. Finally, in answer to Research Question 4, the L2 was not the dominant source of phonological CLI in L3 Portuguese production where lexical items produced are cognates with both the L1 and L2, since increased L1 activation led to increased L1 influence.

6.4. Arguments Presented

Throughout the discussion of the literature of the fields on L1 phonology, L2 acquisition, L3 acquisition and lexical processing in Chapter 2, and the discussion of the findings of this study in Chapter 5, this work presented several arguments relating to methodological processes in third language acquisition. It examined the nature of crosslinguistic influence in the acquisition of L3 phonology and its interaction with requirements for morpholexical processing.

As mentioned above it was revealed that the importance of learner perceptions in conditioning CLI on the L3 is frequently asserted and forms a core thesis of several prominent models of L3 acquisition. However these perceptions are never measured, being simply assumed to be in accordance with structural similarity that can be objectively observed through contrastive analysis. It was therefore asserted that in order to consider perceptions as a factor in L3A, it is necessary to attempt to measure them in some capacity. Data collected from the Language Questionnaire utilised in this study demonstrated that learner perceptions of language distance are formed on a fine-detailed scale. It was thence argued that models of L3A which presuppose CLI to occur on the scale of entire language systems on the basis of perceptions of structural similarity do not adequately account for the complexity of learners' understanding of language structure. Furthermore, it was argued that terms such as 'phonology' may be too broad to adequately measure an aspect of linguistic structure, as participants may perceive some elements as similar and some as dissimilar. It was argued that segmental and suprasegmental features of languages can be individually perceived as proximate or distant from one another.

This work argues that acquisition of phonological patterns in language learning cannot easily be understood through the same lens as other elements of language. By their nature, phonological patterns in language do not exist in units of discrete, mutually exclusive possibilities and the range of potential phonemic structures exist on a continuum of quasi-infinite speech sounds whose extremities are constrained only by the physical limitations of the human vocal tract. A conceptualisation of phonology was thus proposed in which speech sounds which constitute phonemes within a language are defined as discrete points along a continuum of possibility and that the language acquisition process converts the quasi-infinite spectrum of possibilities into discrete units of meaning. By categorising sections of the continuum into ‘phonemes’ we are able to perceive meaning in sound, but, as demonstrated by studies in L1 phonological development in infants, as a consequence of this categorisation process the innate ability to perceive all points on the spectrum as distinct is lost.

Analysis of the results of the tasks performed by the participants of this study were considered to strongly suggest that the single, unified phonological perceptual space proposed by the SLM (Flege, 1995) applies equally to the process of L3A as it does to that of L2A. Similarly, the notion of a single, unified multilingual lexicon with all languages searched in parallel during lexical retrieval was argued to be supported by the cognate effects and the combined CLI effects observed in the present study. It was thus considered that although the potential source material for CLI differs in L2A and L3A, the nature of storage and retrieval of linguistic structures within memory are consistent in all language processing actions. This disputes assumptions of enhanced cognitive links between non-native languages in separation to the native language asserted in earlier works (see, for example, Falk and Bardel, 2011; de Angelis 2007).

Through discussion of the results of the APDT and the OPT, several arguments arose on the nature of L3 linguistic processing and of CLI in the L3A process. In the comparison of APDT and OPT results, it was argued that the articulatory force in plosives was not a key factor in the ability to perceive speech sounds as distinct. Acoustic cues from voice onset time and place and manner of articulation were more relevant in perception, but in production the distinction between fortis and lenis plosives played a role in conditioning the selection of source language for CLI on the phonology of the L3. Differences observed in participant behaviours between the APDT and the OPT were additionally argued to emphasise the importance of analysing both perception and production in studies of language acquisition, since NNL phonemic distinction acquisition processes may occur more slowly than is suggested by observation of NNL production.

Finally, it was demonstrated that the results of the study generally support that CLI can come from either background language or from both simultaneously. It was argued on the basis of the results of this study that CLI in L3A is selective, and that CLI effects can be positive or negative. These results were seen in both the APDT and the OPT and thus support the scalpel model (Slabakova, 2017), whilst contradicting the CEM (Flynn et al., 2004), the L2SF (Bardel and Falk, 2007; Falk and Bardel, 2011) and the TPM (Rothman, 2010, 2011, 2013, 2015). Nonetheless it was also argued that, in partial support of the predictions of the TPM, the OPT data suggest that lexical similarity may be a driving factor behind phonological CLI, though CLI does not occur exclusively from a single background language. Furthermore, although it was argued that the results of this study support the predictions of the scalpel model, it was also observed that this model is not able to fully account for the compromise VOT values seen in L3 fortis plosives. An extension of the NLM-e (Kuhl et al., 2008) into consequences for NNL production was thus proposed in which influence of both L1 and L2 settings on the newly forming L3 setting will cause it to initially form between the two and eventually merge with the appropriate setting with more L3 input. It was argued that this extension of the NLM-e in combination with the scalpel model's predictions of transfer source selection may be utilised to more fully account for the nature of phonological CLI processes in third language acquisition, such as the compromise VOT values frequently seen in plosive production.

6.5. Limitations

It is recognised that the findings of this study are subject to limitations. The small sample size of participants in the study presents a limit to the generalisability of the findings of this study to a broader population and led to substantial effects of individual variation. However, the use of VOT normalisation and Gerstman vowel formant normalisation, as well as generalised linear mixed models allowed for this to be accounted for in statistical analysis. Nonetheless, a larger sample size would have further improved the robustness of this study's results. The language grouping of the participants in the study involved an L3 which was typologically and structurally similar to the L2, with both L2 and L3 relatively distant from the L1. However, simple identification of the possibility for CLI to be sourced from L1 or L2 was not the focus of this work; previous studies in the field of L3A have demonstrated that either L1 or L2 may be selected as the source of CLI on the L3 (see Odlin and Jarvis, 2004; Ringbom, 2005; Llama et al., 2010; Rothman, 2011; Slabakova and García Mayo, 2014). The limitation, therefore, lies in determining whether the observations made regarding L3 production are truly due to CLI, or due to other factors. As discussed in detail in Section 2.1, similarity across participants within groups and distinction across participants between groups, as well as similarities in performance across L1, L2, and L3 are important in order to identify the presence of CLI L3 research. By analysing and directly comparing production data from L1, L2, and L3 this study adequately satisfies Jarvis' (2000) condition of 'crosslinguistic performance congruency'. However the lack of a mirror group (i.e. L1 Spanish/French – L2 English – L3 Portuguese) and the fact that this study's participants have not been compared to external, monolingual baselines may be considered somewhat problematic for addressing concerns of intergroup heterogeneity. Nonetheless, I argue that the consistency with which CLI is seen in other studies of L3A involving pairings of Romance languages with English demonstrate that similar groups show CLI to occur from either background language (Pyun, 2005; Wrembel, 2010, 2012) and produce similar patterns of compromise VOT value (Llama et al., 2010). Thus, despite the limitations of referents internal to the study, I argue that evidence of selective phonological CLI from both L1 and L2 into the L3 are observed in this study. It is recognised that the Language Questionnaire used in this study collected relatively basic data on participants' language background and use. It was decided not to use previously created language background data collection tools such as the Language History Questionnaire (LHQ: Li, Speanski and Zhao, 2006) because, whilst such a tool would provide a more detailed version of Section 1 of the Language Questionnaire used in this study, it does not address the primary purpose of assessing perceptions of language distance, for which the Language Questionnaire was designed. The Language History Questionnaire was updated (Li, Zhang, Tsai and Puls, 2014) however the original version of the LHQ (Li et al., 2006) that was available at the time of this study's data collection was a large, static questionnaire (Li et al., 2014). This study found issues of participant attrition to be prominent, therefore a highly simplified and streamlined approach to gathering participant background data was deemed appropriate, in order to give primary focus to Section 2 and 3 of the Language Questionnaire.

The importance of Section 2 of the Language Questionnaire in this study has been argued above, however it is recognised here that the data gathered through this process is capable only of measuring learners' conscious perceptions of language distance and thus does not directly measure the unconscious perceptions of similarity which are asserted to influence the selection of source language for CLI in L3A. It is therefore necessary to note that although the data of the Language Questionnaire was revealing of the nature of learners' conscious perceptions of language distance, their application in predicting source language for crosslinguistic influence is limited, hence these data were used only in combination with observed effects in perception and production within this work.

6.6. Contribution to the Field

Through analysis of its data and the arguments that it presents, it is considered that this work contributes to knowledge in the field of phonology in third language acquisition in providing additional evidence on the nature of CLI in L3 acquisition and production. The work suggests that lexical similarity may be a driving force behind phonological CLI on a property-by-property level. It further suggests that morpholexical similarity may be a driving factor behind the selection of source language for phonological CLI on a highly localised scale, with cognates being a potential site of heightened crosslinguistic similarity and influencing L3 phonological processing. In addition, this work demonstrates new approaches to methods in L3 phonology research, in particular challenging previous practices of a priori assumptions regarding L3 learners' perceptions of language distance. It shows that learner perceptions of crosslinguistic similarity are not conducive to some L3A models' of language distance perception and CLI occurring on the large scale of full linguistic systems. It also reveals that phonological CLI in third language production is more complex than can be accounted for with current L3 models built through study of L3 morphology and syntax. This study therefore contributes to the future of the field of L3 phonology by proposing the beginnings of a new approach to modelling L3 phonology. It proposes that modelling of L3 phonology be undertaken through the combination of empirically supported models of phonological development and phonemic perception with models of L3 CLI which allow for the recognised possibility for CLI to occur selectively from any background language.

6.7. Directions for Future Study

This work presents a study of the role of cross-language cognates in conditioning CLI on L3 Portuguese. Based on the evidence and the arguments presented here, this chapter concludes with suggestions of directions for future research in order to expand upon the findings of this study and to further deepen and enrich knowledge and understanding in the field of third language phonology.

This study suggests that the presence of localised, heightened lexical similarity as induced by cross-language cognates may have an impact on the phonological CLI processes in L3 production. However, as identified in Section 6.5, the broader implications of these findings are limited by the sample size and language grouping of the participants of the study. It is therefore proposed that future research be conducted with larger scale studies into the impact of cross-language coactivation in lexical processing on phonology in L3 production as well as further, deeper examination of the interaction effects of changing morpholexical and morphosyntactic processing requirements and their impact on L3 phonological planning at varying stages of L3 IL development. Such studies should further aim to include broader ranges of language groupings in order to better distinguish background language influence from general L3 development and to examine CLI effects across typologically and structurally more distant languages.

Finally, this work proposes that future research on third language acquisition and third language phonology undertake changes in methodological considerations in order to address issues of a priori assumptions made regarding learner behaviour throughout earlier works in the field. The prevalent assumption that L3 learners will perceive similarity and distance across their known languages in accordance with the objectively observable structural and typological similarity revealed through descriptive linguistics and contrastive analysis fails to allow for adequate testing of models of L3A which assert the importance of such perceptions in conditioning the selection of source language for CLI on the L3 grammar. The Language Questionnaire employed in the present study represents a simple means of acquiring data regarding conscious perceptions of language distance and similar methods may be utilised in future work to garner some insight into leaner perceptions. In order to attempt to access unconscious perceptions of language distance, future research may consider employing such tests as target language identification tasks under effects of background language priming or in artificially created nonsense texts. Although such tasks are labour intensive, it remains my assertion that it is necessary to attempt to measure learner perceptions of language distance in order to claim that they play a role in conditioning CLI in the L3 acquisition process. In previous studies of L3 phonology, methodological practices have not only failed to account adequately for learner perceptions as described above, but have also frequently been incapable of adequately assessing both the nature of CLI in L3A as exclusive or selective and the impact on data of superficially target-like structures which occur in production but are not representative of true acquisition of non-native phonemic categorisation. It is therefore proposed that future studies of L3 phonology include analysis of both perception and production in order to build a more rounded picture of the language acquisition processes undergone in L3 learners. I additionally argue that future studies should work within methodological frameworks which examine production on a more fine-detailed level in order to better account for the observed possibility for selective CLI, as well as combined and compound CLI.

It is here concluded that these proposed directions for future research are intended to continue to move the field of L3 phonology forward and to address newer, more salient questions regarding the nature of L3 phonological development, and the interaction effects of language processing in the multilingual brain.

Appendix A Participant Details

Participant Language levels					
Participant	**English**	**Spanish**	**French**	**Italian**	**German**
A	Native	Intermediate	Lower Intermediate	Beginner	N/A
B	Native	N/A	Intermediate	N/A	N/A
C	Native	Intermediate	Beginner	N/A	N/A
D	Native	Intermediate	Beginner	N/A	N/A
E	Native	Intermediate	Intermediate	N/A	N/A
F	Native	Intermediate	Intermediate	N/A	N/A
G	Native	Lower Intermediate	Intermediate	N/A	Intermediate
H	Native	N/A	Intermediate	N/A	N/A
I	Native	Intermediate	Intermediate	N/A	N/A
J	Native	Intermediate	N/A	N/A	N/A
K	Native	Intermediate	N/A	Beginner	Beginner
L	Native	Intermediate	Advanced	Intermediate	N/A

Appendix B Data Collection Instruments

B.1 Questionnaire

Language Questionnaire

Thank you for helping me with my research! This quick questionnaire has three sections: Section 1 is about the languages that you speak. Section 2 is about how similar you think your languages are to Portuguese. Section 3 is about learning Portuguese. Please complete all three sections. There is a space at the end where you are welcome to add any comments.

First, please put your name and email below. This is just so that I know who you are and how to contact you. Your personal information will never be shared with anyone and your name will never appear in any reports which I write; all results will be entirely anonymous.

Thank you!

Name: ____

Email: ____

Section 1: Your Languages

Please list the languages that you know, along with your level in each language. This can be your current stage at University here, the highest qualification you have in the language (e.g. GCSE, A level) or your level on the Common European Framework of Reference.

If you are still studying the language or you still use it frequently, please put a tick (✓) in the "Still Study / Use Often" box. If you do not use or study the language anymore, please put which year (approximately) you finished learning/using this language in the "Date Stopped" box.

Language	Level	Still Study / Use Often	Date Stopped

Section 2: Similarities between Portuguese and Other Languages

This section is about your ideas about how similar the Portuguese that you are learning is to the other languages that you know.

I'd like you to rate how close each of your languages is to Portuguese in three different aspects: *Vocabulary*, *Pronunciation*, and *Word Order and Sentence Structure*.

You'll get to rank each of these on a scale from 1 to 7, where 1 represents 'Extremely Different' and 7 represents 'Extremely Similar'.

Remember that there are no right or wrong answers; these are your own perceptions.

Please do this for all the languages that you speak, starting with your mother tongue, English. Don't forget to write which language you're rating in the spaces provided!

2.1: Vocabulary

In terms of their vocabulary, how similar do you think each of your languages is to the Portuguese that you are learning?

Language: ___English___

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

2.2: Pronunciation

In terms of pronunciation, how similar do you think each of your languages is to the Portuguese that you are learning?

Language: __English__

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

2.3: Word Order and Sentence Structure

In terms of word order and sentence structure, how similar do you think each of your languages is to the Portuguese that you are learning?

Language: English

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Language: ________________

	1	2	3	4	5	6	7	
Extremely Different								Extremely Similar

Section 3: Learning Portuguese

This section is about your ideas of what is important in language learning and what you believe is or is not useful for learning Portuguese.

Below are seven statements about learning and using Portuguese with which you may agree or disagree to different extents. You'll get to rank each of these statements on a scale from 1 to 7, where 1 represents 'Strongly Disagree' and 7 represents 'Strongly Agree'.

Remember that there are no right or wrong answers; these are your own perceptions.

Statement 1:

When learning a language, I think that closely imitating the pronunciation of native speakers is important

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 2:

When speaking Portuguese, I want to avoid using sounds from English

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 3:

When speaking Portuguese, I want to avoid using sounds from Spanish

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 4:

My knowledge of English is useful for learning Portuguese vocabulary, grammar, word order, and sentence structure

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 5:

My knowledge of Spanish is useful for learning Portuguese vocabulary, grammar, word order, and sentence structure

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 6:

My knowledge of English helps me learn how to pronounce Portuguese

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Statement 7:

My knowledge of Spanish helps me learn how to pronounce Portuguese

	1	2	3	4	5	6	7	
Strongly Disagree								Strongly Agree

Comments

If you would like to comment further on any part of this questionnaire, then your comments would be hugely appreciated. You are welcome to write them in the box below.

Thank you for filling in this questionnaire! If you ever have any questions, you can always contact me at matt.thompson@soton.ac.uk and I'll be more than happy to answer them for you.

Thanks again,

Matt

B.2 Aural Perception and Distinction Task procedure

B.2.1 APDT test pair order

Group No.	Sound 1	Sound 2	Sound 3	Answer
Example A	ɒ	æ	ɒ	2
Example B	bi	bi	gi	3
Example C	kʰi	kʰi	ʃi	3
1	a	æ	æ	1
2	pi	pi	bi	3
3	ʧi	ʃi	ʧi	2
4	bi	bi	b̬i	3
5	kʰi	ki	ki	1
6	d̬i	di	d̬i	2
7	g̬i	ki	ki	1
8	o	u	u	1
9	pʰi	pi	pʰi	2
10	d̬i	ti	d̬i	2
11	ɒ	ɒ	o	3
12	pi	pi	b̬i	3
13	ki	gi	gi	1
14	ɒ	u	ɒ	2
15	ɐ	æ	æ	1
16	ə	ɐ	ɐ	1
17	tʰi	tʰi	di	3
18	ti	tʰi	ti	2
19	æ	a	æ	2
20	pi	pʰi	pʰi	1
21	ki	g̬i	ki	2
22	ʃi	ʧi	ʧi	1
23	kʰi	kʰi	gi	3
24	di	ti	di	2
25	g̬i	gi	gi	1
26	a	ɐ	a	2
27	bi	pʰi	pʰi	1
28	pʰi	pʰi	bi	3
29	ki	kʰi	kʰi	1
30	ɒ	ɒ	o	3
31	pi	b̬i	b̬i	1
32	d̬i	di	d̬i	2
33	ɐ	æ	ɐ	2
34	di	di	ti	3
35	g̬i	g̬i	gi	3
36	ə	ə	ɐ	3
37	ti	tʰi	tʰi	1
38	o	o	u	3
39	ki	g̬i	ki	2
40	b̬i	b̬i	bi	3
41	ɐ	a	a	1
42	tʰi	tʰi	di	3
43	pi	bi	pi	2
44	ɒ	u	ɒ	2
45	kʰi	kʰi	gi	3

46	bi	pi	bi	2
47	ˬdi	ˬdi	ti	3
48	ki	gi	gi	1
49	ʃi	ʃi	ʧi	3
50	æ	a	æ	2
51	pʰi	pi	pʰi	2
52	ˬgi	gi	gi	1
53	ɐ	ə	ə	1
54	bi	pʰi	bi	2
55	ˬdi	ˬdi	ti	3
56	u	u	o	3
57	tʰi	ti	tʰi	2
58	ki	gi	gi	1
59	ɒ	o	ɒ	2
60	ˬdi	di	di	1
61	ti	ti	di	3
62	ɐ	a	ɐ	2
63	ˬbi	pi	pi	1
64	kʰi	kʰi	ki	3
65	ˬbi	bi	ˬbi	2
66	æ	æ	ɐ	3
67	gi	gi	kʰi	3
68	ɒ	u	u	1
69	tʰi	di	tʰi	2

B.2.2 APDT answer sheet sample

Listening: odd one out

Name: ____

Thank you again for taking part in this research!

In this stage, you are going to hear 69 groups of sounds. Each group has three sounds, spoken by three different people. In each group, two of the people are pronouncing the same sound, whilst one person is pronouncing a different sound. You will decide which of them, the first, second, or third person, is the 'odd one out' pronouncing the different sound. You can show your decision by ticking the relevant box: First, Second, or Third, for each group.

A voice will tell you each time which group of sounds you are about to hear (e.g. "Group two"). There will also be a beep after each group, to separate them more clearly. You will hear each group of sounds twice.

There will be a short gap between each group of sounds; you should try to answer as quickly as you can.

Sometimes you may find that the odd one out is obvious; sometimes you may find that it is very difficult to identify. Don't worry when it is difficult; just choose the one that you feel is most likely.

We'll try some examples first

Example A	First ☐	Second ☐	Third ☐
Example B	First ☐	Second ☐	Third ☐
Example C	First ☐	Second ☐	Third ☐

Answer sheet

For each group, put a tick (✓) in the box for the sound you think is the odd one out.

	First	Second	Third
Group 1	☐	☐	☐
Group 2	☐	☐	☐
Group 3	☐	☐	☐
Group 4	☐	☐	☐
Group 5	☐	☐	☐
Group 6	☐	☐	☐
Group 7	☐	☐	☐
Group 8	☐	☐	☐

Group 9	First ☐	Second ☐	Third ☐

Group 64	First ☐	Second ☐	Third ☐
Group 65	First ☐	Second ☐	Third ☐
Group 66	First ☐	Second ☐	Third ☐
Group 67	First ☐	Second ☐	Third ☐
Group 68	First ☐	Second ☐	Third ☐
Group 69	First ☐	Second ☐	Third ☐

End of listening

Thank you again for taking part in this research, I'll see you again soon!

B.3 Oral Production Task Procedure

B.3.1 L1 English OPT stimuli

tea
shock
hat
pencil
quayside
peek
teaspoon
catcher
sticker
kilo
tackle
cheap
peeved
canter
rotten
peace
church
capital
spanner
keyboard
people
teapot
patter
café
sheep
chopper
chatter
peep
cat
tedious
keeper
shack
teenage
teeter
speedy
pecan
speaker
potter
tease
cater
stalling
stealing
peacock
teeth
copper
staple
peat
coffee
peas

keeping
team
cottage
patter
keepsake
teach
cheaper
peach
quiche
teamwork
polish
space
spinning
Peter
hotter
keys
teacher
stacked
peaky

B.3.2 L2 Spanish OPT stimuli

coro
tengo
perro
pato
chancla
tordo
tuerto
chusco
El coro canta muy bien.
punto
Este chusco está muy bueno.
postre
quise
cano
chisme
El pato tordo es muy lindo.
torpe
Voy a Chipre con mi amiga turca.
Vamos a jugar al tute.
Chipre
Quise subir la torre.
Llegaron al cumbre de la montaña.
cárcel
Llevo un chándal para correr por la calle.
Pulsa la tecla para empezar.
El ladrón ya está en la cárcel.
coma
canta
piso
¡Eres muy terco!

pulsa
quilla
pido
Charlo mucho con mis amigas.
caña
torre
calle
chasco
Mi joya favorita es la perla.
El asaltante era tuerto, y llevaba una chancla.
Usa una coma en vez de un punto.
pero
chicle
El bebé está en la cuna.
Caña se escribe con tilde.
Me llevo un chasco.
chivo
choco
cuna
cuenco
chica
charlo
pace
El hombre cano toma postre.
perla
popa
pollo
chándal
Tengo un piso nuevo.
tute
Pobre chico – ¡es tan torpe!
He oído un chisme.
Ignacio es muy chulo.
tilde
caro
La chica está masticando chicle.
cumbre
come
Su padre no come pollo.
padre
El tanque será caro.
tecla
parte
tanque
terco
toca
pone
toma
quedo
calma
Me quedo en un hostal.
pobre

topa
El toro pace en el prado.
turca
La quilla y la popa hacen parte del barco.
Toca la guitarra.
chico
Pido calma, pero no me escuchan.
No me gusta el choco.
Pone la chirla en un cuenco.
chirla
chulo
toro
El chivo topa el perro.

B.3.3 L2 French OPT stimuli

poché
Il faut rester calme.
Le cahier est sur la table.
compas
chalet
conduit
pilote
cheval
Il y a un poulet dans ma chambre!
tapis
tarte
terrible
calons
temps
partage
calque
camion
J'ai trouvé des choses étranges dans le chalet.
tartines
tibia
Chine
tiroir
théâtre
choisi
quatre
cadre
poulet
C'est très paisible ici et le paysage est si beau.
Ce candidat est terrible.
titre
quelque
tenant
cahier
chemise
pesant

Il conduit son camion quelque soit le temps.
paisible
Le cadre perfide souffre d'une quinte de toux.
Ma professeur de chimie a les cheveux bruns.
tabac
câlin
chambre
Je dois changer ma chemise.
Il y avait quatre tapis dans un coffre.
Chaque dimanche, je prends un œuf poché avec des tartines.
On partage la tarte aux pommes.
changer
J'ai toujours mal au tibia.
perfide
cherché
peluche
chirurgien
Nous nous calons dans un fateuil.
toujours
chou-fleur
Son permis est dans un tiroir chez lui.
poli
Metez le papier calque au panier.
calme
chez
Le chirurgien est très poli.
toux
pommes
cheveux
témoin
coffre
chimie
Comment s'appele le tenant du titre?
Ce cheval est très pesant.
panier
quinte
potage
comment
table
permis
papier
choses
candidat
Le pilote est allé en Chine.
Il a choisi le potage de chou-fleur.
chaque
Un témoin a vu la voleuse sortir du théâtre.
Ma peluche est vraiment câlin.
paysage
J'ai cherché le compas dans le tabac.

B.3.4 L3 Portuguese OPT stimuli

peço
O meu amigo toca a tuba
queijo
pires
chove
É pura loucura!
charme
Estou cheio, comi muito peixe
Nunca puno os meus alunos.
Um dia vão descobrir a cura para câncer
píer
Os barcos estão no porto
Conta ovelhas para adormecer
O colher está perto do pires
O chalé fica lá na curva
toca
colher
tocha
pesco
champô
canja
testa
Prefiro cerveja checa
tarde
chego
caju
O cofre estava vazio
O meu carro está ao lado da casa
curva
O pólen faz-me espirrar
Chega a casa às sete
Gosto dos cachos no teu cabelo
puno
Não gosto dos jogos de chance
acha
Esfregou o suor da sua testa
tique
Chego a Chile na terça
corro
O meu avô poupa sempre
O chão está um pouco sujo
câmera
poro
conta
tia
Aquela pomba é linda
Vamos jogar póquer
turco
O tédio é insuportável
chama
O caju é um tipo de noz

Passa-me o pano por favor
A minha tia é muito táctil
pico (N: da montanha)
Chile
Há um pier muito bonito na praia.
toma
Todos os dias corro pelo parque
tuba
pago
táctil
pensa
terça
Você acha que ele teve um bom dia?
Este é o tema
cacho
Abriu a porta
Pago com cheque, está bem?
Chama o Miguel – ele tem a chave
cara
porto
posse
Nunca chove no pico da montanha
checa
Isso custa quarenta pence.
Há muitos poros na minha cara
câncer
O menino tem um tique.
cheio
péni
perto
No café, peço sempre canja
parque
Passa-me essa tocha por favor.
poupa
tecto
pune
chave
poupo
Se usa uma canga para juntar dois bois
teve
póquer
casa
porta
Compro a carne no talho, assim poupo muito
chance
cheque
pence
carro
carne
pura
Aprender turco é chato
Toma posse da vitória meu irmão

todo
Ela compra todo o queijo
chão
pano
cura
pouco
Na tasca, tomo sempre uma cerveja fresca
Chora quando pensa do chefe
Comprei um novo champô
chalé
porco
Pesco no lago ao domingo
passa
Vão reparar o tecto mais tarde
pomba
canga
pombo
tédio
Eu não como porco.
tipo
cofre
compro
pólen
topo
chato
talho
tasca
peixe
chefe
chega
A câmera está a gravar
chora
Vi um pombo
Encontrei um péni no meu bolso.
A mãe pune muito os seus filhos.
É a cereja no topo.
Ele tem muito charme
Cuido das crianças o dia todo

Appendix C Additional Data

Contents

C.1 Language Questionnaire Additional Data

Table C.1.1: Cross Participant Data - English, French and Spanish Similarity Judgements

	English			Spanish			French		
	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax
n	12	12	12	10	10	10	9	9	9
Mean	2.83	2.08	4.25	6.00	3.85	6.10	4.22	3.78	4.89
S.D.	0.94	0.79	0.87	0.94	1.06	0.99	1.20	1.48	0.93
Range	3	2	2	3	3	3	4	5	3
Highest	4	3	5	7	5	7	6	6	6
Lowest	1	1	3	4	2	4	2	1	3

Table C.1.2: Participant Italian and German Similarity Judgements

Participant	Italian			German		
	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax
A	4	3	5			
G				3	3	4
K	4	4	6	2	2	3
L	4	4	5			

Table C.1.2: Cross Participant Data - Italian and German Similarity Judgements

	Italian			German		
	Lexis	Phon.	Syntax	Lexis	Phon.	Syntax
n	3	3	3	2	2	2
Mean	4	3.67	5.33	2.50	2.50	3.50
S.D.	0	0.58	0.58	0.71	0.71	0.71
Range	0	1	1	1	1	1
Highest	4	4	6	3	3	4
Lowest	4	3	5	2	2	3

Table C.1.3: Questionnaire Section Three Responses Frequencies

Response	Statement number						
	1	2	3	4	5	6	7
7	7	4	3	1	5	0	0
6	2	6	2	0	2	0	0
5	3	2	2	3	5	1	5
4	0	0	2	7	0	0	5
3	0	0	3	0	0	7	1
2	0	0	0	1	0	4	1
1	0	0	0	0	0	0	0

Table C.1.4: Questionnaire Section Three Cross Participant Data

	Statement number						
	1	2	3	4	5	6	7
n	12	12	12	12	12	12	12
Mean	6.33	6.17	5	4.33	6	2.83	4.17
S.D.	0.89	0.72	1.60	1.15	0.95	0.83	0.94
Median	7	6	5	4	6	3	4
Range	2	3	4	6	6	4	3
Highest	7	7	7	7	7	5	5
Lowest	5	4	3	1	1	1	2

C.2 Aural Perception and Distinction Task Additional Data

Table C.2.1: Phase 1 Consonant Tests

Test pair		Participant											
		A	B	C	D	E	F	G	H	I	J	K	L
Bilabial	[pʰ – p]	2	3	3	1	2	1	3	1	0	2	2	2
	[pʰ – b]	3	3	3	2	3	1	3	3	2	3	3	2
	[p – b]	2	1	0	2	1	1	1	1	2	1	1	0
	[p – ̬b]	1	0	1	0	0	0	2	1	0	0	2	0
	[b – ̬b]	2	2	1	1	1	1	2	1	1	2	2	2

Alveolar / Dental	**[tʰ – t̪]**	2	2	2	3	3	3	2	2	2	2	3	2
	[tʰ – d]	3	3	3	3	2	1	2	3	2	3	3	3
	[t̪ – d]	0	0	2	2	2	0	1	2	0	1	1	2
	[t̪ – d̪̬]	3	2	0	1	1	0	3	1	0	0	2	1
	[d – d̪̬]	3	2	2	2	2	3	2	2	1	2	2	1
Velar	**[kʰ – k]**	2	3	2	2	2	3	1	2	3	2	2	2
	[kʰ – g]	3	2	3	3	3	2	3	2	3	3	3	3
	[k – g]	1	1	0	2	0	0	1	0	0	2	2	0
	[k – g̬]	1	3	2	3	0	1	0	3	2	1	2	3
	[g – g̬]	1	1	1	0	2	2	2	2	1	1	2	2
	[ʧ – ʃ]	3	3	3	2	3	1	3	3	3	2	3	2

<u>Table C.2.2: Phase 1 Vowel Tests</u>

Test pair	**Participant**											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
[a – æ]	1	3	3	1	1	1	1	3	1	2	3	1
[a – ɐ]	2	3	2	2	1	3	2	3	3	2	2	1
[æ – ɐ]	2	3	3	3	2	3	2	3	2	2	3	2
[ɐ – ə]	1	1	3	3	1	2	0	2	1	0	1	0
[o – ɒ]	3	2	3	0	3	2	3	2	1	3	2	3
[o – u]	2	2	1	2	1	2	3	1	2	2	2	2
[u – ɒ]	2	3	3	3	3	3	1	3	2	3	3	3

<u>Table C.2.3: Phase 2 Consonant Tests</u>

Test pair		**Participant**											
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Bilabial	**[pʰ – p]**	2	3	3	2	1	1	2	3	2	2	1	2
	[pʰ – b]	3	3	3	1	3	1	3	3	2	3	3	3
	[p – b]	2	1	0	1	2	1	1	1	1	0	1	0
	[p – b̬]	1	0	1	0	0	1	2	0	1	0	1	2
	[b – b̬]	2	2	2	2	1	1	2	1	1	1	2	2

Alveolar / Dental	**[tʰ – t̪]**	2	2	3	2	2	3	2	2	2	2	2	2
	[tʰ – d]	3	3	3	3	3	2	2	3	3	3	3	3
	[t̪ – d]	1	2	3	2	1	2	1	1	1	1	1	0
	[t̪ – d̪̬]	2	0	1	1	2	1	2	2	0	0	1	1
	[d – d̪̬]	2	3	1	3	2	3	3	2	3	2	3	2
Velar	**[kʰ – k]**	2	3	3	2	2	3	1	2	3	2	2	2
	[kʰ – g]	3	3	3	3	3	3	2	3	2	3	3	3
	[k – g]	0	1	1	2	0	1	2	2	2	2	1	2
	[k – g̬]	3	2	2	2	3	2	0	2	1	1	1	3
	[g – g̬]	0	2	2	1	2	2	1	3	2	1	2	3
	[ʧ – ʃ]	3	3	2	3	2	3	3	3	3	3	2	2

Table C.2.4: Phase 2 Vowel Tests

Test pair	**Participant**											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
[a – æ]	1	2	3	2	2	1	2	3	2	2	3	1
[a – ɐ]	2	2	2	2	2	3	3	2	2	2	3	3
[æ – ɐ]	2	3	3	2	2	3	3	3	3	3	3	2
[ɐ – ə]	2	3	1	2	2	2	2	0	1	0	3	2
[o – ɒ]	2	1	2	1	3	2	3	1	1	3	2	2
[o – u]	2	2	1	2	2	2	1	2	2	2	3	2
[u – ɒ]	3	3	3	3	3	3	2	3	3	3	3	2

Table C.2.5: Phase 3 Consonant Tests

Test pair		**Participant**											
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
Bilabial	**[pʰ – p]**	3	3	3	3	2	2	2	2	2	2	3	3
	[pʰ – b]	3	3	3	3	3	2	3	3	2	3	2	2
	[p – b]	2	0	1	2	1	1	1	1	1	0	1	1
	[p – b̬]	0	0	1	0	1	2	1	0	0	0	0	1
	[b – b̬]	1	1	0	1	1	2	1	1	2	1	1	2

Alveolar / Dental	**[tʰ – t̪]**	2	2	3	3	3	3	2	2	2	2	2	3
	[tʰ – d]	3	3	3	3	2	2	3	3	2	3	3	3
	[t̪ – d]	1	1	2	1	1	1	2	2	0	1	1	0
	[t̪ – d̪̬]	2	1	0	1	2	2	2	2	0	2	2	2
	[d – d̪̬]	2	2	3	3	1	3	3	3	1	2	1	2
Velar	**[kʰ – k]**	2	2	2	2	3	2	1	2	3	3	2	3
	[kʰ – g]	2	3	3	3	3	3	3	3	3	3	3	3
	[k – g]	2	0	2	2	0	1	2	2	2	2	2	1
	[k – g̬]	3	1	1	3	3	1	0	2	2	2	2	2
	[g – g̬]	2	1	1	1	2	2	1	0	2	2	3	2
	[ʧ – ʃ]	3	3	2	3	3	3	3	3	3	3	3	3

Table C.2.6: Phase 3 Vowel Tests

Test pair	**Participant**											
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
[a – æ]	3	2	3	1	1	2	2	3	0	3	2	3
[a – ɐ]	3	2	3	2	2	2	2	3	2	2	2	2
[æ – ɐ]	2	3	3	2	1	3	3	2	3	2	3	1
[ɐ – ə]	2	1	0	3	1	1	1	1	0	2	1	1
[o – ɒ]	3	1	3	1	3	2	2	2	1	2	2	2
[o – u]	3	3	1	1	2	1	2	0	2	3	2	3
[u – ɒ]	3	3	3	3	1	3	0	1	3	3	3	3

C.3 Oral Production Task Additional Data

C.3.1 OPT Plosive Data

C.3.1.1 OPT Plosive VOT values

Table C.3.1.1: Average VOT Values – L1 Fortis Plosives

Participant	**/p/**	**/t/**	**/k/**
A	48.337	58.577	67.295
B	40.637	53.478	53.87
C	62.863	82.63	85.522
D	57.037	64.707	63.221
E	52.584	73.523	67.339
F	48.074	65.673	72.014

G	49.766	56.489	65.977
H	57.889	69.444	65.554
I	75.915	82.941	71.138
J	62.378	68.346	67.55
K	55.467	67.9	66.044
L	71.733	76.564	80.049

Table C.3.1.2: Average VOT Values – L2 and L3 fortis plosives

Participant	**L2**			**L3**		
	/p/	**/t/**	**/k/**	**/p/**	**/t/**	**/k/**
A	18.88	18.97	27.60	26.11	20.63	32.31
B	19.76	29.74	30.04	23.89	26.45	35.11
C	22.05	31.76	37.13	29.40	30.94	45.50
D	25.71	31.62	40.92	36.47	43.34	55.56
E	28.14	34.42	44.58	39.03	40.39	49.49
F	32.45	49.21	53.21	40.27	46.38	57.22
G	29.84	38.20	41.06	32.48	31.08	39.76
H	28.01	44.90	43.25	34.40	39.49	45.21
I	34.15	47.16	50.92	46.19	59.04	61.26
J	41.64	53.76	62.66	46.79	60.28	66.59
K	28.56	33.28	43.20	37.73	40.21	51.84
L	18.51	22.64	37.85	27.63	22.32	42.22

C.3.1.2 OPT Normalised VOT Plosive Data

Table C.3.1.3: Average Normalised VOT Values – L1 Fortis Plosives

Participant	**Phoneme**		
	L1 /p/	**L1 /t/**	**L1 /k/**
A	23.01461	29.00913	36.0682
B	22.02302	28.80664	31.98578
C	31.50949	43.3946	45.76339
D	29.91232	33.67615	41.33914
E	34.26747	39.74574	42.05935
F	29.55681	40.52209	43.82459
G	29.94329	36.37324	39.16757
H	30.53329	40.6178	39.30227
I	42.09246	42.53755	39.9287
J	30.19278	36.7433	37.9654
K	26.60352	31.02866	32.34801
L	37.68818	41.3345	42.08467

Table C.3.1.4: Average Normalised VOT Values – L2 and L3 fortis plosives

Participant	L2			L3		
	/p/	/t/	/k/	/p/	/t/	/k/
A	13.93	11.91	18.02	15.72	14.38	18.09
B	16.15	20.50	21.91	15.78	18.12	20.47
C	14.42	17.99	22.14	15.53	17.00	21.91
D	19.75	21.61	27.15	22.76	27.91	31.87
E	23.22	24.87	30.73	28.60	29.42	31.63
F	24.56	30.29	34.15	26.60	32.43	33.27
G	23.82	26.15	27.59	21.09	20.94	22.77
H	21.08	29.78	27.79	24.34	26.48	28.10
I	24.38	30.07	31.61	30.86	38.18	35.27
J	27.60	28.98	34.14	27.40	33.04	32.08
K	19.23	19.53	25.25	22.99	24.04	26.45
L	14.06	14.69	23.77	16.36	14.54	21.13

Table C.3.1.5: Average L3 Normalised VOT Values – Non-cognate Condition

Participant	/p/	/t/	/k/
A	16.59	14.38	16.93
B	14.73	18.34	19.83
C	13.67	15.31	18.38
D	21.85	26.39	27.84
E	24.26	28.64	30.52
F	24.67	30.21	32.06
G	19.20	22.51	20.91
H	23.42	26.66	26.60
I	28.59	31.81	29.19
J	24.89	32.49	31.92
K	22.40	26.10	24.12
L	17.44	12.69	18.15

Table C.3.1.6: Average L3 Normalised VOT Values - L1 Cognate Condition

Participant	/p/	/t/	/k/
A	16.60	14.11	15.74
B	16.28	17.56	19.18
C	17.63	19.29	20.76
D	23.14	31.70	35.22
E	34.24	33.86	29.80
F	30.01	33.37	36.09
G	26.76	19.97	21.62
H	27.48	24.69	24.93
I	33.76	44.21	37.99
J	29.21	34.91	34.22
K	23.53	25.15	24.76
L	21.16	16.00	19.54

Table C.3.1.7: Average L3 Normalised VOT Values – L2 Cognate Condition

Participant	/p/	/t/	/k/
A	14.11	13.67	16.54
B	15.12	14.34	25.98
C	14.65	15.77	22.66
D	20.09	25.24	30.50
E	23.81	29.43	30.91
F	26.13	32.72	31.18
G	19.18	18.61	22.89
H	25.55	24.90	30.08
I	27.80	36.58	34.76
J	28.08	34.20	30.55
K	23.08	21.96	25.31
L	11.78	14.33	20.11

Table C.3.1.8: Average L3 Normalised VOT Values - L1-L2 Cognate Condition

Participant	/p/	/t/	/k/
A	15.53	14.97	21.94
B	16.55	19.71	20.71
C	16.27	17.68	23.45
D	24.49	29.08	34.13
E	31.43	28.06	33.93
F	26.48	32.70	34.76
G	22.02	21.07	25.08
H	24.13	27.93	30.06
I	32.46	39.68	37.62
J	27.81	31.56	32.92
K	22.95	24.17	30.09
L	16.17	14.86	24.95

C.3.2 OPT Affricate and Fricative Data

Table C.3.2.1: L1 Affrication and Frication

Participant	Fricative %Correct	Affricate %Correct
A	100.00	100.00
B	100.00	100.00
C	100.00	100.00
D	100.00	100.00
E	100.00	100.00
F	66.67	100.00
G	100.00	100.00
H	100.00	100.00
I	100.00	100.00
J	100.00	100.00
K	100.00	100.00
L	100.00	100.00

Table C.3.2.2: L2 Affrication and Frication

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B	100	100	100	100
C	100	100	100	100
D	100	100	100	100
E	100		100	100
F	100	100	100	100
G	100	100	100	100
H	100	100	100	100
I	100	85.715	89.285	91.66667
J	96.43	71.43	82.145	83.335
K	100	100	100	100
L	100	100	100	100

Table C.3.2.3: L3 Affrication and Frication: Full dataset

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B	97.37	100	100	99.12333
C	97.37	100	100	99.12333
D	92.105	97.37	97.37	95.615
E	39.475		31.58	35.5275
F	21.055	39.475	26.32	28.95
G	100	100	94.445	98.14833
H	100	97.37	86.84	94.73667
I	86.84	94.735	97.37	92.98167
J	78.945	89.475	94.735	87.71833
K	44.74	81.575	78.945	68.42
L	26.315	81.58	92.105	66.66667

Table C.3.2.4: L3 Affrication and Frication: Non-cognate Condition

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B	100	100	100	100
C	100	100	100	100
D	100	100	100	100
E	28.335		50	39.1675
F	28.335	53.335	45	42.22333
G	100	100	100	100

H	100	100	95.455	98.485
I	71.665	100	100	90.555
J	91.665	100	100	97.22167
K	46.665	91.665	91.665	76.665
L	66.665	90	100	85.555

Table C.3.2.5: L3 Affrication and Frication: L1 Cognate Condition

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B				
C	75	100	100	91.66667
D	100	100	100	100
E	25		75	50
F	0	25	0	8.333333
G				
H				
I	75	100	100	91.66667
J	75	75	100	83.33333
K	25	50	50	41.66667
L	0	50	75	41.66667

Table C.3.2.6: L3 Affrication and Frication: L2 Cognate Condition

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B				
C	100	100	100	100
D	100	100	100	100
E	55		46.665	50.8325
F	28.335	40	30	32.77833
G				
H				
I	91.665	100	100	97.22167
J	81.665	100	100	93.88833
K	61.665	100	90	83.88833
L	36.665	91.665	91.665	73.33167

Table C.3.2.7: L3 Affrication and Frication: L1–L2 Cognate Condition

Participant	Phase 1	Phase 2	Phase 3	Total
	%Correct	%Correct	%Correct	%Correct
A	100	100	100	100
B	93.75	100	100	97.91667
C	100	100	100	100
D	75	91.665	91.665	86.11
E	41.67		33.33	37.5
F	16.665	33.335	66.665	38.88833
G	100	100	87.5	95.83333
H	100	93.75	75	89.58333
I	91.665	83.335	91.665	88.88833
J	66.665	75	83.335	75
K	33.335	66.665	66.665	55.555
L	33.33	75	91.665	66.665

C.3.3 OPT Vowel Data:

C.3.3.1 OPT Vowel Formant Frequencies

Table C.3.3.1: Average L1 Vowel Formant Values

Participant	/æ/		/ɒ/		/ə/	
	F1	F2	F1	F2	F1	F2
A	768.523	1618.952	648.351	1079.088	548.882	1463.038
B	691.943	1672.915	560.076	1056.469	542.605	1783.103
C	840.682	1622.605	665.437	1220.621	566.257	1847.989
D	699.977	1464.035	569.790	1090.089	616.446	1589.086
E	672.433	1450.327	525.669	1094.499	470.446	1457.055
F	830.970	1669.465	604.869	1205.609	513.157	1744.255
G	799.267	1520.087	550.033	1040.999	554.799	1372.200
H	887.311	1630.838	647.604	1114.576	696.887	1620.687
I	935.280	1569.363	689.216	1137.563	713.492	1604.248
J	884.712	1547.102	598.907	1072.800	726.577	1586.020
K	876.610	1593.376	733.807	1171.225	760.162	1701.120
L	977.458	1567.061	703.493	1191.482	586.230	1592.549

Table C.3.3.2: Average L2 Vowel Formant Values

Participant	/a/		/o, ɔ/		/e/	
	F1	F2	F1	F2	F1	F2
A	521.16	1412.30	448.18	1172.70	429.19	1876.16
B	691.35	1692.35	494.02	1180.84	431.56	2261.07
C	650.30	1629.60	535.12	1311.70	507.67	2074.48
D	622.29	1560.39	503.97	1324.09	446.55	2126.29
E	563.56	1431.96	464.55	1202.34	460.66	1710.02

F	663.30	1635.84	412.80	1321.93	401.27	2137.87
G	635.66	1485.83	473.46	1048.84	382.27	2067.32
H	698.41	1727.43	500.33	1319.31	499.94	2190.74
I	732.48	1659.44	573.93	1396.11	570.54	2184.83
J	682.11	1564.08	516.55	1173.58	552.33	2192.40
K	698.70	1486.50	557.92	1268.07	545.55	2120.06
L	639.00	1598.65	491.66	1276.96	497.68	2177.62

Table C.3.3.3: Average L3 Vowel Formant Values

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	499.54	1452.52	373.88	1484.74	380.41	1818.13
B	531.89	1503.14	432.50	1192.87	374.79	2079.34
C	543.71	1697.42	403.62	1297.69	427.07	1875.73
D	494.15	1549.94	358.97	1478.41	373.90	1692.38
E	569.19	1422.87	469.25	1214.90	467.24	1713.51
F	593.75	1618.08	420.86	1345.35	374.39	2063.63
G	514.50	1350.14	404.20	1441.90	380.13	2102.20
H	695.16	1592.77	559.02	1264.17	483.31	2234.71
I	722.94	1682.02	551.73	1365.08	551.53	2250.55
J	680.74	1495.71	440.66	1086.15	453.39	2325.99
K	648.20	1372.19	395.86	1127.30	454.09	2066.96
L	588.19	1659.08	432.56	1400.81	491.64	2008.39

Table C.3.3.4: Average L3 Vowel Formant Values – Non-cognate Condition

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	491.19	1482.23	359.66	1588.82		
B	550.54	1507.33	433.63	1291.16	369.69	1829.66
C	559.23	1724.16	401.40	1415.40		
D	468.46	1624.11	356.25	1638.88		
E	552.51	1474.86	472.03	1263.21		
F	568.18	1671.92	404.22	1384.28		
G	519.23	1343.89	403.49	1463.89	396.38	1974.46
H	693.81	1621.79	553.87	1273.76	452.20	1802.72
I	729.12	1710.66	549.34	1368.29		
J	687.38	1554.64	431.77	1100.09		
K	677.86	1480.81	391.24	1216.54		
L	582.04	1700.01	420.28	1460.57		

Table C.3.3.5: Average L3 Vowel Formant Values – L1 Cognate Condition

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	521.97	1534.25	387.81	1385.12	414.68	1853.41
B	529.65	1550.37	433.19	1122.84	325.49	2738.41

C	540.46	1746.70	443.82	1358.32	411.21	1974.99
D	528.71	1619.37	366.69	1485.34		
E	590.67	1480.07	446.61	1232.92	459.07	1682.17
F	547.64	1728.98	440.15	1370.16	349.24	1863.60
G	502.83	1366.32	414.39	1410.10	471.40	2487.27
H	732.05	1590.12	558.23	1304.21	548.00	2083.40
I	715.38	1705.57	547.69	1346.25	554.03	2197.87
J	671.63	1558.89	460.85	1116.40	452.28	2325.71
K	690.54	1459.18	404.00	1093.42	462.54	2099.20
L	598.31	1785.13	432.62	1407.55	458.60	1864.73

Table C.3.3.6: Average L3 Vowel Formant Values – L2 Cognate Condition

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	501.32	1446.21	376.86	1535.85	391.71	1783.73
B	492.62	1472.26	436.74	1096.61		
C	549.97	1703.14	378.01	1234.63	421.52	1746.82
D	502.65	1534.57	362.92	1420.23	330.69	1638.17
E	577.83	1415.38	470.55	1183.33	481.26	1670.31
F	593.51	1613.81	413.37	1386.17	390.85	2107.28
G	467.69	1333.04	396.69	1478.86	314.15	2166.49
H	670.33	1478.44	548.93	1253.66	584.22	2317.47
I	731.39	1660.58	551.61	1376.55	552.58	2237.38
J	670.84	1459.11	428.39	1052.23	438.41	2234.76
K	634.80	1370.24	387.03	1103.62	465.14	2036.91
L	591.95	1664.59	417.60	1405.70	483.70	2015.67

Table C.3.3.7: Average L3 Vowel Formant Values – L1-L2 Cognate Condition

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	500.89	1418.48	374.43	1374.37	362.52	1827.90
B	516.30	1495.07	427.97	1139.26	385.88	2239.24
C	528.52	1669.00	413.02	1228.35	451.95	1932.66
D	498.75	1505.68	353.22	1385.02	396.24	1708.36
E	567.36	1387.12	475.87	1191.73	461.87	1762.65
F	626.87	1567.62	433.28	1261.76	377.53	2069.28
G	516.78	1357.85	407.23	1400.74	364.03	2133.35
H	698.65	1575.92	572.98	1239.43	487.94	2480.43
I	713.44	1677.79	556.44	1356.68	549.29	2292.02
J	687.91	1480.67	453.13	1094.02	467.51	2405.76
K	636.20	1287.47	406.51	1066.04	445.65	2069.39
L	585.45	1603.57	460.85	1346.04	499.21	2007.23

C.3.3.2 OPT Vowel Gerstman-Normalised formant frequencies

Table C.3.3.8: Gerstman-Normalised L1 Vowel Formant Frequencies

Participant	/æ/		/ɒ/		/ə/	
	F1	F2	F1	F2	F1	F2
A	700.18	800.80	476.76	220.15	291.83	633.11
B	554.00	706.96	325.00	192.53	294.66	798.91
C	812.30	664.98	507.97	329.52	335.74	853.06
D	732.82	677.87	489.70	257.80	576.83	818.35
E	739.67	720.85	269.11	236.77	92.05	730.01
F	747.43	610.85	458.74	130.53	341.64	688.29
G	747.04	831.12	151.61	169.04	162.99	626.75
H	713.81	839.59	184.72	208.29	293.50	827.18
I	728.09	680.68	206.65	141.90	258.10	724.21
J	783.81	712.35	353.16	183.04	545.54	755.78
K	854.98	623.10	558.97	161.69	613.60	740.87
L	772.12	637.67	378.96	99.74	210.68	674.18

Table C.3.3.9: Gerstman-Normalised L2 Vowel Formant Frequencies

Participant	/a/		/o, ɔ/		/e/	
	F1	F2	F1	F2	F1	F2
A	537.80	375.73	348.38	214.11	296.16	686.97
B	769.34	481.79	361.97	188.74	236.94	806.64
C	641.47	472.53	460.92	288.82	418.68	735.60
D	570.83	422.34	418.48	278.42	343.75	772.95
E	626.82	415.18	332.86	191.65	320.66	687.60
F	528.15	487.81	229.42	311.65	225.57	758.90
G	770.58	394.78	429.04	122.73	245.85	749.30
H	682.56	505.84	345.75	249.68	335.48	797.22
I	650.47	415.55	292.06	258.86	284.26	726.89
J	648.07	409.61	339.97	195.02	406.24	756.14
K	633.56	394.76	412.88	279.99	396.24	725.83
L	517.95	379.97	263.20	207.67	271.99	693.35

Table C.3.3.10: Gerstman-Normalised L3 Vowel Formant Frequencies

Participant	/ɐ/		/u/		/ə/	
	F1	F2	F1	F2	F1	F2
A	513.62	386.33	267.08	401.49	284.23	595.14
B	607.54	393.36	415.09	238.49	334.56	713.10
C	510.86	530.09	265.81	308.69	312.54	631.48
D	507.54	541.25	277.51	488.66	304.17	645.05
E	581.72	485.99	309.28	280.84	304.28	771.82
F	582.08	495.11	315.13	331.06	245.52	740.95
G	622.26	358.30	358.58	393.62	286.26	735.93
H	677.79	346.81	433.25	196.03	314.24	480.04
I	590.67	455.45	263.88	260.44	267.24	800.14

J	627.53	370.53	204.28	177.47	226.84	762.18
K	615.78	372.38	243.94	261.08	317.56	693.03
L	595.39	525.09	313.07	393.51	419.19	692.78

Table C.3.3.11: Gerstman-Normalised L3 Vowel Formant Frequencies: Non-cognate Condition

Participant	/ɐ/		/u/		/ə/	
	F1	F2	F1	F2	F1	F2
A	487.5448	404.9677	245.4288	452.9845		
B	645.4337	395.3191	417.3891	285.501	327.2359	595.6376
C	539.6861	554.6177	262.6392	368.3821		
D	462.3227	594.0219	273.6794	606.053		
E	533.699	537.3024	317.4569	326.6561		
F	540.9286	525.9459	295.719	354.2662		
G	629.1369	355.527	354.4852	409.7498	353.3259	669.6737
H	676.3412	354.8139	425.4661	202.2936	281.7674	375.2235
I	605.9566	471.2327	257.6186	261.7857		
J	637.4528	399.2967	189.276	182.9222		
K	660.0418	425.7242	239.6595	306.333		
L	581.759	546.1131	287.7131	426.5666		

Table C.3.3.12: Gerstman-Normalised L3 Vowel Formant Frequencies: L1 Cognate Condition

Participant	/ɐ/		/u/		/ə/	
	F1	F2	F1	F2	F1	F2
A	560.0297	437.4051	294.554	347.1673	323.0259	610.8745
B	598.7745	417.3042	415.4458	202.9957	222.8664	965.5054
C	503.112	562.0115	331.3635	338.2024	258.3541	678.5907
D	570.6102	586.7388	287.3603	502.654		
E	632.538	541.9359	245.1727	300.1248	288.3658	735.0922
F	494.4592	567.1916	340.9341	340.2459	176.4378	677.8487
G	599.2759	366.5055	388.0579	369.7638	403.6891	932.4972
H	742.8506	336.1342	429.8926	214.0172	377.2307	452.1721
I	581.2258	468.1502	256.6359	249.9408	274.0617	768.1724
J	601.7211	407.3181	238.0169	191.4012	228.6396	759.0339
K	659.093	433.6574	257.6096	241.0066	310.8432	712.2174
L	615.9005	585.625	288.896	403.701	368.2437	664.3812

Table C.3.3.13: Gerstman-Normalised L3 Vowel Formant Frequencies: L2 Cognate Condition

Participant	/ɐ/		/u/		/ə/	
	F1	F2	F1	F2	F1	F2
A	517.7342	381.9967	273.0833	438.2784	302.1822	583.574
B	524.9866	390.7847	420.7809	192.2922		
C	522.4321	528.6337	221.0353	277.1522	319.084	551.0643
D	524.9052	529.8372	285.4133	447.5632	234.5959	621.385
E	606.8525	477.307	312.7709	251.6588	340.4751	729.8253
F	590.3086	493.6066	297.4697	352.4881	271.7187	770.2964

G	538.9338	347.6203	341.6198	408.7348	143.2535	747.4049
H	635.0258	315.6171	411.0626	192.8149	485.6967	63.72564
I	606.2678	443.8046	265.5373	267.9578	268.6824	790.2561
J	615.4459	350.3288	184.6927	161.2101	200.2348	713.2304
K	599.2582	371.9515	225.7382	249.2241	336.8247	685.3854
L	608.6843	527.3517	289.8903	389.0087	422.6188	716.2668

Table C.3.3.14: Gerstman-Normalised L3 Vowel Formant Frequencies: L1-L2 Cognate Condition

Participant	**/ɐ/**		**/u/**		**/ə/**	
	F1	**F2**	**F1**	**F2**	**F1**	**F2**
A	516.4585	369.0166	269.1841	336.1121	256.2663	598.615
B	572.5828	389.1601	408.3063	212.344	350.713	762.5063
C	483.5561	509.7436	285.41	270.8406	340.3598	670.522
D	509.6123	508.5631	269.3256	412.687	336.9036	656.1887
E	580.118	449.3841	327.5735	256.8417	286.9547	821.4848
F	617.0181	463.3552	340.3153	283.3767	248.6021	739.7792
G	629.0612	362.9141	361.9824	371.0825	249.9338	751.0983
H	681.4546	342.7149	458.8622	180.6071	321.2401	537.5674
I	567.6834	453.4261	271.7823	256.0897	262.1752	826.4124
J	637.3375	363.579	224.1519	182.6892	248.6553	805.8647
K	595.7684	329.0593	260.3008	236.6563	305.0173	690.1732
L	587.7846	496.9498	369.9995	363.8729	434.8203	683.8477

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