PROPOSAL:THE PHONOLOGY OF THE ABSOLUTE INITIAL STATE OF L3 ACQUISTION

By

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ABSTRACT OF THE DISSERTATION

Proposal:The phonology of the absolute initial state of L3 acquistion

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The present dissertation aims to examine how bilinguals perceive and produce sounds in a language unfamilar to them in perception and production in order to uncover how a first and second language impact the acquistion of a third. In particular, Spanish-English bilinguals will be recruited in both orders of acquistion (Spanish L1-English L2 and English L1-Spanish L2) and exposed to sounds in French (closer to Spanish) and German (closer to English). By using this combination of languages and by giving the same speakers two L3s to perceive and produce, the relative impact of order of acquisition and cross-linguistic acoustic similarity can be be examined in tandem. In order to elicit production in all 4 languages, a shadowing task in German and French, and a word reading task in Spanish and English will be carried out. For perception, phoneme categorzation tasks and AX discrimination tasks will be

done. Measures of voice-onset time and formant values will be evaluated in stops and vowels in all three languages in production, where perpcetion will use categorization of sounds, goodness ratings, and discrimination patterns to evaluate how cross-linguistic influence of the L1 and L2 impact L3 perception and production. The results of each study, as well as the production-perception interface, have implications for L3 models, which predict that whole language influence occurs (Rothman, 2015; Bardel and Falk, 2007) or that both languages are active during L3 acquistion (Westergaard et al., 2017; Slabakova, 2017).

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Chapter 1: Introduction

1.1 Introduction

The difficulty of learning a new language in adulthood has a well documented history. This is especially true in the case of phonological acquisition. For example, many studies over the course of the past five decades have demonstrated that adult second language (L2) learners often produce and perceive the sounds of the target language in a non-native manner (Flege, 1991; Flege & Eefting, 1988). This difficulty arises, in part, because bilinguals often navigate complex communicative situations in which they produce and perceive speech from both of their languages in real time. Much less is known about the acquisition of a third language (L3A), particularly with regard to L3 production, perception, and phonological learning. The present dissertation explores the production patterns and perceptual categorization routines of adult bilinguals during the initial stages of L3 acquisition.

Empirical studies in L3 phonological acquisition have found evidence of multi-directional influence in language production (Llama & Cardoso, 2018; Llama, Cardoso, & Collins, 2010), and have found that the impact of previously learned languages varied in their relative influence on the third language. In some cases, L2 influence on L3 production has been found, where in others, L1 influence or simultaneous influence of both languages on L3 production has been reported. It is unclear what factors could be at the root of these varied findings.

At large, empirical studies in L3 acquisition have used low samples and their results have been used as the basis of predictive models. An issue with the use of few participants to make generalizations is that it increases the likelihood of false positive and false negative results due to an insufficient quantity of samples from a hypothetical population distribution to reliably infer information about that group. In addition to low samples, L3 studies typically use analyses such as an ANOVA, t-tests, non-parametric tests against zero, such as the Kruskal Wallis test. An issue with these choices of analyses is the lack of evidence for the null hypothesis within the larger

umbrella of the frequentist approach to inferential statistics. That is, in the case of L3 acquisition, where the interest is which of two source languages impacts a third, the researcher is interested in the possibility of providing evidence that L3 performance is either L1 or L2 like. Often, the lack of a so-called "significant" p-value in frequentist analysis is taken as evidence of similar performance between groups or within subjects. This conclusion is not well justified, since it is unclear if null results are due to low samples with wide confidence intervals and how much noise is expected in the data. That is, the lack of a significant p-value alone is not evidence for the null hypothesis. When only a p-value is reported, and not detailed descriptive statistics, it is difficult to establish objective and precise criteria for evidence for practical equivalence.

Additionally, factors such as L2 and L3 proficiency, language dominance and choices of methods and analysis may play a role in the conclusions drawn by these studies. L3 proficiency has varied in the body of literature, with some studies examining beginners, while others study intermediate and advanced learners. Language dominance and use has not always been considered in L3 studies.

The present dissertation aims to address the issue of low sample sizes and varied statistical analyses by, firstly, recruiting bilinguals who do not yet know a third language. Secondly, more fitting statistical analyses are used to evaluate equivalence for within and between group comparisons, such as Bayesian Regression with a region of practical equivalence. In terms of sample size, it is probable that low samples in L3 research have occurred as a result of the difficulty in finding subjects with similar enough backgrounds in three languages. To work around the issue of low availability in participants, bilinguals' first exposure to a third language is studied in the present dissertation. It is likely that relatively homogeneous populations of bilinguals are in greater supply than trilingual populations, particularly when suggested methodological practices are to be used, such as the use of mirror-image groups (groups with the same L3 but opposite order of acquisition). With the increase in sample size, more precise observations and conclusions may be drawn about the very starting point of L3 phonological acquisition which are far less likely to be explained by statistical

limitations such as sampling error.

Additionally, first exposure to the L3 can be very valuable information when it comes to modeling third language acquisition. Broadly, Third Language Acquisition (L3A) refers to the acquisition of a third language by an individual who already speaks to languages. Current models of L3A do not always account for potential individual differences in CLI, and typically are restrictive in their predictions. By investigating first exposure, it is possible to gather evidence regarding whether there is a default state of L1 and L2 CLI at first exposure to an L3, and whether this relative language influence is variable at the individual level. If the goal of L3 models is to predict the trajectory of L3 acquisition, then it seems pivotal to uncover the potential variability of its starting point.

To deal with the potential impact of proficiency and dominance on L3 production and perception, L2 proficiency was measured using the LexTALE in English (Izura, Cuetos, & Brysbaert, 2016; Lemhöfer & Broersma, 2016) and Spanish (Izura, Cuetos, & Brysbaert, 2016). The Bilingual Language Profile (BLP) was used to measure language dominance and background (Birdsong, Gertken, & Amengual, 2012). Finally, participant groups will be exposed to either German or French, to examine how phonetic similarity across languages may play a role in the first exposure to an L3.

1.2 Cross-lingusitic language features

In order to gain insights into the relative influence of a first and second language the present dissertation makes use of both (relative) voice-onset time (VOT) in stop production and perception and spectral qualities of vowels, specifically the first and second formants, in vowel perception and production. In the following sections, the vocalic systems of Spanish, English, French, and German, as well as their respective uses of voice-onset time, are overviewed.

1.2.1 Voice-Onset Time

Voice-onset time (VOT) is a phonetic measure in milliseconds of the release of the closure and its relationship with the onset of the vibration of the vocal folds (Lisker & Abramson, 1964). In particular, when the vocal folds begin to vibrate prior to the release, this is described as pre-voicing and is characterized by a negative VOT value. On the other hand, when the release occurs prior to the onset of voicing, a positive VOT is measured. Stops with a positive VOT are considered phonetically voiceless, where a negative VOT is phonetically voiced. VOT has been found to be a primary acoustic cue in the distinction of stop consonants in many of the world's languages. However, the use of VOT to make distinctions between sounds is language specific. For example, Spanish and French belong to a classification of languages referred to as true-voicing languages (Lisker & Abramson, 1964). This label suggests that the difference between a stop consonant that is phonemically voiced, such as /b/, is also phonetically voiced (negative VOT) and its counterpart that is phonemically voiceless, such as /p/, is also phonetically voiceless (positive VOT). True voicing languages stand in contrast to aspirating languages, such as German and English, in that the phonemic categories /p/ and /b/ exist within these languages, but are distinct in the way that they make use of VOT. That is, in aspirating languages, /p/ typically has a long-lag VOT (a longer duration in milliseconds) than the true-voicing languages' /p/. In the latter case, /p/ also has positive VOT, but typically with a much shorter duration. The phoneme /b/, on the other hand, is often realized with a short-lag positive VOT in aspirating languages, in which it likely has acoustic/phonetic overlap with the true-voicing language /p/. In other words, true voicing languages, like Spanish and French, use lead (phonetically voiced) and short-lag (phonetically voiceless) VOT to distinguish stop consonants, where aspirating languages (English and German) use short-lag and long-lag VOT. Overall, these cross-linguistic differences in VOT provide a useful continuous measure that can provide insights into cross-linguistic influence.

1.2.2 Vocalic systems

Another useful language feature to examine cross-linguistic influence is the vowel inventory of each language. Studies examining the articulatory space of vowels typically involve spectral measurements such as formant frequencies. In these studies, the frequency of the at least first and second formants are measured and compared for each vowel. The first formant (F1) is an acoustic correlate for vowel height, with higher values corresponding to lower vowels. The second formant (F2) represents vowel frontness, with higher values corresponding to a more fronted vowel. The chosen languages also vary in the size of their vowel inventories. The Spanish vowel space is the smallest of the present study and consists of 5 distinct vowel monophthong categorizations (Bradlow, 1995). English, French and German have larger relative vowel spaces, where English has 11 monophthongs, and German has 14 (Bradlow, 1995; Jongman, Fourakis, & Sereno, 1989). French has as many as 16 phonemic vowel sounds.

Cross-linguistic differences in vowel spaces are important in part due to evidence that language specific L1 categories seem to matter during L2 learning. That is, previous research has identified patterns in learning novel vowel contrasts, where some are easier than others and this ease is driven by cross-linguistic similarity and vowel inventory size between languages. (Escudero & Vasiliev, 2011; Leussen & Escudero, 2015).

The main question of the present dissertation is how cross-linguistic acoustic similarity and language status effects interact in L3 acquisition. In other words, it will be examined whether L1 and L2 phonological systems have equal impact on the L3 in perception and production in that they are equally affected by cross-linguistic acoustic similarity, regardless of the most similar acoustic sound to an L3 sound is an L1 or L2 sound. Alternatively, it is possible that a privileged status of either the L1 or L2 could cause perception and production errors, in which L3 learners assimilate L3 sounds to a sound that is not the best acoustic match.

Chapter 2: Literature Review

2.1 Models of third language acquisition

Research in third language acquisition has attempted to model the interplay between L1 and L2 language systems and their cumulative influence in the process of the acquisition of a third. Among questions asked by third language models is whether the L1 or L2, or a combination of both languages, serves as the basis in L3 acquisition. This question is complicated in the context of multilingualism due to the widespread diversity in bilingual populations that include wide variation in ultimate attainment in adult L2 learners, and, in the case of phonological acquisition, wide variation in the production patterns of L2 segments. To date, the models of L3 acquisition have largely focused on morphosyntax.

2.1.1 The Cumulative Enhancement Model

The Cumulative Enhancement Model (CEM) (Flynn, Foley, & Vinnitskaya, 2004) was one of the first formal models of L3 acquisition in adulthood. The authors argued that L3 acquisition can provide unique insights about language learning that is not possible in L1 or L2 research alone. The key question in the founding of the CEM was whether the properties of the L1 maintain a privileged status in L3 acquisition, or if L3 acquisition is cumulative process, in which all grammatical properties of previously known languages impact subsequent language acquisition, and, importantly, are helpful. Flynn, Foley, & Vinnitskaya (2004) conducted a study to provide evidence for the newly proposed CEM. The study examined the production of restrictive relative clauses in adults and children who spoke L3 English (L1 Kazakh-L2 Russian). The results revealed similar performance on the experimental task by adults and children, and that the production of relative clauses was influenced by the participants' L2 Russian. This influence was facilitative, since this syntactic structure is common in Russian and English, but not Kazakh. The authors note, however, that the results of this study could also be explained by a special status for the L2, rather than the L1.

Berkes & Flynn (2012) conducted a further study to empirically test the predictions of the CEM. German L1 and Hungarian L1-German L2 speakers were tested in English (their L2 and L3). The authors found evidence that the L3 group performed better than the L2 group when the syntactic structure in question was L1-like, contrary to Flynn, Foley, & Vinnitskaya (2004), which found facilitation when L2 and L3 elements were similar. The authors argue that the results of these two studies taken together suggest that both the L1 and the L2 may influence the L3 grammar, and that these languages' influence help to produce target-like L3 productions, when the L3 has a common feature with either the L1 or the L2. A proposed issue with this model is that it can not explain non-facilitative influence from previous languages in the L3 (Rothman, 2011). Non-facilitation refers to when L3 performance is not target like and resembles performance in the L1 or L2. Several empirical studies have found evidence for non-facilitation in L3 tasks and would underly the predictions of further L3 models.

2.1.2 The L2 Status Factor Model

In contrast to the CEM, the L2 Status Factor Model (L2SF) predicts that the L2 will influence the L3 by default. This prediction stems from the proposed cognitive similarity between the L2 and the L3. These proposed cognitive similarities stem from the Declarative-Procedural model, which posits that the grammar of late learned languages are largely subserved by the declarative memory system, whereas early learned languages are subserved by procedural memory. Procedural and declarative memory are long term memory systems which serve distinct general cognitive functions. The declarative memory is largely used to store explicitly known knowledge, such as factual information. The procedural memory, on the other hand, subserves implicit knowledge and procedures, such as riding a bike. During first language acquisition, learning is argued to be largely implicit and is seen as a procedure in this view. Alternatively, L2 learning is associated with declarative memory and explicit learning of a grammar, at least to a larger extent than L1 learning (Paradis, 2009) As a result, the L2 Status Factor does not make predictions in L3 learning for simultaneous

bilinguals, since it is argued that both of their languages are procedural. In summary, the L2 Status Factor predicts that, due to the cognitive similarity between a late-learned L2 and L3, the L2 will influence the L3 by default. Likewise, unlike the CEM, this influence will not always be facilitative, and is predicted to block access to the L1.

Several studies have found L2 influence in L3 tasks. In an early study Bardel & Falk (2007) examined two sets of participants learning Swedish as an L3 (n = 5), and either Dutch or Swedish as the L3 (n = 4). The participants varied in their L1 and L2, and sometimes spoke three languages (which the authors classified as 2 L2s). This design was chosen to vary the order of acquisition of V2 and non-V2 languages, which differ in their placement of negation. An inspection of individual language background by the participants in Bardel & Falk (2007) (p 471-472) reveals that 4 of the participants spoke a non-V2 L1 and a V2 L2, and the remaining 5 spoke a V2 L1 and non-V2 L2. The researchers were investigating whether cross-linguistic similarity (the presence or absence of V2 in the L1 or L2) affected the production of V2 in the L3. The results provided evidence that that the group with the V2 L2 outperformed the non-V2 L2 group. The authors took this result as evidence for a privileged status of the L2 in L3 production, despite its lack of facilitation. These results contradict the predictions of the CEM, which suggested that L3 learning is a cumulative process that takes advantage both L1 and L2 grammars in L3 learning.

The L2 Status Factor model has seen further empirical support in studies examining L3 syntax. Bayona (2009) examined the acquisition of middle and impersonal passive constructions in L2 and L3 Spanish. The L2 group consisted on mostly English L1 speakers, and the L3 group consisted of English L1 and French L2 speakers. The author found that the L3 Spanish group was more accurate in rejection or acceptance of target-like use of middle and passive constructions in L3 Spanish than the L2 group. These results suggest that the L2 influenced that L3, and provided evidence for both the L2 Status Factor and the Cumulative Enhancement Model. In another early study, Leung (2005) investigated the acquisition of determiner phrases and adjective word order in French as an L2 (L1 Vietnamese) and L3 (L1 Cantonese-L2 English). Using a

battery of tests, the authors concluded that the L3 group experienced influence from their L2 in both determiner phrases, which was facilitative in this case, and adjective order, which resulted in non-target like pre-nominal French adjectives. In this case, the results could arguably be accounted for by the L2 Status Factor, while the CEM cannot explain non-facilitation. However, the author's narrative conclusion of these results did not claim that there was sole access to the L2, or that the L1 was blocked. Rather, they suggest that L3 learning is not simply another case of L2 learning, in which the L1 is the sole influence.

This result was replicated in other studies. For instance, Bohnacker (2006) found that L1 Swedish-L2 English-L3 German speakers showed evidence of English like word order in L3 German V2 constructions, rather than facilitative L1 Swedish, Additionally, Falk & Bardel (2011) found that 44 L3 German learners with L1 English-L2 French or L1 French-L2 English behaved differently in tasks involving object pronoun placement. This distinct behavior was likened to L2 influence and suggested that order of acquisition was more deterministic in predicting CLI than typology. Interestingly, later studies found that L1 access was possible when learners had higher metalinguistic awareness of cross-linguistic similarity between the L1 and the L3. In a study of L3 learners of a V2 language who spoke a V2 L1 and non-V2 L2, Falk, Lindqvist, & Bardel (2015), participants were given a survey which measured their awareness of cross-linguistic features in their known languages. The results revealed that participants who scored higher on the metalinguistic survey also showed evidence of facilitative influence of their L1. This outcome led the authors to revise the predictions of the L2SF to include the potential for L1 influence when metalinguistic awareness is high.

2.1.3 The Typological Primacy Model

Later studies in L3 morphosyntax would first aim to demonstrate that influence of previously known languages in L3A is not always facilitative, and would then suggest an alternative explanation and methodology for the results found in previous studies

supporting L2 influence in L3 acquisition. In one such study, Rothman & Cabrelli Amaro (2010) aimed to demonstrate that the influence of previously known languages is not always helpful, as the CEM predicts, by examining null subjects in L3 learners. The study included two groups of Spanish-English bilinguals who were learning either L3 French or L3 Italian. Importantly, all participants spoke L2 Spanish, which allows for null subjects, and spoke either L3 French (obligatory overt subjects) or L3 Italian (optional null subjects). As a result, dropping a subject in L3 French would result in non-target like production, where the opposite would be true in L3 Italian. The authors found that the data from this study provided evidence that the L2 was the influence on L3 production in both L3 groups, and provided evidence against the CEM, since the French group experimented non-facilitative effects from a previously learned languages, and the L2 Status Factor, since neither group showed evidence of L1 influence. Despite these results, the authors posited that it was possible that the perception of cross-linguistic structural similarity (Kellerman, 1983) could also be a potential explanation for the results obtained in (Rothman & Cabrelli Amaro, 2010).

Eventually, this perspective was formalized as The Typological Primacy Model (Rothman, 2010, 2011, 2013, 2015) (TPM). TPM, like the L2SF, predicts that a single language will influence the L3, but differs in that this language may be either the L1 or the L2, and that which language transfers to the L3 is determined by psychotypology after exposure to input. Rothman (2015) explains that L3 input is parsed in a hierarchical manners in which the lexicon is the primary cue parsed to determine cross-linguistic similarity between the L3 and the languages known by the L3 learner, followed by phonological or phonotactic cues, functional morphology and finally by syntactic structure. Importantly, the transfer of one grammar holistically is predicted to occur during the initial stages of acquisition. This idea of initial stages is described by Rothman as "very early in the L3 process" Rothman (2015, p. 180). At what the TPM refers to the "absolute initial state," it suggests that both languages are in principle available to the L3 learner, but does not elaborate or make predictions as to how features of the L1 and L2 will affect absolute initial state perception and

production. The present dissertation refers to the "absolute initial state" as "first exposure" to avoid potential misunderstandings regarding the amount of exposure that L3 learners have prior to the experimental tasks done in the present dissertation. As a result, the TPM does not make clear predictions in the context of the present dissertation, since the learners examined here are intended to perceive and produce the L3 at their very first exposure. Nonetheless, the TPM would best be able to account for results in which L3 speakers produce and perceive the L3 in a practically equivalent manner to their L1 or L2 in a cross-sectional design, rather than solely the L2.

Several published studies include conclusions in which the TPM is supported. In the discussion of Rothman & Cabrelli Amaro (2010), the authors suggested that it could not be determined whether L3 performance was due to L2 effects or psychotypology. As a result, the authors suggested the use of language combinations in which the order of acquisition of L1 and L2 are reversed. These groups, sometimes referred to as mirror-image groups, would include groups such as L1 Spanish-L2 English and L1 English-L2 Spanish speakers who learned the same L3. In this view, between-group performance should be similar if transfer is driven by psychotypology, and groups should behave differently if L2 status is deterministic. For example, if mirror-image groups had been used in Rothman & Cabrelli Amaro (2010) with L1 Spanish-L2 English and L1 English-L2 Spanish groups, the acceptance or rejection of L3 null subjects would allow for the examination of the predictive power of L2 status and psychotypology relative to one another. In a future study using this methodology, Rothman (2011) aimed to investigate whether L3 Brazilian Portuguese would be influenced by Spanish both when it was and was not the L2. The study examined adjective placement and meaning in the L3. The first group consisted of L1 Italian-L2 English speakers learning L3 Spanish, while the second group spoke L1 English and L2 Spanish and was learning L3 Brazilian Portuguese (BP). Based on the absence of a main effect for group in a one-way ANOVA, Rothman (2011) concluded that there was similar performance between groups and used this as evidence for the basis of the

TPM. These results suggested that both groups performed in a target-like manner on the experimental task and also supported the Cumulative Enhancement Model.

Following the formal introduction of the TPM, further studies included mirror-image groups in their design and aimed to test the predictions of the model relative to the L2 Status Factor. Several of these studies involve the acquisition of L3 Brazilian Portuguese (BP) by Spanish-English bilinguals in both orders of acquisition. Montrul, Dias, & Santos (2011) examined the production of clitic and object expressions in L3 BP by mirror-image groups of Spanish-English bilinguals. Using an oral production task and a written Acceptability Judgment Task, (AJT), it was found that L3 BP was influenced by Spanish whether it was the L1 or the L2 of the participants. Examining the same language combination and using similar mirror-image groups, Giancaspro, Halloran, & Iverson (2015) also found investigated the use of differential object marking (DOM) in L3 BP. The results suggested that Spanish influenced L3 BP whether it was the L1 or the L2. Like Montrul, Dias, & Santos (2011), Parma (2017) also investigated L3 BP clitic development and expanded upon previous studies by including both a perception and production task. Another novelty of Parma (2017) was the inclusion of an online measure, a self-paced reading task, to measure comprehension, while the study also included a story-telling task to measure production. The results of the comprehension task did not find a reliable difference between experimental conditions. The production task, on the other hand, found evidence of errors in clitic production in L3 BP by both L1 and L2 Spanish speakers that could be likened to Spanish influence. The results of these studies provided evidence contrary to the predictions of the L2 Status Factor and suggest that Spanish influences L3 BP.

Following these initial results in the language combination of L3 BP with English and Spanish, other studies aimed to test whether either the L1 or the L2 could influence performance on L3 tasks. The evidence outside of the BP/Spanish/English triad has been more limited and controversial. Some accounts in favor of the TPM's predictive power have aimed to accumulate evidence in its favor. For instance, in a recent systematic review of 92 studies in L3 acquisition, Puig-Mayenco, González

Alonso, & Rothman (2020) concluded that, in support of the TPM, that either the L1 or L2 influenced L3 performance in 59 out of 92 studies. On the other hand, 29 of the studies out of 92 found that the L2 influenced the L3. Importantly, the findings were not coded in a mutually exclusive manner, since the authors coded 25 total studies as being explained both by L2 status and typology, meaning that the results of these studies reported that the L2 transferred to the L3, but could not rule out the possibility that psycho-typological transfer could also explain the results, since the studies did not use mirror image groups (i.e., L3 groups with the same languages, but the opposite order of acquisition). A closer examination of this systematic review reveals, however, that the coding procedure did not follow a clear objective criterion. That is, there are instances in which the coding provided by the authors in the appendix contradicts the narrative conclusions of the cited studies, and it is unclear how the authors of the systematic review determined when to depart from the conclusions of authors of studies and when they decided not to.

Limitations of the TPM in addition to the lack of robust and cross-linguistic support include overstated predictive power and over-interpretation of results. The potential problem when it comes to the predictive power of the TPM is the vagueness associated with the term "initial stages" of L3 acquisition. Puig-Mayenco, González Alonso, & Rothman (2020) describes this as some 20-25 hours of instruction, before which time access to either language is possible. This vague criterion makes it quite difficult to derive the predictions of the TPM in the case of learners who first encounter an L3. The problem of over-interpretation can be seen in the use of single language properties and inappropriate statistical tests to justify narrative conclusions. For example, the TPM is rather explicit in its prediction that languages transfer holistically to the L3, rather than on a property-by-property basis that the CEM would suggest. While, some of the evidence gathered to date provides counter-evidence to sole L2 influence on the L3, it is unclear how these studies support holistic transfer. In other words, it does not seem that the body of evidence can rule out the influence of both languages within the property examined, since small samples which provide inconclusive results

(non-significant p-values) do not entail equivalence within or between subjects. Such small samples and choices of methods do not allow for potential gradient and small effects of co-activation to be observed. This is due to the idea that, on one hand, it is not possible to determine whether group results have to do with sampling issues, and, on the other, clear criteria for co-activation of both languages known by a bilingual was not explicitly included in predictions and design of these studies. As a result, in the case of the L3 BP studies, it cannot be determined based on the results of studies to date that Spanish is solely activated and that English is not activated. Telling this would require much larger samples and clear criteria for interpreting how results support models prior to data collection, which could include potential for non-binary interpretation of data.

2.1.4 The Linguistic Proximity Model

The prediction that a sole language will influence L3 production and perception is not shared by all models. More recent models of L3 acquisition, like the CEM, predict that both the L1 and the L2 are available to influence an L3. For example, the Linguistic Proximity Model (LPM) predicts that there is full transfer potential (FTP) of either linguistic system, but that this occurs in a gradient fashion and on a property-by-property basis (Westergaard, 2021; Westergaard, Mitrofanova, Mykhaylyk, & Rodina, 2017). In the founding article of the LPM, Westergaard, Mitrofanova, Mykhaylyk, & Rodina (2017) posed several research questions. In addition to investigating whether a sole language influences an L3, they also examined whether CLI comes from the more typologically similar language, and whether this influence is facilitative. To provide evidence that could aid in answering these questions, the authors recruited 22 Norwegian-Russian simultaneous bilinguals who spoke English as an L3. The participants completed a binary Grammaticality Judgment Task related to verb movement. The results of the tasks indicated that, compared to L1 Norwegian speaking children, bilingual children were able to benefit from their knowledge of Russian when learning L3 English. At the same time, the bilingual participants did not perform as well as L1 Russian children learning English. The authors interpreted

these results, taken together, as influence from both the L1 and the L2 in the L3 English of the Russian-Norwegian bilingual children. That is, the intermediate score of the Russian-Norwegian simultaneous bilingual children learning L3 English relative to the comparison groups was taken as evidence of the co-occurrence of facilitative influence from their Russian and non-facilitative influence from their Norwegian.

The LPM, like the TPM and CEM, predicts that similarities between languages plays a major role in L3 acquisition, rather than order of acquisition, as the L2 Status Factor predicts. The LPM departs from the TPM in that it predicts that abstract structural properties causes CLI, rather than the general perceived typological proximity. In other words, it suggests that cross-linguistic influence is decided on a feature-by-feature basis, rather than generalizing whole language predictions. Additionally, the LPM predicts that all languages are available to the L3 learner throughout the learning process, unlike the TPM.

A methodological consideration advocated for by the LPM is the use of subtractive groups. Unlike mirror image groups, which seek to compare two trilingual groups, subtractive groups compare L3 learners to L2 learners. In the case of the studies to date, L3 learners of English who speak Russian and Norwegian were compared to Russian L1/English L2 and Norwegian L1/English L2 groups. It has been argued that this design allows for gradient effects of both the L1 and L2 to be observed. That is, intermediate values in L3 performance on experimental tasks relative to the L2 performance of the comparison groups is taken as evidence of co-activation of both languages. On the other hand, if no difference could be found between L2 and L3 learners of the same language, the LPM would consider this evidence for the influence of a single language on the L3.

Following the introduction of the model, several studies have tested the predictions of the LPM. In order to test whether bilinguals have access to two languages during L3 learning, Mitrofanova & Westergaard (2018) conducted a study on Norwegian-Russian bilinguals and Norwegian monolinguals in which they taught them some of an artificial

language which was designed to contain Norwegian-like lexical items, but also Russian like case marking to distinguish subjects from objects. The results revealed that the bilingual group performed better than the monolingual group on a sentence/picture matching task, in which the monolinguals relied solely on word order when making decisions. These results suggested that the bilingual group was able to make use of both of their languages at first exposure. In a series of studies, Stadt, Hulk, & Sleeman (2016) examined L1 Dutch - L2 English - L3 French speakers in both English immersion and general Dutch-dominant educational settings. In the first study, the results of a Grammaticality Judgment Task indicated that third year the immersion group showed signs of heavy L2 influence in the L3, where the regular group showed evidence of CLI from both the L1 and the L2.

In a follow up study, the authors recruited 4th year students from the same educational background to investigate whether L2 influence would differ between 3rd and 4th year students (Stadt, Hulk, & Sleeman, 2018b). The results revealed that both 3rd and 4th year immersion groups behaved similarly and showed evidence of primarily English influence on their L3 judgments, though evidence for L1 influence was also found. In a second follow up study, the authors gave similar materials to the an L3 German group (Stadt, Hulk, & Sleeman, 2020). In this case, L3 German judgments were concluded to have been influenced by the more typologically similar L1 Dutch, rather than L2 English as found in the previous cases. Taken together, the results of these studies suggest that both typology and L2 Status may play a role in modeling the patterns of cross linguistic influence in an L3. Finally, these authors also conducted longitudinal study (Stadt, Hulk, & Sleeman, 2018a), again with L1 Dutch-L2 English-L3 French speakers. In this study, they found that the L1 was more influential in the beginning stages of L3 development, but that the L1 also maintained influence as L3 proficiency increased. In a more recent study, Jensen et al. (2021) investigated similar groups to Westergaard et al. (2017), in which simultaneous Russian-Norwegian bilinguals were compared to subtractive L1 Russian-L2 English and L1 Norwegian-L2 English groups, but included seven total linguistic properties.

The results indicated that the L3 group experienced facilitative influence in some cases, but non-facilitative influence in others. Additionally, the sources of this influence could be likened to either Russian or Norwegian. The results of studies, taken together, suggest that both languages are active in L3 learning, and it also appears that they remain active throughout L3 development.

Like other L3 models, the LPM has received criticism. Scholars have argued that the LPM makes vague predictions that create a problem in modeling L3 transfer acquisition (Bardel & Falk, 2021; Wrembel, 2021), since it is unclear when transfer of a particular structure occurs and when it does not. Likewise researchers have argued that, unlike the TPM and the L2SF, the LPM is not easily falsifiable (Bardel & Falk, 2021). However, Westergaard (2021) argue that the LPM does make specific predictions, since it is predicted that accuracy should fall between L1 and L2 values on experimental tasks. The authors state that, when using subtractive groups, if the L3 group performance falls above or below the one of the two L2 groups, then then model would be falsified.

Additionally, it is notable that the empirical studies that serve as the basis of the LPM (Westergaard, 2021; Westergaard, Mitrofanova, Mykhaylyk, & Rodina, 2017) utilize groups of simultaneous bilinguals, which do not allow for the examination of potential L2 status effects. Following this idea, Westergaard, Mitrofanova, Mykhaylyk, & Rodina (2017) suggest that an optimal design to examine both the individual contributions of languages, as well as potential language status effects, would be the so-called fully combined design. This suggestion entails the use of both mirror-image groups, as seen in the TPM studies (e.g. L1 Spanish-L2 English-L3 BP and L1 English-L2 Spanish-L3 BP), and subtractive groups (e.g. L1 Spanish-L2 English-L3 BP, L1 Spanish-L2 BP and L1 English-L2 BP) used in the LPM studies. As a result, a fully combined design would result in the use of 6 total groups, in which a mirror image design contains L1 speakers of both background languages who learn the L3 as an L2.

2.1.5 The Scalpel Model

The Scalpel Model (Slabakova, 2017) is an additional model of L3A which overlaps in many of its predictions with the LPM. Like the LPM, the Scalpel Model rejects the idea of wholesale transfer of either L1 or L2 proposed by the TPM. Rather, it suggests that, given L3 input, the L1 and L2 combined grammar should successfully extract facilitative features from the input. In this view, non-facilitation is driven by misleading, processing complexity, and frequency of a construction. That is, more complex constructions and less frequent constructions are predicted to be associated with non-facilitative CLI.

The major divergence of the Scalpel Model from other L3 modes lies in its focus on the role of input in driving non-facilitation. Evidence for this claim comes from 2 empirical studies. Both studies examined three groups of participants L1 Basque-L2 Spanish-L3 English, L1 Spanish-L2 Basque-L3 English, and L1 Spanish-L2 English (García Mayo & Slabakova, 2015; Slabakova & García Mayo, 2015). García Mayo & Slabakova (2015) tested the use of null objects, which are not allowed in English, they are in Basque and sometimes in Spanish. Using speaker judgments, the results showed that null objects were often correctly rejected in L3 English. The second study, examining the same groups, focused on topicalization (Slabakova & García Mayo, 2015). In this case, L3 English speakers did not show evidence of target like behavior on grammaticality judgment tasks. The results of these studies suggest that one feature, topicalization, is difficult to acquire, where null objects was easier to acquire in L3 English. The author suggests that this difficulty could be explained the likely lower frequency of topicalization in L3 English input relative to the lack of null objects. Overall, the predictions of the Scalpel Model at first exposure might suggest that facilitation would occur in the event that the L3 stimulus has a clear bias to the L1 or the L2. That is, the Scalpel Model and the CEM should share similar predictions for the behavior of L3 learners at first exposure, but differ as the L3 develops. The Scalpel Model does not seem to predict or concur with the prediction of the LPM that L3 performance on experimental task should fall between L1 and L2 performance.

2.2 Models of L2 phonological acquisition

Notably, much of the evidence for the L3 models to date come from studies which examine the acquisition of (morpho)syntactic features. The models do not always spell out specific predictions when it comes to L3 phonology. In the case of the TPM, full transfer could be taken to mean the transfer of an entire language system to the L3, including phonology, but this stipulation is not explicitly spelled out in the recent articles articulating the predictions and motivations of the TPM (Rothman, 2010, 2011, 2013, 2015). In the LPM, phonology is also not directly addressed, but there does not seem to be any reason why the same predictions should not apply to phonology as syntax. Specifically, the LPM should predict that L3 performance should be intermediate and fall between L1 and L2 performance on experimental tasks. Though a model of L3 phonological acquisition has yet to be proposed, the expansion of L2 models of phonological acquisition has been proposed (Wrembel, Marecka, & Kopečková, 2019).

Many accounts for L2 phonological acquisition exist. In general, these models all have in common that language-specific L1 categories drive L2 speech development. It is still not well known how the predictions of these models apply to L3 speech development when L2 categories are also theoretically available to the L3. In the section that follows, a brief overview of each model, along with its evidence, will be covered. Following the model introductions, its relationship and proposed expansion to L3 phonology will be discussed.

2.2.1 The Speech Learning Model

The original SLM (Flege, 1995) focuses on the acquisition of segments in the L2 and emphasizes the importance of cross-linguistic similarity in L2 speech learning. In this view, new segments are predicted to be easier to learn, where segments which have close matches in the L2 will be much harder to acquire at a native-like level. Essentially, the SLM proposes that L1 and L2 sounds are linked through a process referred to as "interlingual identification," in that the L2 sound encountered as first

exposure are seen as either good or bad phonetic variants of a native category (Flege, 1995). In this view, acquisition of L2 segments occurs after increased exposure to these segments, where segmental complexity modulates the rate of learning (Flege, Aoyama, & Bohn, 2021). Additionally, the SLM posits that allophonic variation and segment position matter, as opposed to the learning of a phoneme generalizing across positions. For instance, Iverson, Hazan, & Bannister (2005) conducted a study in which they successfully trained Japanese speakers to better identify /r/ and /l/ in word initial position, but that this training was not effective for word-medial or word-initial clusters containing liquids.

The original SLM also suggested that the age of first exposure (the younger the better), and L2 experience were important predictors to L2 learning success. The SLM makes a distinction between identification as opposed to categorization. The importance of this distinction involves the learning of phonetic variants during the learning process, which lead to new L2 phonetic category formations. For example, using a two-alternative forced choice task, Bohn & Flege (1992) asked Spanish monolinguals to identify English stops and provided them with pre-voiced, short lag and long lag stops as tokens. Importantly, Spanish monolinguals identified English stops as long lag /t/ as /t/, despite the lack of a long-lag category in their native inventory.

2.2.1.1 The revised SLM

The SLM was recently revised, and has updated some assumptions and predictions. The revised model maintained many of the same assumptions as the original, and importantly focuses on sequential bilinguals, where speech learning begins when the phonetic categories of the L1 have been established. According to Flege, Aoyama, & Bohn (2021), the updated tenets of the Revised Speech Learning Model (SLM-r) are that, first, phonetic categories are formed based on their statistical regularities in the input, such that greater exposure to a particular phonetic cue should be correlated with the re-tuning of that cue towards the input. Second, all learners make use of the same learning mechanisms in L2 learning that they do in native language learning. That is,

the SLM-r refutes the idea of a critical period for speech learning, and suggests that non-native production and perception is due to differences the quality and quantity of input between native speakers and L2 learners and L1 effects. Another important update to the SLM-r is the idea that perception and production co-evolve. In other words, the SLM-r does not predict that perception will precede production.

The revised model has not yet received empirical support, due to its recent revision. It is outside the scope of the present dissertation to evaluate the predictions of the SLM-r when it comes to statistically driven re-tuning of phonetic categories. However, the phonetic categories that are in place in a bilingual at the first exposure to L3 learning could be treated as an integrated inventory when it comes to L3 learning. Based on the idea that the same mechanisms are in place in L1 and L2 phonetic category formation, the same mechanisms should be in place for L3 phonetic category formation. In this view, the acoustic similarity of an L3 segment to an L1 or L2 segment should predict how difficult learning an L3 segment will be. In this view, there is not reason to predict a blocking of one language system (L1 or L2) provided that these systems have well-established phonetic categories.

2.2.2 The Perceptual Assimilation Model

Relative to the SLM, the Perceptual Assimilation Model (SLM) focuses on the perception of sound contrasts by L2 learners (Best & Tyler, 2007). The PAM involves various scenarios in which the cross-linguistic inventories of specific languages predict how easily L2 sounds will be to acquire. For instance, if a L2 learner's native language contains a contrast that also exists in the L2, then this contrast will be easily perceived in the L2 (two-category assimilation). In the event that two native language categories correspond the a single L2 category (single category assimilation), discrimination is predicted to be intermediate. In the event that two non-native sounds are equally good exemplars on an L1 category (uncategorized assimilation) discrimination is predicted to be poorer.

Evidence for the predictions of the PAM has been found in studies which involve

the presentation of sounds to naive learners of an L2 (first exposure), or to more experienced L2 learners. Experiments typically present the subjects with native-language vowel categories in written form and auditory stimuli of L2 vowel sounds and participants are tasked with choosing the closet matching native-language vowel category given the options, and to rate the goodness of fit of this decision.

This methodological paradigm has found evidence that two category assimilation is difficult for L2 learners. For example, Escudero & Chládková (2010) found that Spanish L1 speakers assimilated SSBE /ae/ and /a/ to Spanish /a/ (that discrimination of this contrast was difficult). Additionally, Escudero, Sisinni, & Grimaldi (2014) provided evidence that Salento Italian L1 speakers assimilated SSBE /ae/, /a/ and /ˆ/ to Salento Italian /a/, while Escudero & Vasiliev (2011) Spanish speakers assimilated Canadian English /ae/ and /e/ to Spanish /a/. Finally, Escudero & Williams (2011) found that Spanish listeners assimilated the two categories in Dutch /a/ and /a:/ to their single Spanish category /a/.

The present dissertation tests whether assimilation acquired during second language acquisition apply to third language sound perception. In other words, it tests whether L3 perception mirrors L2 perception in similar ways that has been observed in L3 production. Specifically, it tests whether L3 speakers categorize L3 sounds similarly to L2 sounds, and whether phonetic discrimination of sounds that would be phonemic in the L1 is accessible in the perception of L3 words at first exposure, or whether there is an initial blocking or the L1 or L2 bias effect.

2.2.3 The Second Language Linguistic Perception Model

The Second Language Linguistic Perception Model (L2LP) is a computational model of L2 speech learning and is similar to the PAM in that it focuses on sound contrasts as the basis for L2 speech learning, rather than single segments (Leussen & Escudero, 2015). In this view, it is difficult for L2 learners to make contrasts which are not present in their L1. In their revision of the L2LP, van Leussen & Escudero support this claim with several empirical studies. Namely, that these studies have provided

evidence that L2 learners experience difficulty with the contrasts of /r/ and /l/ in Japanese, (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004) "beat" and "bit" in Spanish and Portuguese (Flege, Frieda, & Nozawa, 1997) "bet" and "bat" in Dutch (Broersma, 2005). The authors argue that these results suggest that linguistic experience is at the heart of L2 learning. Specifically, cross-linguistic comparisons of L1 categories and L2 categories are thought to predict the ease of L2 category learning. The L2LP, unlike the PAM and the SLM, also aims to model the entire learning process, rather than the beginning stages of L2 speech learning. This entire learning process is predicted computationally and is based on Stochastic Optimality Theory (Boersma, 1998).

An important postulate of the L2LP is the optimal perception hypothesis. Essentially, this proposal suggests that the initial perception of L2 sounds is the result of L1 acquisition. The developmental of L2 learners is predicted similarly to PAM, where a single category assimilation from PAM, in which a native category must be split, is called a new category scenario in the L2LP. This scenario is predicted by both models to be difficult for the L2 learner. On the other hand, the PAM and the L2LP predict that the case when two L1 sounds correspond well to two L2 sounds that discrimination of these sounds will be relatively easier. This is referred to as a single category assimilation in PAM and a similar scenario in the L2LP. The final scenario of the L2LP is the subset scenario. In this case, a single L2 phoneme is perceived as two L1 categories. The same case is referred to as uncategorized or categorized-uncategorized in the PAM, and both models predict that discrimination of these sounds will be better than the case of new scenarios, but not as good as discrimination of subset scenarios.

Empirical support has been found for these predictions. In two-category assimilation/similar scenario, Escudero & Boersma (2004), native Dutch speakers assimilated the Spanish /i/ to their native Dutch /i/, and the Spanish /e/ to their Dutch /I/. However, the L2LP predicts that the similar (two-category assimilation) scenario may lead to inappropriate lexical contrasts, and argues that pre-lexical and lexical contrasts

should be taken into account when it comes to sound discrimination. Evidence for this claim stems from studies which found that L2 learners could not perceive a contrast in lexical items that they could discriminate outside of lexical items (Curtin, Goad, & Pater, 1998). Other studies show that some lexical items can also be reliably distinguished by L2 learners that could not be told apart pre-lexically (Cutler, Weber, & Otake, 2006; Weber & Cutler, 2004). As a result, an important tenet of the revised L2LP (Leussen & Escudero, 2015) is that meaning-driven learning predicts the developmental path of L2 phoneme perception. The L2LP simulates the entire trajectory of L2 learning based on the various learning scenarios. In the revised L2LP, Leussen & Escudero (2015) suggest that category reduction is possible when it is driven by meaning based learning.

The predictions of the L2LP which are important for the present dissertation are the Full Copying hypothesis. If L3 phonological learning is another instance of L2 learning, then the L2LP and the TPM should share the prediction that the initial state of L3 learning is the end state of either L1 or L2 learning, but not both. In this view, bilingual participants who are first exposed to an L3 should produce and categorize L3 sounds as similarly to a single language, rather than producing or perceiving some sounds as L1-like and others as L2-like. Additionally, these participants' behavior on the experimental tasks should a) resemble either their own L2 behavior or L1 behavior or b) in the case of L1 influence, resemble a monolingual comparison group who is first exposed to an L2 (e.g. Spanish L1, English L2, exposed to German, and Spanish L1 exposed to German should behave similarly if Spanish is language which is "fully copied" at first exposure.)

2.3 Previous literature in L3 phonology

In the research to date, L3 models have focused largely on empirical results stemming from experiments in morpho-syntax to derive predictions about how the L1 and L2 affect L3 acquisition. Fewer studies have been conducted in L3 phonology, and it remains unclear whether L3 models make specific predictions for phonology and

morphosyntax. Despite this lack of specificity in the models when it comes to phonology, some trends have emerged in the body of research. Specifically, it appears that the L1 and L2 likely both affect L3 perception and production, with the L2 often providing a greater level of influence in the beginning stages of acquisition, even when it is not facilitative. This trend cannot readily be accounted for by the TPM, the L2SF, the CEM nor the Scalpel Model, leaving only the LPM which can predict co-activation of all languages known by a bilingual in L3 acquisition. The following sections cover the empirical studies that have been done in L3 production studies across L3 proficiency levels, and the fewer studies carried out in L3 perception, as well as their relevance to L3 models.

2.3.1 L3 Production Studies

The findings in empirical studies of L3 phonological cross-linguistic influence have varied. One of the first studies to examine progressive influence of the L1 or L2 on L3 production was the seminal case study of williams_language_1998. This study elicited the production of an adult L1 British English, L2 German, and L3 Swedish speaker in the L2 and L3 upon her arrival to Sweden. The speech samples were rated for native-likeness by native speakers of German and Swedish respectively, with low ratings (i.e. non-nativeness) being elaborated upon. In the event of non-native speech, the raters guessed where the speaker in the recording might be from. The informant was rated as having near native productions in her L2 German, while her L3 Swedish was rated as being non-native like and to be German-accented. The experiment was repeated after 6 months in Sweden, however, and the Swedish raters then judged the informant's Swedish to be British English accented.

This study constituted evidence of an L2 status effect in the initial stages of L3 phonological acquisition, in which the second learned language influence L3 production, but also provided evidence that this effect diminishes as L3 proficiency increases. This notion has been called the 'foreign language effect' (Meisel, 1983), which refers to the idea that speakers who learn a second non-native language are biased to sound unlike

a native speaker of their native language.

The default L2 status effect has received some empirical support in the L3 phonology literature. In a study of global accent production, heavier L2 influence in L3 productions was found by L1 Polish, L2 German and L3 English speakers based on ratings of EFL instructors (Wrembel, 2010). Similar findings have also been reported in vowel production (Kamiyama, 2007) and vowel reduction and speech rhythm (Gut, 2010). L2 influence has also been found in VOT productions. Llama, Cardoso, & Collins (2010) examined L3 Spanish VOT production by French-English mirror-image bilingual groups and found that both groups had L2-like productions of the L3.

Other findings in L3 production, however, have yielded mixed results. Several studies have found that acoustic properties of the participants' productions fall between L1 and L3 values, suggesting that both the L1 and the L2 have some influence on L3 productions, rather than solely one language. For instance, (Wrembel, 2014) measured VOT and aspiration in all languages of participants with two different language combinations: L1 Polish, L2 English, and L3 French; (2) L1 Polish, L2 English, and L3 German. The results showed that each language had a specific stop-value, and that the L3 VOT productions were intermediate, falling between the L1 and L2 values. Similarly, (Wrembel, 2011) examined thirty-two learners of L3 French with L1 Polish and L2 English who were recorded reading lists of words in carrier phrases. As in previous studies (Wrembel, 2014), combined transfer from the L1 and the L2 in VOT productions was found. Findings of combined L1 and L2 influence in VOT productions were also reported by Wunder (2010) in L3 Spanish speakers, and by Blank & Zimmer (2009) in L3 English speakers who spoke L1 Brazilian Portuguese and L2 French. Other studies have found an L1 influence on production despite L3 proficiency (Wrembel, 2012), or in advanced L3 learners (Llama & Cardoso, 2018). Importantly, these studies report L3 VOT values which fall between L1 and L2 values. Following the suspicion that intermediate values might have to do with either sampling issues or proficiency effects, Parrish (2021) examined Mexican Spanish-English bilinguals who produced voiceless stop-initial French words in isolation at first exposure to the language. The

results found that the relative VOT of the L3 fell between their own L1 and L2 values, in line with previous research, and that suggested that intermediate values were less likely to have been seen in previous studies as a result of small samples or proficiency effects. However, a subsequent analysis of the data suggested that wide individual variation existed, in which some participants produced L3 French as L1 Spanish like, and other produced intermediate, L2-like values. This result suggests that higher samples could reveal group trends and provide better insights into individual variation in crosslinguistic influence, as opposed to assuming that a single group trend exists.

2.3.2 L3 Perception studies

Overall, studies in L3 perception have been much more scarce relative to studies in production. These few studies have often used methods found in L2 speech acquisition research, such as studies testing the predictions of the Perceptual Assimilation Model. For instance, Wrembel, Marecka, & Kopečková (2019) examined the categorization and discrimination of L3 vowels by 10 young trilinguals who spoke L1 German-L2 English-L3 Polish. To test categorization, a cross-linguistic similarity task was used in which participants heard minimal pairs of sounds and had to rate how similar sounds were on a 1-7 Likert scale. The results showed evidence that participants assimilated L3 sounds to both L1 and L2 categories, but preferred the L2. In a second experiment, and AX discrimination task was given to participants to evaluate whether retroflex and palato-alveolar silibant discrimination, a feature of Polish, could be accessed in L3 words. The results revealed that discrimination of the L1 Polish contrast was very good (84% accuracy), suggesting that L3 learners retain access to L1 sound contrasts in L3 words. Additionally, this language specific phonetic discrimination was attended to by even L3 beginners. Balas (2018) also used the PAM as a perceptual framework to work in and adapted it to L3 learners. The study recruited three groups of Polish L1 speakers, including two L3 groups (L1 Polish-L2 English-L3 Dutch and L1 Polish-L2 English-L3 Dutch). The third group spoke only English as an L2. All three groups were listened to Dutch vowels and were asked to categorize them given Polish vowel categories. Unfortunately, the L3 groups were not given L2 English

categories as options during this task, so the results of this study cannot directly provide evidence that L3 learners categorize L3 sounds using both the L1 and L2. The same study also conducted an AXB discrimination task of 8 Dutch vowels and found that discrimination was at ceiling for all vowels involved.

An additional line of research in L3 perception studies has pondered whether L3 learners have a general perceptual advantage over their L2 learning counterparts. In an early study, Werker (1986) investigated mono, bi and multilingual participants' discrimination of non-native perceptual contrasts and did not find any evidence that the bi or multilingual group had any perceptual advantage. Patihis, Oh, & Mogilner (2015) examined Korean stops by naive mono and multilingual listeners and found that phoneme discrimination was feature dependent, rather than bilingualism providing a general advantage. Antoniou, Best, & Tyler (2013) investigated the contrast of Ma'di stops by early English-Greek bilinguals, English monolinguals and Greek monolinguals. The researchers wanted to know whether language model affected categorization and discrimination. They found that categorization is modulated by language mode, but discrimination of novel sounds was not. In particular, the Greek monolingual group was most successful in the discrimination of the novel contrast, where the English monolingual group was the least accurate. The bilingual group, regardless of language mode, displayed intermediate ability to discriminate the novel sounds. In a further study, Antoniou, Liang, Ettlinger, & Wong (2015) taught mono and bilingual participants an artificial language based on either English or Mandarin. The results revealed that bilingual participants outlearned the monolingual groups overall, but universally more difficult unfamiliar L3 segments do no seem to be learned more easily by bilinguals. Wrembel, Gut, Kopečková, & Balas (2020) also found that cross-linguistic influence is structure dependent and varies among individuals. Onishi (2016) reported a bilingual advantage, but, rather than feature dependent, suggested that this advantage was global. The study involved speakers of Korean who spoke L2 English and L3 Japanese. The author found a correlation between successful discrimination of L3 contrasts and L2 experience, and argued that this correlation is

evidence for a bilingual advantage.

These findings suggest that crosslinguistic similarity of both a bilingual's languages play a role in the ease of acquiring a novel, L3 sound. Additionally, research focused on a bilingual advantage in phonetic learning can inform L3 models, since it implies that bilinguals have access to the phonetic categories in both languages that they speak, even at first exposure, whether or not the advantages of bilingualism on phonetic learning are global or feature dependent. Few studies have investigated the role of VOT in L3 perception. On such study is Z. Liu, Gorba, & Cebrian (2019), which examined the perceptual boundary of a VOT continuum in L1 Mandarin, L2 English and L3 Spanish. Using a /pi-bi/ continuum, the authors found that the perceptual boundaries of each language were 28ms for Chinese, 24.6ms for English and 23ms for Spanish. Despite the goal of the study being to examine regressive transfer and to compare the L3 speakers to monolinguals, descriptive evidence of L2 effects can be inferred from the reported means. Additionally, J. Liu & Lin (2021) examined perception and production of word-initial voiced and voiceless stops in speakers of L1 Mandarin, L2 English and L3 Russian or Japanese. The authors found that voiced stops were effectively perceived, but not reliably produced, where voiceless stops were both successfully perceived and produced.

2.4 Methods and anylsis in previous work

The widely varied findings in previous work do not have a clear plausible correlate, but may be related to issues related to sampling issues combined with methodological choices. In this subsection, an overview of sample sizes in previous work will be given, followed by potential issues related to small samples. Subsequently, common methods in the body of research used to analyze L3 data will be discussed, followed by their potential shortcomings. Finally, the manner in which the present dissertation addresses these issues will be covered.

Overall, it is unclear whether sufficient sample sizes have been used in the body of

research to date. Of the empirical studies reported in the present dissertation, none used a power analysis or otherwise justified their sample size per group. Unfortunately, the tradition in L3 research has involved model building with small samples. The use of small samples are associated with higher sampling error, and, as a result, a higher risk of type 1 error (Brysbaert, 2020). In other words, a single study with a small sample cannot rule out the possibility that their results are due to sampling error, or a non-representative pool of participants from an assumed population distribution. As Brysbaert (2020) argues, low samples lead to low statistical power, and in turn provide a metaphorically blurred picture of our desired outcome.

In addition to issues associated with low sample size, L3 research to date has used statistical methods which provide dubious evidence for their claims. Among these issues is the interpretation of the results of various inferential statistical methods, such as the lack of a main effect in an ANOVA, as a basis for determining whether groups or individuals perform experiment tasks in a practically equivalent manner rather than a statistical Test of Equivalence (Lakens, 2017). At the heart of this issue is a criticism which may apply to frequentist methods of statistical analysis in general; testing against the null hypothesis. If the null hypothesis is rejected, evidence is provided that the difference between or within groups is non-zero. On the other hand, if a non-zero difference is not found, there is not evidence for practical equivalence. Such as assumption has been made in the L3 literature, and in particular in L3 model building.

For example, in his seminal article introducing the Typological Primacy Model, Rothman (2011) concluded that two groups of L3 learners did not perform differently on the L3 Brazilian Portuguese acceptability judgment task and took this as evidence for similar performance between the groups, and evidence of typological similarity effects in L3 judgments. There are two possible issues with this conclusion. Firstly, the lack of a power analysis does not rule out sampling error. It cannot be argued that the sample used in this study was high enough to reliably detect an effect (or lacktherof). Secondly, a wide confidence interval from the low sample size would make

providing evidence for statistical equivalence in a test of equivalence likely impossible. Unfortunately, the reporting of results in many L3 studies to date do not allow for post-hoc power analyses to be run, since means and standard deviations are seldom reported. It remains unclear whether studies in L3 research are sufficiently powered to be able to generalize, and, by extension, to build models.

Despite the lack of empirical data available to evaluate the statistical power of L3 studies to date, it is probable that the sample sizes used are not statistically powered. Brysbaert (2020) argues that, for between group comparisons, samples of at least 80 per group are often necessary, but a power analysis should be carried out to justify sample size. To the present author's knowledge, no L3 study has been able to recruit this many participants per group. For instance, the seminal study motivating the TPM (Rothman, 2011) recruited just 11 and 15 in two groups. Plonsky (2015) suggests that combating issues associated with low sample size is possible in ways other than simply increasing sample size. For instance, he suggests that the use of descriptive statistics, including effect sizes and confidence intervals, would be an improvement in L2 research in general. This advice is in line with the idea that frequentist analysis, and linguistic research, has relied on p-values to determine the presence of a so-called significant statistical difference. Plonsky (2015), along with others, have argued that the use of p-value alone to make real-world inferences in problematic due to issues associated with sampling error and the presence of the magnitude of an effect.

In order to address these potential issues, the present dissertation recruited bilinguals, rather than trilinguals, at first exposure to a third language in order to pull from a likely higher and more homogeneous population of participants. This higher sample, coupled with the use of Bayesian inference allow for both a categorical and gradient interpretation of the data. In doing so, less reliance is put on a narrative interpretation of the results, and the results lend themselves to a more objective outcome.

2.4.1 Bringing L2 speech models and L3 models together and evaluating predictions

By using the methods used to test the prediction of models of L2 phonological acquisition (The SLM, the PAM, and the L2LP), more nuanced evidence may be obtained to evaluate the predictive power of L3 models. With the revision of the SLM, at least three L2 speech models advocate for the study of naive or beginning learners in L2 speech learning research. The present dissertation adopts this point of view and applies it in a third-language context in perception and production. By measuring the perception and production patterns of the first (or, at least, very early) exposure to a third language, coupled with measurements in each language, and the variation of cross-linguistic influence can be observed/studied in L3 perception and production. If, as the SLM-r predicts, category formation is driven by input and retuning of L1 categories in L2 acquisition, and the same mechanisms that are used in L1 phonetic category formation in L2 phonetic category formation, then it is reasonable to suppose that the SLM would predict that those same mechanisms are at play in L3 phonetic category formation, and that this process is guided by L3 input.

Following this logic, the question becomes whether L1 or L2 categories, or a combination of both, are retuned to L3 categories. Additionally, it is unclear what conditions determine which language category, whether L1 or L2, is initially chosen and its rate of retuning to become more target (L3) like as L3 input exposure increases. The present dissertation focuses on which category is chosen as the initial L3 category, while the rate of change in these categories is left for future research. One possibility which may influence whether an L1 or L2 category influences an L3 is the acoustic similarity of the L3 segment relative to an individuals' L1 and L2 phonetic categories. The TPM predicts that phonetic cues do play a role in L3 input parsing, in that they are parsed and used in order to make a decision of which language system to holistically transfer. However, the TPM would (likely) not predict that two segments would be assimilated to two distinct language categories. Additionally, if one language holistically impacts the acquisition of a third at first exposure, then the behavior of

L3 learners should resemble L2 learners, provided the L1 is the source of influence in L3 acquisition, or should be practically equivalent in a within-subject comparison. In the case of the predicted behavior of L2 influence on L3 productions, L2 production and perception should be practically equivalent in a within-subject comparison. The predictions of the Linguistic Proximity Model would be able to account for the same L3 sound being categorized differently by the same subject, and by different subjects, and for two different L3 sounds being categorized as an L1 and L2 category respectively.

Chapter 3: The Present Study

The present study investigates the production and perception of segments in words in a language by bilinguals that they do not yet know, specifically, French or German. In so doing, the present dissertation aims to investigate the very initial stage of L3 phonological acquisition acquisition by providing an overview of the initial relative influence of both L1 and L2. In this study, late Spanish-English bilinguals of both order of acquisition will be given an aspirating L3 (German) and a true-voicing L3 (French) to shadow. In perception, the participants will match L3 vowel sounds to L1 and L2 categories, and complete an AX discrimination task. Following these tasks, the link between perception and production will be analyzed and discussed.

3.1 Research Questions

The present dissertation is guided by the following research questions. Broadly, this project focuses on the influence of the L1 and L2 system on L3 perception and production, and how cross-linguistic similarity might predict this influence. By taking these factors into account, more precise evidence can be provided to evaluate the predictions of L3 models. The following section introduces a total of 7 research questions that will be covered over three total chapters. In each subsection, a research question will be introduced, followed by hypotheses and predictions, as well as additional possible outcomes and their interpretations.

3.1.1 Chapter 2: Production

RQ1: Will Spanish-English bilinguals produce L3 words with Spanish or English like VOT?

Based on the results of (Parrish, 2021), in which L3 VOT was found to fall between L1 and L2, it is predicted that these participants' L3 VOT will also fall between L1 and L2 values in both L3 German and L3 French. This result would support the Linguistic Proximity Model, which suggests that L3 learning is a case of co-activation

of the L1 and the L2. However, there are several other possible scenarios that would support other L3 models. If L3 VOT values are practically equivalent to L1 or L2 values, the Typological Primacy Model would be supported, since single language influence would be a plausible explanation of this result. If L3 VOT is also target like, and it practically equivalent to L1 or L2 VOT, then the Cumulative Enhancement Model and Scalpel Model could also explain the results. On the other hand, if L3 VOT is practically equivalent to L2 VOT, this result is not (always) facilitative, and mirror image groups with distinct L2s both show L2-like L3 VOT, the L2 Status Factor would be the only model capable of explaining the data.

Additionally, there are no specific predictions about whether each L3 segment will be influenced to a similar degree, or whether some segments will be more influenced by the L1 or L2 than others. The results of (Parrish, 2021) suggest that each segment was similarly influenced by the L1 and L2, but there was some variation. In terms of L3 models, again the LPM would be the only model that could account for variation in the activation of both languages across segments in which both L1 and L2 influence can be seen. If some segments were L1 like and others were L2 like, then the CEM, Scalpel Model, and LPM could account for this, where TPM the L2SF could not.

RQ2: Will Spanish-English bilinguals produce vowels more like English or Spanish?

The predictions in vowel production are analogous to those in stop production. It is predicted that L3 vowel production will be intermediate between L1 and L2 values. The evidence in support of L3 models and their predictions is also identical in the case of vowels. That is, full transfer models (TPM, L2SF) predict that each segment should be equally affected by the same source language, either the L2 (L2SF) or the closest typological language (TPM). Full transfer models would be supported in L3 production and perception were found to be practically equivalent to either the L1 or the L2 Partial transfer models (LPM, the Scalpel Model) suggest that production and perception L3 vowels are influenced by both the L1 and the L2 and that performance on experimental tasks of L3 vowels should fall between L1 and L2 performance.

RQ3: Will the same CLI trends be observed in L3 German as L3 French in production?

It is predicted that the phonetic differences in the input will affect the performance in the shadowing task, at least at the group level. In Parrish (2021), L1 Spanish-L2 English bilinguals shadowed French, which is phonetically similar to Spanish in its use of VOT to distinguish stop consonants. As a result, the French stimuli were unaspirated short lag stops. The group results, however, revealed that many participants aspirated word initial stops, presumably due to the influence of L2 English. This result suggested that L2 influence is frequent and pronounced in some participants. However, other participants produced target-like L3 French tokens. In this latter case, it was unclear whether L3 productions were target-like due to effective mimicry or language influence. By including a German L3 group, both explanations can be tested. If, between groups with the same order of acquisition, relative VOT of shadowed German tokens are practically equivalent to the relative VOT of shadowed French and they are not target-like, then the phonetics of the stimuli will not seem to be a contributing factor to L3 pronunciation. That is, for example, if L1 Spanish-L2 English speakers aspirate German and French at the same rates, despite the German tokens being aspirated and French tokens being unaspirated, then the aspiration of the input would not reliably predict L3 production patterns. If, on the other hand, L3 German VOT is aspirated more often than L3 French, it could be interpreted as evidence that the phonetic qualities of the input at first exposure to an L3 interact with language status effects. A third possibility is that typological similarity of segments is the most influential factor predicting L3 pronunciation at first exposure. In order for this view to be supported, close to target-like L3 production should be seen from both orders of acquisition. For example, if the L3 were French and if typological (acoustic) similarity was the most influential predictor, it would be expected for L1 Spanish-L2 English and L1 English-L2 Spanish speakers to produce L3 French as close to their own Spanish, whether or not it is the L2.

RQ4: Will primary influence of the L1 or L2 remain consistent in vowels and stops?

Generalization across segments in an important piece of evidence to evaluate the predictions of full transfer models in L3A, since it provides evidence for or against holistic influence. In particular, if stop categories are influenced by a specific language, then full transfer models, such as the TPM and L2SF would predict that vowel categories should be influenced by the same language. Alternatively, if stops and vowels are influenced by different languages known by the L3 learner, then this would falsify the predictions of full transfer models.

3.1.2 Chapter 3: Perception

RQ5: Will bilinguals categorize L3 vowel sounds using L1 and L2 categories?

A closely related question to generalization across L3 segments is whether the same sounds will be perceived and categorized using a single language's categories, or whether the same sound may be assigned to an L1 category in one instance, but an L2 category in another. If the same sound is categorized differently by the same speaker, and if those categorizations are both L1 and L2 categories, then this will be taken as evidence of uncertainty, and access to both languages in the event of this uncertainty. The predictions of L3 models would likely be the same in this case as the categorization of different sounds in L1 and L2 categories.

RQ6: Is language specific discrimination fully accessible in L3 words?

In addition to categorization, the present dissertation will test whether language specific perceptual discrimination is accessible during the first encounter to a third language. Such information is useful in examining whether potential issues in L3 perception is due to difficulty in auditory discrimination or whether language mode effects may be a more appropriate explanation for potential non-target like categorization of L3 sounds. That is, if the participants categorize L3 sounds to L2 sounds when an L1 sound is more acoustically similar, but they still are able to discriminate fine phonetic distinctions, then it could be plausible that L2 mode effects, rather than lack of discrimination, contribute to L3 categorization.

3.1.3 Chapter 4: Production and Perception

RQ7: Will the relative influence of a particular language perception match production?

It is unclear whether L3 models would predict that L3 perception and production develop in tandem, or whether perception should develop prior to production. Similarly to generalization, the link between perception and production can give information about how third language phonological acquisition may begin in terms of previous language influence. That is, the present dissertation will gather data that will shed light on not only whether single language influence affects all segments, but also whether this influence is distinct in perception and production. Currently, the predictions of L3 models are not well equipped to handle potential differences in perception and production. As a result, the outcome of the relationship between L3 perception and production will can only be evaluated by these models post-hoc.

3.2 Method

3.2.1 Participants

4 total groups of participants will take part in each experiment, in what Westergaard, Mitrofanova, Mykhaylyk, & Rodina (2017) refers to as a fully combined design. There will be 2 bilingual groups with opposite orders of acquisition, Spanish L1-English L2, and English L1-Spanish L2, with each of these groups hearing either L3 German and L3 French, and 2 monolingual English and monolingual Spanish groups, who also both shadow French or German. German and French were chosen as the third languages primarily due to the phonetic differences in voice-onset time, where French is a true-voicing language (like Spanish) and German is an aspirating language (like English). Additionally, German and English and French and Spanish are typologically related in a global sense (i.e., not necessarily on a structure by structure basis). As a result, the present design will allow for the examination of language status effects, global typology effects, and structure by structure similarity effects. By doing so, the relative influence of each of these factors can be determined in these populations, and

the evaluation of L3 model predictions can be carried out. Based on a power analysis carried out in (Parrish, 2021), the bilingual groups will contain 75 participants per group, where the monolingual groups will contain 50 participants per group, for a total of 250 participants.

3.2.2 Materials

Each participant will produce stop-initial tokens in each language that they speak, and shadow tokens in both L3s (French and German). In the case of the bilingual groups, this involves both a Spanish and English word reading task, where the monolingual groups will only complete the word reading task in their L1. Additionally, bilinguals participants will complete the LexTALE proficiency test in their L2 (Izura, Cuetos, & Brysbaert, 2016; Lemhöfer & Broersma, 2012), and the Bilingual Language Profile to gather biographical information.

3.2.2.1 Bilingual Language Profile

To measure language use and language dominance, the Bilingual Language Profile (BLP) (Birdsong, Gertken, & Amengual, 2012) will be used. The BLP is a self-report questionnaire which was designed to measure language dominance. The questionnaire asks several questions related to language use, attitudes, and age of acquisition in bilinguals. The answers are scales that include Likert scale, discrete numbers of years, and percentages of language use. The BLP can be administered online and was chosen for its comprehensiveness while also taking around 10 minutes to complete.

3.2.2.2 LexTALE

The LexTALE (Izura, Cuetos, & Brysbaert, 2016; Lemhöfer & Broersma, 2016) will be used to measure English and Spanish proficiency. The LexTALE is a lexical decision task, in which participants see either words or pseudowords on a screen one at a time. Participants are supposed to then decide whether the word presented is a real word in the language or a pseudoword. The task is intended to be a measure of vocabulary

size, which has been argued to correlate to language proficiency. Either the English and Spanish versions of the task will be used in the study, depending upon the L2 of participant.

3.2.2.3 Stimuli

The following conditions will be tested in the body of the present dissertation in both perception and production. The predictions in Figure 3.1 are those that would support the idea that cross linguistic acoustic similarity drives CLI patterns in L3A. Additionally, these broad predictions serve for both perception and production, since there is little evidence that suggests that these L3A CLI patterns are distinct. In Chapter 2, these L3 conditions will be produced in shadowing tasks, where the chosen words for each condition will be recorded by native speakers and embedded in an online experiment for participants to listen to and repeat. In Chapter 3, the perception, involving both categorization and discrimination, of these conditions will be examined. As a result, the predictions here will be evaluated separately for production (chapter 2) and perception (chapter 3), while evaluating the link between perception and production will be covered in Chapter 4.

The conditions were designed to examine the relative impact of cross-linguistic acoustic similarity of stops and vowels on the production and perception of stops and vowels. Condition 1 aims to avoid acoustic bias and uses a vowel sound, /i/, which is present in both English and Spanish, together with a fricative word onset /f/. In contrast, condition 2 uses a voiceless stop initial /p/, together with /i/, to investigate whether L3 French tokens and L3 German tokens are produced as similarly to their respective references. Condition 3 introduces a conflict, in which the Spanish vowel /o/ is paired with an aspirated /p/ in L3 German. In theory, these bilinguals have access to language specific phonemes which include the Spanish-like /o/, aspirated /p/ and unaspirated /p/, but it is unclear whether access to Spanish and English phonemes is possible within the same L3 word. By examining and comparing L3 productions in condition 3, insight can be gained as to whether two language specific

acoustic cues can be produced as target-like in the event that they are distinct and when they are the same. Condition 5 investigates an analogous circumstance, but uses an English-like vowel. Conditions 7 and 8 use a vowel not found in either English or Spanish, with a VOT bias (condition 7), and with a fricative (condition 8). If within-word acoustics influence the categorization of sounds within that word, then the vowel in these conditions should be produced distinctly in condition 7, but similarly in condition 8.

Production conditions and predictions

Condition	Example words	Vowel Prediction	Stop Prediction
Condition 1: No vowel bias No VOT bias	*fini* (French) *fif* *Viel* (German) *fif*	No difference	N/A
Condition 2: No vowel bias VOT bias	*pipe* (French) *pip* *piepen* (German) *piep*	No difference	French VOT will be Spanish-like. German VOT will be English-like.
Condition 3: Spanish vowel bias VOT bias	*pot* (French) *poppe* *pocht* (German) *pop*	No difference	**German VOT will be less aspirated than cond 2**
Condition 4: Spanish vowel bias No VOT bias	*fot* (French) *foffe* *focht* (German) *fof*	No difference	N/A
Condition 5: English vowel bias VOT bias	*pette* (French) *peppe* *pecht* (German) *pep*	German and French vowel will be Spanish-like,	**French VOT will be more aspirated than cond 4**
Condition 6: English vowel bias No VOT bias	*fete* (French) *fef* *fecht* (German) *fef*	No difference	N/A
Condition 7: Uncategorized vowel VOT bias	*puf* (French) *puf* *Püf* (German) *Püf*	No predictions	No predictions
Condition 8: Uncategorized vowel No VOT bias	*fu* (French) *fuf* *Fü* (German) *Füf*	No predictions	N/A

Figure 3.1: Vowel and stop conditions and predictions

3.2.2.4 Chapter 2: Shadowing Task

The shadowing task is designed to elicit productions of L3 words at first exposure. This task is the same as the shadowing task in Parrish (2021), but the word list has been updated and an L3 German block will be included During the task, the participants will see an orthographic representation of a word that they will shadow and they will

play a recording of that word produced by a native speaker. Then, on the same screen, the participant will record themselves repeating the word they just listened to by clicking a button to record, and the same button to stop recording. The participants will be able to listen to their recording, and then will click a separate button to submit their recording. The shadowing task will be programmed in Labvanced (Finger, Goeke, Diekamp, Kai, & Peter, 2016).

3.2.2.5 Chapter 2: Word Reading Tasks

Together with the shadowing task, the word reading tasks will be used to elicit L1 and L2 productions in order to make within-speaker comparisons between L1, L2 and L3. The word reading task be similar to the shadowing task, and is also replication of the method in Parrish (2021). In these tasks, words will be presented on the screen in isolation and orthographically. Participants will record themselves reading the word aloud and will be able to listen to their recording prior to submission. The stimuli in the word reading tasks will be similar cross-linguistic matches to the words used in the shadowing task. Specifically, voiceless stop-initial words will be used in all three places of articulation in one and two syllable words. All three places of articulation, as well as fricative initial stimuli, will be paired with high low and mid vowels. The word reading tasks will be programmed in Labvanced (Finger, Goeke, Diekamp, Kai, & Peter, 2016).

3.2.2.6 Chapter 2: Procedure

Participants will complete the experimental tasks in a semi-longitudinal fashion, in which each participant will complete 1 of 4 language specific blocks on different dates. Data collection will take place online and participants will be recruited using the online platform Prolific.co. Every potential participant will first complete a screening block, in which they will take the LexTALE (Izura, Cuetos, & Brysbaert, 2016; Lemhöfer & Broersma, 2016) in their L2 and the Bilingual Language Profile (Birdsong, Gertken, & Amengual, 2012). Exclusion criteria will include a LexTALE score under 50% correct

or knowledge of a third language. Once participants are eligible for the experimental tasks, they will begin with either L3, followed by the L1 or L2 in a counterbalanced manner. The blocks will begin with the production task, either a shadowing task (L3) or a word reading task (L1 and L2). Then, in the same experiment, the participant will complete the phoneme categorization task followed by the AX discrimination tasks. In order to control for potential language mode effects brought on by the experiment, the language specific blocks will be given of separate days. Instructions will be given in each block in the participant's native language, either English or Spanish.

3.2.2.7 Chapter 2: Analysis

In the production tasks, both vowel and stop production will be analyzed using Bayesian Multilevel regression models. In the case of stops, Voice Onset Time will be modeled as a function of language, consonant frame, LexTALE score, and a continuous dominance measure obtained from the BLP. Random intercepts will include words and participants. In vowel production, F1 and F2 will be modeled separately using the same predictors as the stop model. A region of practical equivalence (ROPE) will also be established to determine whether any differences in productions between two languages can be attributed to noise in the data, and provide evidence that two specific languages are being produced in a near-equivalent manner. Such evidence would entail the entire posterior distribution falling within the equivalence bounds.

3.2.2.8 Chapter 3: Perception

In order to examine perception of vowels, a phoneme categorization task will be carried out in both German and French in separate sessions on different days. During this task, participants will hear tokens produced by L1 German or French speakers, in which a vowel sound is embedded in a consonant frame and choose which English or Spanish sound that best matches the sound that they heard. The English and Spanish sounds will be presented orthographically on a screen in carrier words. One at a time, a stimulus sound will be played and the participant will choose its closest

match by clicking on the English or Spanish word on screen. Following their selection, the participants will rate how closely the sound they heard matches the selection that they chose by clicking a slider scale. The scale ranges from 1-7, but the selection is any point on the scale, thus rendering a continuous rating.

The stimulus sounds will be similar to the vowel sounds in the production sentences, and are listed in figure 3.2. The vowel sounds will be presented in two distinct consonant frames per language: a fricative frame (/fvf/) and a voiceless bilabial obstruent frame (/pVp/). These frames were chosen due to the similarity between German and English versus and Spanish and French bilabial stops, which are similar to one another. By including a bilabial frame, it is possible to determine whether language specific acoustic cues bias the categorization of the vowel sound to L1 or L2 categories. For example, in the case of the vowel sound /i/, which is present in both English and Spanish, if the bilabial consonant frame matters for vowel categorization, then the German frame should result in more selections of English categories, and the French frame should result in more selections of Spanish categories when the vowel sound is present in both English and Spanish. On the other hand, the fricative frame allows for the examination of selections when no or vowel only acoustic bias present. The experiment will be programmed in Psychopy (Peirce et al., 2019).

Phoneme	English word	Spanish word	French word	German word	Bias
/ɛ/	bet	-	*bête*	Bett	English
/e/	-	beta	*beauté*	Seele	Spanish
/ɪ/	bit	-	-	Mitte	English
/iː/	beat	bita	fini	viel	Both
/y/	-	-	tu	über	Neither
/ä/	bought	bata	-	Katze	Both
/o/	-	camión	sot	oder	Spanish
/ǫ/	-	bota	-	-	

Figure 3.2: Perception Conditions

In terms of discrimination, the present dissertation will focus on English vowel contrasts using an AX discrimination task. In particular, the discrimination task is designed to determine whether L3 learners have access to perceptual discrimination present in either their L1 or L2, or whether order of acquisition of languages may impact phonetic discrimination ability. In the AX discrimination task, the participants will hear a sequence of two words drawn from a *sheep-ship* like continuum in 2 language-specific (French and German) blocks and decide whether those words sound the same or different. The continua will be created by using the tokens from the German and French L1 speakers productions of the vowels in both consonant frames made for the phoneme categorization task and resynthesizing them using a Praat script. In addition, a second set of continua, using a *pat-pot* like continuum, will be created though this contrast is not present in French or German, to further test whether English vowel contrasts are accessible in L3 sounds. The continua will be purely spectral, and duration will be held constant. In each 7 step continuum, all 49 possible combinations of sound will be presented a total of three times each, resulting in 147 repetitions per continuum per participant. Each continuum will be created by resynthesizing L1 French and German informant speech using a PRAAT scripts. The task will be programmed in Psychopy (Peirce et al., 2019).

3.2.2.9 Chapter 3: Procedure

The procedure for chapter 3 is included in the procedure for chapter 2. That is, perception and production tasks will be given in four language specific blocks on different days, following a screening block. Instructions will be given in the L1 of the participant, either English or Spanish, during each block.

3.2.2.10 Chapter 3: Analysis

Phoneme categorization will be analyzed in a descriptive manner. Specifically, it will show the preferred category per condition per language, and its goodness ratings. This data will be visualized and used in comparison to both production and discrimination

data. The AX discrimination task will again use Bayesian linear regression to model correctness as a function of language, consonant frame, LexTALE score, and dominance, with random intercepts per participant and item.

3.3 Timeline

The timeline to completion starts with obtaining IRB approval, followed by experiment creation, data collection, data analysis, and finally with writing the results and discussion potions of the dissertation. Here, I propose a timeline for the completion of each step, including allowing time for feedback, up until a defense date in May 2023. Following the defense of this proposal and implementation of the committee's recommendations in late January, the IRB will be submitted for review by mid-February. While awaiting IRB approval, the experiments will be created in which stimuli are created and L1 German and French informants will provide audio for re-synthesis in perception experiments and shadowing in production experiments. Once IRB approval is obtained and the experiments are created, data collection will begin in mid-April and take place over the summer, with the goal of being completed by early September, 2022. Once all data has been collected, analysis and writing writing will begin in early September with the goal of being finished by mid-Spring 2023 (March). Following the completed dissertation draft, editing and revisions will be carried out and a final draft will be sent to the committee for review in April 2023 at least one month prior to a defense date in May 2023.

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