TRANSFER OF CONSTRAINTS AT THE INITIAL STATE OF PHONOLOGICAL ACQUISITION

by © Sarah Fradsham

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Abstract

This thesis investigates language transfer in bilinguals at the beginning of the learning of a novel language. Participants are speakers with L1 English and L2 French, or L1 French and L2 English. The task consists of having participants produce coda clusters that are allowed in Russian. Results show that both groups performed well on clusters that are allowed in English and French, but poorly on those that are not found in either language. Optimality Theory analyses show that the English L1 group only transfers their English knowledge, while the French L1 group transfers both English and French knowledge. This is shown through the repair strategies used, as the English L1 group tended to repair using medial epenthesis, and the French L1 group used a combination of medial and word-final epenthesis. These results show support for the Linguistic Proximity Model, as it accounts for the combination of sources for transfer. To explain these patterns of transfer, it is hypothesized that English is transferred because of psychotypology, or possibly because English is the most restrictive language as it has the smallest amount of allowable coda clusters. Under the Subset Principle, the most restrictive language is optimal for facilitating learning of novel languages.

General Summary

This thesis investigates language transfer in bilinguals at their first exposure to a novel language. Participants were speakers with L1 English and L2 French, or L1 French and L2 English. In a repetition task, participants were asked to produce consonant clusters from a language they had no prior experience with. Results show that both groups performed well on clusters that are allowed in English and French, but poorly on those that are not found in either language. Optimality Theory analyses show that the English L1 group only transfers their English knowledge, while the French L1 group transfers both English and French knowledge. The reasoning for transfer is not determined, as English could be transferred because of perceived typological similarities, or possibly because English is the most restrictive language, as it has the smallest amount of allowable coda clusters. Under the Subset Principle, the most restrictive language is optimal for facilitating learning.

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Table of Contents

List of Tables

List of Figures

List of Tableaux

List of Abbreviations

BP	Brazilian Portuguese
C	consonant
CEM	Cumulative Enhancement Model
EFL	English as a Foreign Language
EVAL	evaluator
GEN	generator
IPA	International Phonetic Alphabet
L1	first language
L2	second language
L3	third language
L*n*	subsequent language
LPM	Linguistics Proximity Model
MSD	Minimal Sonority Distance Parameter
OT	Optimality Theory
SD	Sonority Distance
SDP	Sonority Dispersion Principle
SSP	Sonority Sequencing Principle
TPM	Typological Primacy Model
UG	Universal Grammar
V	vowel

1. Introduction

How novel phonological systems are learned in adulthood is an interesting area of research, as the adult learner has at least one full phonological system already acquired at the beginning of the learning process. The adult learner may then draw on previously acquired knowledge to facilitate the learning of a novel system. With the acquisition of a third language (L3), or subsequent languages such as a fourth, fifth, etc. (referred to as L*n*), the learner has various sources from which they can transfer their language knowledge to facilitate learning, including their first language (L1) or their second language (L2). As it has been hypothesized in various theories which assume that learners have access to Universal Grammar (UG) in adulthood (see White (2003) for a review), it may also be the case that UG may be relied upon as a source of language knowledge during the learning process. Given the number of potential sources of language knowledge, it remains unclear what knowledge is transferred from where, when, and why.

The main goal of the current study is to investigate the transfer of constraints into a new language at the beginning of the acquisition process in adulthood, while attempting to determine the source of the transfer. By investigating specific phonological structures, along with a methodology that is designed to distinguish sources of transfer, I endeavor to analyze potential sources of transfer, including those from previously acquired languages and UG.

The study is designed as follows: participants with two previously acquired languages, English and French, will be presented with nonce words containing coda clusters that vary from their previously learned languages, which they will be asked to repeat. The participants' previously acquired languages will be important in determining the reasoning for transfer. Two groups of participants will be used, with one group having English as an L1 and French as an L2, and the

other group having French as an L1 and English as an L2. This is referred to as mirror-imaging methodology (Barkley 2010; Kilpatrick 2009; Llama, Cardoso & Collins 2010).

The coda clusters presented will be based on Russian, which has a larger variety of coda clusters than English and French. The productions of the participants will then be analyzed using Optimality Theory (OT) (Prince & Smolensky 1993) to create interlanguage constraint rankings, which can be compared to the rankings of English and French. The comparisons can then show transfer of constraint rankings from the participants' previously learned rankings into their interlanguage grammar.

The mirror-imaging methodology will be used to detect patterns between the groups and aid in discovering why the transfer occurs. For example, if both groups show patterns in the L3 that resemble English, regardless of whether English is their L1 or L2, it can be assumed that transfer occurs because of a perceived typological similarity between English and the target language. Or, if both groups tend to show patterns of the L2, it can be assumed that transfer is caused by L2 transfer effects. If patterns do not follow those of either language, and such patterns trend towards unmarked structures, it may be assumed that the learner is accessing default settings of UG to facilitate their learning.

To analyze the patterns of the groups, Optimality Theory will be used. This method of analysis is effective, as it is capable of accounting for potential sources of transfer including the L1, L2, and UG, as all constraints in OT are universal and are ranked language specifically. By establishing the constraint rankings from each language under investigation, and assessing the rankings of the learners' interlanguage, the constraint rankings can be compared to determine similarities or differences. If any similarities occur between a learner's interlanguage ranking and one of their previously learned language's constraint rankings, it can be assumed that the learner has

transferred their language knowledge into their ranking of the novel language. If drastic differences occur that do not match those of the previously learned languages, it can be assumed that UG played a role in the learning of the novel language.

Coda consonant clusters will be used as the feature under investigation for the transfer. Consonant clusters provide a useful testing ground since the restrictions on which clusters are allowed are language specific. Speakers presented with clusters that are unattested in their L1 and L2 may use different types of repairs, which may help show transfer. Therefore, all three languages chosen for this study must allow for consonant clusters in coda position for transfer to be possible, but also vary in restrictions on the clusters to provide evidence regarding the source of the transfer.

While previous studies in the literature have investigated phonological transfer in L*n* acquisition, none to my knowledge have attempted to investigate transfer using mirror-image methodology in conjunction with an OT framework. This investigation aims to provide useful insights for researchers into efficient ways to investigate transfer in adult language acquisition, as well as add to the literature of L2/L3 acquisition of coda clusters.

This thesis will be structured as follows: first, an overview will be provided on the recent research relevant to this topic, including L2/L3 acquisition, subset and superset grammars, sonority, Optimality Theory, and previous investigations of transfer. A discussion will follow on the relevant constraints on coda clusters in English, French, and Russian. Next, the methodology of the current study will be detailed, followed by the results of the study. The Optimality Theoretic analyses of the data will then be presented. Finally, the results of the analyses will be discussed, and theoretical implications and directions for future research will be addressed.

2. Background

This study will focus on language acquisition of adults in terms of phonological production. In this section, I first discuss previous studies of adult language learners in terms of second language acquisition and third language acquisition. Next, I consider the literature on sonority and markedness, as these will be relevant to the variables tracked within the study. Then, I address the theoretical framework to be used, and why. Finally, I will provide an overview of methodologies used in transfer studies, including the methodologies used within this study.

2.1. Transfer in L2 Acquisition in Adulthood

Unlike the L1 learner, the adult L2 learner already has at least one fully developed language system at their disposal. As the learner has previously acquired language knowledge, this can in turn influence their L2 acquisition, in facilitative (e.g. Popa 2016) or non-facilitative (e.g. Brown 1998) ways. Transfer from the L1 is very evident in L2 acquisition (see Major 2008, for a review). It has been shown that while transfer from the L1 is prominent in the initial stages of acquisition, its influence will decrease over time (Major 1986).

Throughout the literature, it has been suggested that adult learners also have access to UG throughout L2 acquisition. For example, the Full Transfer/Full Access Hypothesis (Schwartz & Sprouse 1996) states that the initial state of the L2 grammar is the L1 grammar, and that the learner also uses their access to Universal Grammar to facilitate learning. Some studies have shown support for UG access in the course of L2 acquisition (e.g. Broselow, Chen & Wang 1998; Özçelik 2018). For example, Özçelik (2018) found that L1 English speakers learning stress patterns in L2 Turkish transferred their L1 settings, but reset several parameters with settings not found in the L1 or L2, leading to the conclusion that they were guided by UG. The author notes

that more evidence is needed to determine whether the learner has full, unimpeded access to UG, rather than partial access.

Broselow (1984) proposes that when a learner encounters forms that are not permissible in their native language, they will produce errors that alter the target form so that the structure is grammatical in their language. The most common errors produced by L2 learners in non-native clusters are epenthesis and deletion, with the site of these processes differing depending on the cluster, along with acoustic cues (Yun 2014). These errors serve as repairs to simplify complex clusters. The location of the cluster in the word has been shown to impact the types of repairs used. In their study of Spanish L1 learners of L2 English, Flores and Rodríguez (2015) found that when repairing English clusters, the learners would use different strategies depending on the location of the cluster. They tended to use epenthesis for word initial clusters, whereas for word medial clusters they would employ substitution or deletion, and for word final clusters they would use deletion or devoicing as the repair. The grammatical and functional aspects of the word being produced can also have an affect on error rates, such that epenthesis rates increase when deletion would result in a higher semantic loss (Abrahamsson 2003). When producing word final codas throughout L2 learning, accuracy rates are U-shaped, where their accuracy is high at the beginning of acquisition, lowers during the intermidate stages where the learner focuses more on grammar, and increases again at more advanced stages (Abrahamsson 2003).

2.2. Transfer in L3 Acquisition in Adulthood

While the literature on L2 acquisition is considerable, in comparison the research on L3 acquisition is underdeveloped. Although the research on L3/L*n* acquisition has grown significantly in recent years, there is still much to be discovered. While some traits of L3 acquisition may be similar to those of L2 acquisition, the biggest difference between L2 and

L3/L*n* acquisition is the addition of other language knowledge. L*n* acquisition includes any learners with knowledge of two or more languages, such as those learning an L3, L4, L5, etc. With the addition of two or more already acquired languages, the learning process of the additional language becomes much more dynamic. As stated above, when acquiring an L2, transfer may occur from the L1 or from the learner's access to Universal Grammar. Learning an L3/L*n*, one has access to a larger range of linguistic knowledge, and has more potential sources which can facilitate their learning. In addition to the L1 and UG, as L2 learners have, L3/L*n* learners also have access to all their previously learned languages to rely on for transfer. For an L3 learner, this means they can transfer knowledge from the L1, L2, or UG. Transfer also has the potential to come from a combination of multiple sources, which will be discussed shortly.

Questioning the reasoning that transfer occurs from one source rather than another helps in understanding the complete picture of mechanisms involved in L3/L*n* acquisition. The reasoning behind the transfer may be affected by variables such as the learner's first and second languages, the new language which is being acquired, and the perceived relations between these languages. These variables, which are generally not taken into account in studies on L2 acquisition, help to develop our understanding of language transfer and acquisition in ways that L2 acquisition may not be able to.

In order to address these questions, it is necessary to distinguish between different contexts of language acquisition. This includes considering different classifications for bilinguals, including simultaneous and sequential. Simultaneous bilinguals are learners who acquire both languages from a young age, with exposure to their second language commencing before the age of 4 (Unsworth 2005). Acquisition of an L2 from the age of 4 or later would then classify the learner as a sequential (successive) bilingual. For sequential bilinguals, second language acquisition

proceeds differently from that of the first language, as the sequential learner is more cognitively mature when acquiring the L2. Thus, when acquiring an L3/L*n*, the learner's cognitive state will be more similar to when they began their acquisition of the L2. When transferring language knowledge into a newly acquired language, this may play a role, by increasing transfer from the L2 in the course of L3 acquisition (Wrembel 2010).

This type of transfer has been termed the L2 status factor, and was noted in a study of L3 morphosyntactic acquisition (Bardel & Falk 2007), in which successive bilingual learners were found to transfer knowledge to the L3 from the L2. The authors propose that the L2 has a privileged status, due to a higher degree of cognitive similarity to an L3, as these are two non-native systems as opposed to a non-native system and a native system.

Although no formal theories on full transfer from the L1 into the L3 have been proposed, studies have noted this type of transfer. For example, Jin (2009) found that during a grammaticality judgment and correction task, L3 learners of Norwegian with L1 Chinese and L2 English transferred their L1 knowledge into the L3. Despite English being more similar to the L3 Norwegian, in terms of not allowing null subjects, the L1 still influenced the learners' performance. Rothman et al. (2011) refer to this as an 'L1 factor', and argue that this pattern suggests the L1 has a privileged status. Cabrelli (2012: 37) notes that while L1 transfer can occur, assuming its exclusive transfer based on a privileged status would also assume that the acquisition of the L2 and L3 systems are 'virtually the same', which has been shown to not be the case.

The Cumulative Enhancement Model (CEM) (Flynn, Foley & Vinnitskaya 2004) theorizes that transfer into the L3 can come from the L1 or the L2 in a facilitative way, or will have no effect. This theory was based on L3 syntactic transfer and predicts the absence of non-facilitative

transfer. Another factor that may affect language transfer is psychotypology, which is the learner's perception of the typological difference between two languages, whether or not the perceived relatedness coincides with the language's actual typology (Rothman & Cabrelli Amaro 2010: 26). Thus, a learner's perceived similarities between previously learned languages and the novel language may result in transfer from the more typologically similar language to the L3. The Typological Primacy Model (TPM) (Rothman 2011) predicts such transfer, which has been noted in L3 acquisition of morphosyntax (Rothman 2011) and lexis (Cenoz 2001). Rothman (2013) illustrates that the TPM constitutes a cue hierarchy which determines the structural linguistic proximity of the L1 and L2 to the L3 to determine the source for transfer. This hierarchy consists of the lexicon, phonological/phonotactic cues, functional morphology, and syntactic structure, which are listed from most influential to least influential in their involvement in language transfer at the initial stages. Although, not all factors are accessible to the learner when transfer occurs, and language pairings may impact which knowledge is available to the learner at the time. While there has not been empirical evidence of this type of transfer in phonological studies, Cabrelli Amaro (2012), in her review of L3 phonology, suggests that it may also be possible that typological similarities can impact phonological transfer.

The Linguistic Proximity Model (LPM) (Westergaard et al. 2017; Westergaard 2021) theorizes that at the initial state, the L3 is the entirety of the previously learned languages, and that language transfer may come from the L1 or L2. Transfer is not based on the order of acquisition, but by similarities of abstract linguistic properties. This model assumes that facilitative transfer occurs when the learner correctly predicts the L3 grammar through similarities found in a previously acquired language, while non-facilitative transfer occurs when the learner misanalyses the L3 input, or has not acquired significant input of the L3, and incorrectly assumes similarities

between the L3 and a previously acquired language. This model in turn accounts for facilitative and non-facilitative transfer, as well as combined transfer from multiple sources. Archibald (2022) offers evidence for property-by-property transfer. He argues that parsing occurs structure by structure, and draws on the integrated I-language, where transfer may occur from anything in the I-language (the L1, the L2, etc.). I-language is defined as the internalised linguistic system (Chomsky 1986).

As mentioned above, a major difference between L2 acquisition and L3 acquisition is the potential to have multiple sources of transfer. This may be seen successively over a period of time, with transfer from one source at one stage of learning and another source at another[1], or simultaneously. Combined transfer may include any combination from the L1, the L2, or UG. For example, in her study investigating orthographic-phonological correspondence rules, Barkley (2010) found influence of both the L1 and L2 (English and Spanish) when producing the L3 Brazilian Portuguese intervocalic grapheme <s>.

The L2 status factor focuses on the status of the language being transferred, and assumes the L2 will have a privileged status, thus only accounting for transfer from the L2. The CEM and TPM do not focus on language status, and both can account for transfer from the L1 or L2. Yet, the CEM does not account for non-facilitative transfer, while the TPM accounts for facilitative and non-facilitative transfer. None of these theories can account for a combination of L1 and L2 transfer. The LPM can account for transfer from the L1 or L2, as well as a combination of the two, in both facilitative and non-facilitative ways.

[1] As this thesis does not encompass the longitudinal effects of language transfer, this type of combined transfer will not be discussed in detail.

2.3. Subset/Superset Grammars

When looking into the acquisition of multiple grammars, it is important to understand the relation between the grammars. A subset grammar is a grammar that has more restrictive structure in relation to another, which is considered its superset. For example, a language that allows complex codas would be a superset to one that only allows simple codas, which in turn would be a superset to a language that does not allow codas at all.

The Subset Principle is said to be "the essence of the learning component" (Manzini & Wexler 1987: 414) and states that the learner, when presented with two different grammars, will always choose the most restrictive grammar, as there would be no way to falsify the less restrictive grammar by positive evidence alone. This is because if the learner transfers their language knowledge of the less restrictive grammar, then the interlanguage grammar would contain structures that are not found in the target language, therefore requiring negative evidence to deem these structures ungrammatical. The learning of a superset grammar would allegedly be easier than learning a subset grammar, as one could use gracious amounts of positive evidence to add more complex structures to their interlanguage grammar, versus having to restrict the grammar after transferring structures that are not found in the target. While this hypothesis seems strongly motivated, it makes no predictions with respect to learning based on other types of evidence. Direct positive evidence refers to when a learner is exposed to a particular structure in the language, for example, a learner of English who hears the word [stɛps] (*steps*) will conclude that English allows complex consonant clusters in onset and coda position. Direct negative evidence refers to when a learner is explicitly told that an utterance is ill-formed. Indirect negative evidence refers to the lack of evidence given to the learner, which they use over time of exposure to conclude that the language does not use a certain structure. For example, if a learner of English

is never exposed to rising coda clusters besides [-Cs] clusters, they can assume that other rising coda clusters, such as *[misl], are ill-formed.

Indirect positive evidence refers to errors made by native speakers of the learner's L2 in the learner's L1. Schwartz & Goad (2017) give an example of a native English learner of L2 Brazilian Portuguese (BP) and a native BP learner of L2 English conversing. In this context, the L1 English learner may hear the other pronounce a word like *star* as [istar], thus the native English speaker may assume that BP does not allow [sC] clusters due to the repair of the cluster in English. The authors show that indirect positive evidence may be used by the learner to aid in the acquisition of a subset grammar in a scenario such as this. In their study, English speakers were exposed to dialogue containing BP accented English, which was followed by a production task where they were asked to read orthographically presented words in the accent they heard. About one third of the participants, when reproducing initial [sC] clusters in the accented speech, repaired these clusters, mostly by prothesis. This was taken to indicate that some participants were able to correctly assume the ill-formedness of initial [sC] clusters in BP While the authors indicated that indirect positive evidence is a viable source of evidence for the learner, more research is needed to better comprehend how indirect positive evidence can play a role in second language acquisition,

Trapman and Kager (2009) also found evidence that learning in both superset and subset scenarios can result in acquiring phonotactic knowledge. Participants were L1 Russian and L1 Spanish learners of L2 Dutch, where Russian is a superset to both Dutch and Spanish and Dutch is a superset to Spanish. A word-likeness task and a lexical decision task were used to test knowledge of the legality of consonant clusters in Dutch, with the results showing that both L1 Russian learners and L1 Spanish learners were able to discriminate illegal Dutch clusters from

the legal clusters. These studies show that a learner can make use of indirect positive evidence and negative evidence in addition to positive evidence during acquisition.

While this study will not focus on the role of subset/superset grammars in acquisition, the relations between the languages tested can make predictions about knowledge transfer. As mentioned above, The Subset Principle assumes that when learning a new grammar, the learner will choose the most restrictive grammar when presented with two different grammars. This hypothesis has also been discussed in relation to adult L2 acquisition (Ayoun 1996; Monou & Kawahara 2016), where the L2 learner will start with the settings of the L1 if the L1 is a subset to the L2, or if the L2 is a subset to the L1, the learner will start with the setting of the L2. Thus, this can be extended into adult L3 acquisition. For this specific project, it may be predicted that the most restrictive of the two previously learned languages will be transferred, as positive evidence will be primarily available to the participant in this task.

2.4. Sonority and Markedness

Consonant clusters found in onsets and codas are restricted by the sonority of each consonant in the cluster. Typically, the nucleus is the sonority peak of a syllable with consonant clusters occurring before the nucleus rising in sonority and those occurring after the nucleus falling in sonority. Despite this general pattern, the sonority allowed in each cluster is restricted language-specifically and can allow different combinations in the onset and the coda. A general guide for discussing the sonority of each consonant is the Sonority Index (Selkirk 1982), which is a scale tht gives general sonority levels to different sound classes. The general Sonority Index consists of: Stops: 1 < Fricatives: 2 < Nasals: 3 < Liquids: 4 < Glides: 5.

The Sonority Sequencing Principle (SSP) (Selkirk 1984) states that each syllable contains a sonority peak, that can be preceded by an onset of decreased sonority and/or followed by a coda of decreased sonority. Figure 1 illustrates the use of sonority in the English word *plans*. The beginning cluster rises in sonority from 1 to 4, then rises to the peak in the nucleus, and then falls in the coda cluster from 3 to 2, which follows the SSP.

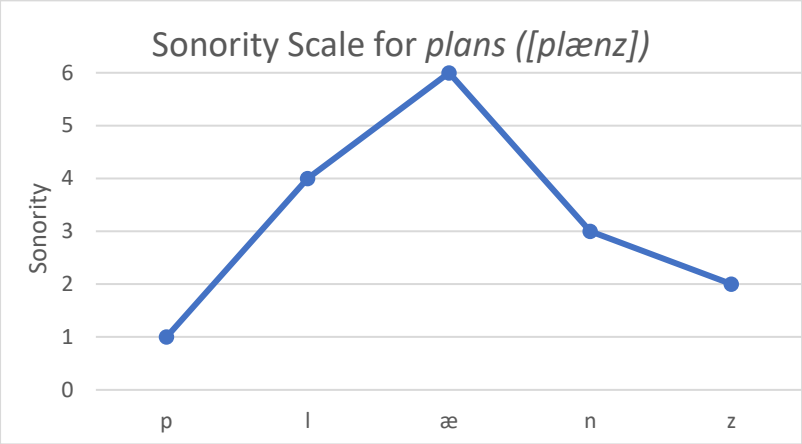

Figure 1: Sonority Index of the word *plans*

Drozd (2003) notes that the SSP plays a vital role in the acquisition of complex coda clusters. In their study of L1 Spanish/ L2 English bilinguals' production of complex English coda clusters, they found that the smaller the distance in sonority between the consonants in the cluster, the more likely the speakers were to make errors. The author also notes that in cases of deletion, the participants would consistently delete the least sonorant segment, so that the sonority decrease between the nucleus and coda is minimal. For example, when repairing the word [pɪnz], the participants tended to delete the fricative to produce [pɪn], to achieve a minimal sonority descent. It was also found that minimal sonority distance had an effect on error rates, as there were more errors made in clusters that had a low sonority distance between segments, compared to clusters with a larger sonority distance between segments.

The Minimal Sonority Distance (MSD) parameter is a language specific requirement that imposes a certain distance of sonority in the formation of consonant clusters. This parameter determines how many levels the sonority must rise in an onset cluster, or fall in a coda cluster, to be considered well-formed. Broselow and Finer (1991) argue that the MSD parameter is transferred from the L1 to the L2 in acquisition, and moves through stages towards the target language throughout. They tested L1 Korean and L1 Japanese speakers on their pronunciation of English onset clusters using a vocabulary test consisting of real and nonce English words, and found higher error rates in the production of clusters with lower sonority distance. They concluded that the MSD could predict which unacquired clusters would prove more difficult based on sonority sequencing, as well as which structures would be easier to learn based on transfer from the L1.

The Sonority Dispersion Principle (SDP) (Clements 1990) states that onsets with a sharp steady increase in sonority are less marked than onsets with an imbalanced increase, and that codas with a shallow gradual decrease in sonority are less marked than codas with a sharp decrease. For example, an onset cluster that rises by four, say a stop + glide cluster, would be more marked than a cluster that rises by three, say a stop + liquid cluster. The stop + glide cluster would have a more severe increase between the consonants and a small increase toward the nucleus, whereas in the stop + liquid cluster the increase is not as severe and is more balanced as it increases toward the nucleus. In terms of codas, a cluster consisting of sonority that falls by one, such as a liquid + nasal cluster, would be unmarked compared to a cluster with a decrease of 4, such as a liquid + stop cluster. The liquid + nasal cluster would have a gradual decrease from the nucleus (SD 6) to the liquid (SD 4) to the nasal (SD 3), where there is only a slight drop in sonority, whereas in the

liquid + stop cluster, the sonority falls from the nucleus (SD 6) to the liquid (SD 4) down to the stop (SD 1), with a steep drop of three between the consonants.

Eckman and Iverson (1993) refute the claims of Broselow and Finer (1991), and instead argue that L2 knowledge is better explained by typological markedness, with the SDP. They first noted that using solely sonority sequencing gives incorrect predictions for languages that have C + liquid clusters (ex. [pre]), but do not allow C + glide clusters (ex. [njo]), such as German. As well, if they had assumed that C + [glide] clusters were allowed in Japanese and Korean, then the sonority distance for these languages would be set at 2, but this would then allow for other clusters with a setting of 2 that are not permitted in these languages.

Eckman and Iverson instead argue that typological markedness is better suited to explain the patterns observed, using the SDP. As mentioned above, the SDP says that onsets with a sharp steady increase are less marked than ones with an imbalanced increase. Testing L1 Japanese, Korean, and Cantonese learners of English, they used data collected from conversations between the participants and an experimenter to analyze 11 cluster types. Their analysis showed the majority of the cluster productions could be explained using typological markedness, and the variation they found in two Cantonese speakers' productions could be attributed to transfer from the L1.

Hancin-Bhatt and Bhatt (1997) note that neither Broselow and Finer (1991) nor Eckman and Iverson (1993) offer accurate representations of transfer to the L2. Both studies tested Korean and Japanese speakers learning English onset clusters, but these language pairings cannot show transfer of onset clusters, as Korean and Japanese do not have such clusters. Instead, they can only account for developmental effects, which are universal processes that determine which

structures are learned easier than others, by means of markedness in sonority sequencing or UG principles.

Hancin-Bhatt and Bhatt's 1997 study uses Japanese speakers for comparison to the previous studies, as well as Spanish speakers, as this language has onset clusters that could potentially be transferred into the L2. They offer an analysis that shows the significance of the interaction between developmental effects and transfer effects on L2 syllable structure. Their study supports the MSD model, as it accounts for both transfer and developmental effects. Transfer effects were shown through the higher production rates of Spanish speakers of onset -stop + liquid- clusters, such as [kled], and onset fricative + liquid clusters, such as [flars], than Japanese speakers, where the Spanish speakers transferred their MSD setting of 2, and Japanese speakers transferred their MSD setting of 5. Developmental effects were found in different error rates of stop + liquid and fricative + liquid onsets, in which the onsets with the smaller sonority distance resulted in higher error rates. The outliers to these results were the error rates in the stop + glide onsets, such as [kyuk], in the Spanish speakers' productions, as well as the equal difficulty of stop + glide and stop + liquid onsets. The authors explain these error rates as transfer effects, therefore showing the need for both types of effects in the acquisition of clusters.

Not only did the authors find that the MSD model provided correct predictions for onset clusters, but it also correctly predicted accuracy for coda clusters as well. They found that codas with the steepest sonority fall, the liquid+ stop clusters, were produced more accurately than clusters with a smaller gap in sonority, such as liquid +fricative clusters. The MSD model alone could not account for the language specific error types found in the participants' repairs. The authors use an Optimality Theory analysis to account for the differences in the Japanese and Spanish learners' repair types.

2.5. Optimality Theory

In Optimality Theory (OT), a phonological grammar consists of a language-specific ranking of universal constraints (Prince & Smolensky 1993). In order to determine output forms, first, an input is taken, and the generator (GEN) creates a set of possible output candidates. Then, the evaluator (EVAL) chooses the optimal output based on best satisfaction of the highest ranked constraints in the grammar. So, if a language has Constraint A ranked higher than Constraint B, and GEN produces several different outputs, including one that violates Constraint A and one that violates Constraint B, the optimal candidate will be the candidate that only violates constraint B.

Eckman (2004: 540-543) gives an overview of OT approaches to L2 phonological acquisition, concluding that OT can give insights into L2 patterns not accounted for by L1 transfer. The theory is beneficial to the study of adult language acquisition, as it formalizes the role of UG and transfer from previously acquired languages in accounting for the state of the L2 grammar between the initial state and the final target grammar. In this interlanguage grammar, constraint rankings proposed to be present in UG or those established in previously acquired languages may both influence phonological patterns. The interaction of default and learned constraint rankings in OT provides a notable way of accounting for variability and restructuring of interlanguage grammars (Hancin-Bhatt 2008).

For example, Hancin-Bhatt (2000) found that when Thai learners of English were acquiring codas, their errors showed that they relied on their native language rankings for the production of simple and complex English codas. First, Hancin-Bhatt (2000) established the rankings of Thai

codas to be *COMPLEX>> DEP-IO >>MAX-IO >> IDENT-IO[2]. The target language, English, has the constraint *COMPLEX ranked lower than MAX-IO. Below are the rankings for a pronunciation with a complex English coda, which show that the Thai speakers transfer their native rankings into the L2 English, as the Thai ranking of *COMPLEX >> MAX-IO is found instead of the target ranking.

Tableau 1: Parse of /nalt/. Deletion of Segment is Optional.[3] (from Hancin-Bhatt 2000: 224)

/nalt/	*COMPLEX	DEP-IO	MAX-IO	IDENT-IO
a. nalt	*!			
b. nal.t□		*!		
☞ c. nat			*	
d. naC			*	*!
e. nalC	*!			*

2.6. Methodologies of Transfer Studies

A range of methods have been used in identifying transfer in second and subsequent language acquisition. For eliciting spoken productions, a variety of elicitation tasks can be used. Interviews (e.g. Hammarberg 2001) and spontaneous speech (e.g. Wrembel 2010) are good methods in eliciting natural speech patterns. One elicitation method used by some researchers is the wordless picture story, where the learner is shown a series of pictures that follow a storyline, and is asked to tell the story in the target language., This method has been applied in studies on child and adult multilinguals (e.g. Cenoz 2001; Griessler 2001; Slobin 2005). Reading tasks, including word lists, phrases, and paragraphs, have also been used commonly in eliciting foreign language productions (e.g. Flores & Rodríguez 2015; Wrembel 2010).

[2] *COMPLEX: prohibits any complex codas. DEP-IO: prohibits deletion of segments. MAX-IO: prohibits the insertion of segments. IDENT-IO: requires the identity of the segment to remain the same as the input.
[3] This table has been slightly altered from the original for the convenience of the reader. The transcriptions of the candidates have been standardized, with the deleted segments in some of the candidates removed. The constraint CODA-AC is omitted from the constraint ranking and the tableau, as it is not relevant to the argument at hand.

While many studies have been able to pinpoint where the language transfer derives from, it can be more difficult to determine why such transfer has occurred. Methodology plays a vital role in investigating the reasoning for transfer. With various factors to consider, the age of acquisition of the L2, language typology, and UG influences, it can become difficult to determine why the transfer came from the source that it did. Mirror-imaging is one method that has aided in determining the source of transfer. In this method, two test groups are used, with one group having a reverse order of the other group in acquiring L1 and L2 (Barkley 2010; Llama, Cardoso & Collins 2010; Kilpatrick 2009). A study done by Llama et al. (2010) using mirror-imaging methodology of English/French bilinguals learning Spanish measured VOT values of voiceless stops in Spanish and showed there was a preference for L2 transfer, regardless of whether the L2 was English or French. L2 transfer took precedence over typological similarity in the production of voiceless stops, where, in this case, French is more typologically similar to the L3 (Spanish). In a follow-up study, Llama and Cardoso (2018) tested VOT values of voiceless stops produced by English/French bilinguals learning Spanish with a higher level of proficiency than those in their 2010 study. This study showed a less dominant role of the L2 in transfer, with transfer from the L1 being more predominant. Given the greater proficiency of participants in the 2018 study relative to those in the earlier study, the authors note that the results from both studies support the claim that the effects of L2 transfer fade as proficiency rises and transfer from L1 increases.

Non-word repetition tasks provide a useful way to elicit productions that can show transfer. Task items can be designed to investigate a specific phenomenon, so that other factors do not influence the speaker's production. While non-word repetition tasks are commonly used for child acquisition studies, the word learning mechanisms used for such tasks are accessible throughout adulthood as well (Papagno & Vallar 1995). The correlations between word learning, non-word

repetition, and serial recall that is found in children are also noted in adults (Gupta 2003). The accuracy of productions of non-words remains similar whether they are repeated as a single unit or whether they are repeated in a sentence in the speaker's native language (Davidson, Jusczyk & Smolensky 2004).

Lin (2001) notes that task effects may affect repair strategies for consonant clusters. In this study, EFL students were administered 4 different tasks targeted to elicit productions of consonant clusters, all ranging in different levels of formality. It was found that in more formal tests, such as reading miminal pairs and word lists, the learners would more frequently employ epenthesis as the main repair strategy, while in more informal tasks, such as sentence reading and conversation, the learners would more frequently repair using substitution and deletion. It is noted that in the more formal tasks, the learner are focused on accurate productions, while the informal tasks required more focus on sentence structure and grammaticality.

2.7. Summary

When learning a novel language, the adult learner has at least one fully acquired language at the beginning of the learning process. Thus, language knowledge can be transferred into the learning of the novel language from any previously acquired knowledge, or potentially from UG. Some theories assume transfer based on language status, such as the L2 status factor, while others assume transfer based on psychotypology, such as the TPM. Some theories suggest that transfer is wholesale, as in the Full Access/Full Transfer hypothesis, while others theorize language knowledge is transferred on a property-by-property basis, as in the LPM.

Investigating sonority in acquisition is useful as it can demonstrate transfer effects as well as developmental effects. Language-specific parameters, such as a language's MSD, have been

shown to transfer into a novel language. Developmental effects have also been shown to play a role in acquisition, such as influences from the SSP.

Optimality Theory allows for an investigation that may show transfer from a previously learned language, or potentially from UG, as all constraints in OT are universal and are ranked language specifically. Mirror-imaging helps determine the reason for transfer, as it incorporates contrasting linguistic backgrounds, so that similarities in the source of transfer can be determined to occur due to language status or psychotypology. Non-word repetition tasks can be specifically designed to elicit certain phenomena under investigation, and correlate with word-learning in natural language acquisition.

The main goal of the current study is to investigate the transfer of constraints into a new language, while trying to determine the source of the transfer. Two languages will be used in a mirror imaging method to aid in determining the source of transfer, with a third language being used in the stimuli. Production of the novel stimuli may reflect transfer of properties of the previously known languages or properties of UG.

Coda consonant clusters will be used as the feature under investigation for transfer, as allowable clusters are language specific. Speakers presented with clusters that are unattested in their L1 and L2 may use different types of repairs, which may help show transfer.

Optimality Theory will be used in the analysis, as all constraints in OT are universal and are ranked language specifically. OT can be used to see if the constraint rankings of the interlanguage grammar resemble the rankings of either of the mirror image languages or the target language, which will in turn aid in determining where the transfer is coming from.

The next section will describe the languages under investigation for this study. First, I will discuss why English, French, and Russian were chosen for this study. Then I will describe the various allowed coda clusters in each language. Finally, I will illustrate how these coda clusters are restricted in Optimality Theory and compare the languages' constraint rankings.

3. Coda Constraints in English, French, and Russian

Participants in this study are L1 speakers of French and L2 speakers of English or vice versa. Target forms that participants were asked to repeat are based on Russian phonotactic constraints and were produced by a Russian speaker. This chapter will outline restrictions on coda clusters in English, French, and Russian. Relevant phonological processes that affect coda clusters in these languages will also be described. Then, I will detail the relevant constraints and their rankings in Optimality Theory for each language, to serve as the basis for the analyses.

English and French have majority-language status in Canada, so these two languages were selected for the mirror imaging method, as there would be ample access to learners with either L1 English and L2 French, or L1 French and L2 English. Both English and French have differing phonological systems, with French being a superset to English in terms of coda consonant clusters. Russian was used as the basis for the novel language participants encountered. Russian was chosen as it is typologically dissimilar from both English and French and is a superset of both of these languages in terms of coda clusters. This is expected to minimize any transfer based on typological similarities or subset effects, and allow transfer from either L1 or L2. It is beneficial to have typologically dissimilar languages, as if one language is typologically more similar to the target language then this may influence the source of transfer. However, it is possible that the learner will perceive a typological similarity between a previously known language and the target, so this factor cannot be eliminated completely. As well, this study will only be using positive evidence in the learning of the target language. Therefore, a superset grammar is optimal, since the Subset Principle states that a subset grammar must make use of negative evidence to learn the grammar. This task may not give enough exposure to the target language for the learner to avail of negative evidence.

In terms of coda clusters, while all three languages allow coda clusters containing up to at least three consonants, only clusters of two consonants will be investigated. The next subsections will discuss the relevant phonological details of each language with regard to CC coda clusters.

3.1. English Coda Clusters

English allows many coda consonant clusters with falling sonority. The sonority distance for falling coda clusters can be as low as one and as high as three, such as [falt](*fault*) (SD 3), [ænt](*ant*) (SD 2), [æsk] (*ask*) (SD 1). There are very few clusters allowed with a sonority rise, and these all consist of stop +/s/, in both monomorphemic words, such as [baks] (*box*), and bimorphemic words, such as [pats] (*pot*+s). English only allows a limited amount of sonority plateaus in coda clusters, such as [-kt] (*act*), [-pt] (*kept*), [-fs] (*gifs*), (and [-rl][4] (*girl*).

Some variable phonological processes which affect final clusters may be relevant to the results, as some of the task items will involve clusters in which these processes can apply. For one, many dialects of English delete word final t/d in various contexts, including preceding a consonant, a vowel, or before a pause (Anttila & Andrus 2006). For example, when a speaker produces a word like *cost* [kast], the final /t/ may be optionally deleted, and instead produced as [kas].

In disyllabic words with /t/ medially and /n/ word finally, such as *button*, the /t/ may optionally undergo glottalization, so that it is instead produced as [bʌʔn] (Rogers 2013: 55). Syllabification of nasals and liquids word finally is also an active process in disyllabic words. For example, a word like *ladle* [lejdəl] will be produced as [ledl̩] (Rogers 2013: 59), where the schwa is deleted and the word final /l/ is resyllabified as the nucleus of the second syllable.

[4] For transcription purposes, the symbol [r] will be used to represent the rhotic sound and its variations in English, French, and Russian.

3.2. French Coda Clusters

Coda clusters in French have been subject to various analyses in the literature. Some work argues that French allows clusters with a rising sonority (Tranel 1987) while other studies propose that such sequences instead form simple codas with the second consonant functioning as an onset to an additional syllable, containing an empty nucleus (Dell 1995). In the former analysis, it would be assumed that French allows falling, rising, and plateau sonority clusters. In either case, allowing rising sonority codas or empty nuclei can be considered less restrictive than English, thus making French a superset of English. For the purposes of this paper, the former analysis will be used, and codas in French will be assumed to have complex clusters including those of falling, rising, and plateau sonority.

In falling sonority clusters, the sonority distance can be between one and three, similar to English, for example words like [film] (*filme*) (SD 1), [sœrf] (*surf*) (SD 2), and [kart] (*carte*) (SD 3). Contrary to English, in sonority rising clusters, the sonority distance can increase up to a sonority distance of three, such as [prism] (*prisme*) (SD 1), [ʃifr] (*chiffre)* (SD 2), and [kadr](*cadre*) (SD 3). Sonority plateaus in French include [-kt], [-rl], and [-mn], for example *directe, perle,* and *hymne*. In analyses using empty nuclei, only simple codas would be legal, and the examples given above would rather be analyzed as [kar.t], [kad.r], [dirɛk.t] etc..

Many complex coda clusters in informal French speech, specifically in Quebec French, may optionally undergo simplification by deletion of the final consonant (Côté 2004). In European varieties of French, the simplification of obstruent + liquid coda clusters is less pervasive, and constrained to certain phonological contexts (Villeneuve 2010). French also allows for word final schwa insertion in words that contain simple and complex codas (Purse 2019). While this process happens more so in words with an orthographic <e>, such as *page* ([paʒ] or [paʒə]), it

also occurs in words that are not written with an orthographic <e>, such as *lac* ([lak] or [lakə]). Word final schwa insertion can also be found between word boundaries where a word final consonant is followed by a word initial consonant. For example, a phrase such as *bonne nuit* can be pronounced as [bɔnnɥi] or [bɔnənɥi], with the schwa inserted after the consonant in the first word.

3.3. Russian Coda Clusters

Two-consonantal coda clusters in Russian form a superset of both English and French. While also allowing falling clusters as low as one, rising clusters as high as three, and the plateau clusters listed above, Russian has a larger variety of such clusters.

The table below outlines the two consonantal clusters that are allowed in Russian. As well, the table outlines which of the clusters that are legal in Russian are also legal in English and/or French. Although Russian coda clusters are a superset of French and English in terms of sonority patterns, the process of word-final devoicing in Russian eliminates some sequences that are legal in the other languages. For this reason, not all clusters that are legal in English and/or French are represented.

Table 1: Two Consonantal Codas in Russian (Adapted from Trapman & Kager (2009) and Holden (1978))

		plosives			fricatives			nasals		liquids	
		p	t	k	f	s	ʃ	m	n	r	l
plosives	p		pt		pf	ps			pn	pr	pl
	t	tp			tf	ts	tʃ	tm		tr	tl
	k		kt		kf	ks				kr	kl
	b									br	bl
	d							dm	dn	dr	
	g							gm	gn	gr	gl
fricatives	f		ft	fk		fs	fʃ	fm		fr	
	s	sp	st	sk	sf			sm	sn		sl
	ʃ		ʃt								
	v							vm	vn	vr	vl
	z							zm	zn		zl
nasals	m	mp	mt		mf	ms	mʃ		mn	mr	ml
	n		nt	nk	nf	ns	nʃ	nm		nr	
liquids	r	rp	rt	rk	rf	rs	rʃ	rm	rn		rl
	l	lp	lt	lk	lf	ls	lʃ	lm	ln		

1. Blue-coloured squares indicate coda clusters that are legal in English. Red-colored squares indicate coda clusters that are legal in French. Purple-colored squares indicate coda clusters that are legal in both English and French.

3.4. English Constraint Rankings

As mentioned in Section 3.1, English allows falling coda clusters as low as one and as high as three in sonority distance, rising sonority clusters consisting of stop +/s/, and limited sonority plateaus [-kt], [-pt], [-fs] and [-rl]. [5] In this section, I outline crucial constraint rankings which account for major patterns in English coda clusters. This analysis takes Hall (2002) as a starting point and develops on his proposal. In his paper, Hall develops an account of English and German constraint rankings pertaining to coda clusters, as an argument against extrasyllabic consonants in these languages. Hall proposes a constraint SON, detailed below, which is

[5] The OT analyses presented for English and French will not encompass all the legal coda clusters in the languages concerned, but rather only those that pertain to the study.

undominated in English grammar. This constraint is able to account for the legality of stop+/s/ clusters while disallowing other rising clusters. It also allows for obstruent plateaus, while disallowing nasal plateaus.

(1) SON[6] (Hall 2002: 42)

> 'A sonorant consonant in the syllable coda may only be preceded by segments of higher sonority.'

Yet, as this constraint allows all obstruent + obstruent clusters, additional constraints are needed to eliminate clusters with combinations of peripheral consonants, such as labials ([p] [b]) and dorsals ([k] [g] [ŋ]). These forms violate the constraint *PLOSIVE + [PERPIH][7], defined below. The constraint *[N + PERIPH] is needed to disallow clusters such as *[-nk].

(2) *PLOSIVE + [PERIPH]

> A plosive consonant cannot follow a consonant specified as [peripheral] in a coda cluster.

(3) *[N + PERIPH]

> /n/ cannot precede a peripheral consonant in a coda cluster.

Illustrative tableaux also include the constraint *COMPLEX, which is violated by any syllable node which contains more than one element. This constraint is relatively low-ranked in the languages considered here, as they all allow complex codas and onsets.

(4) *COMPLEX (Prince & Smolensky 1993)

> No more than one C or V may associate to any syllable position node.

[6] This constraint has two parts in Hall's definition, as he uses it to account for onsets and codas. As this analysis only pertains to codas, part (a) of this constraint has been left out.
[7] This constraint is based on two constraints proposed by Hall (2002: 47), *TP/TK and *PK/KP. These constraints are combined here to help simplify the analysis.

Finally, some faithfulness constraints are outlined below. These constraints are ranked low in the following tableaux but are necessary as they allow for repairs that could potentially be used to produce well-formed outputs for clusters that are not attested in English.

Faithfulness Constraints: (McCarthy & Prince 1995)

(5) IDENT–IO(F)

Output correspondents of an input [F] segment are also [F].

(6) DEP-IO

Every segment of the output has a correspondent in the input. (No insertion)

(7) MAX-IO

Every segment of the input has a correspondent in the output. (No deletion)

In the following tableaux, the winning candidates for the non-occurring forms are not from collected data but illustrate potential repairs for hypothetical input clusters. In tableau 2, the optimal candidate is candidate (*b*), as it only violates DEP-IO which is ranked below SON, which candidate (*a*) violates. In tableau 3, candidate (*a*) is the winner as it only violates *COMPLEX, which is ranked lower than DEP-IO.

Tableau 2: Parse of a Non-occurring Form /katl/

/katl/	SON	DEP-IO	*COMPLEX
a. [.katl.]	*!		*
☞ b. [.ka.təl.]		*	

Tableau 3: Parse of the Word cats /kæts/

/kæts/	SON	DEP-IO	*COMPLEX
☞ a. [.kæts.]			*
b. [.kæ.təs.]		*!	

These tableaux use word-medial epenthesis as the repair strategy for illegal clusters. For this type of repair to arise, two constraints are needed to determine the site of epenthesis, which are outlined below.

(8) ANCHOR-R (Kager 1999)

A segment at the rightmost edge of the input is also at the rightmost edge of the output.

(9) CONTIGUITY (Kager 1999)

The portion of S_1 standing in correspondence forms a contiguous string, as does the correspondent portion of S_1. (No medial epenthesis or deletion of segments)

For epenthesis to occur word medially, ANCHOR-R has to be ranked above CONTIGUITY. This is demonstrated in tableau 4 below. The faithful candidate in (*a*) fatally violates SON, just as demonstrated in tableau 2. Candidates (*b*) and (*c*) both violate DEP-IO, but candidate (*c*), which undergoes word-final epenthesis, fatally violates ANCHOR-R, which is ranked higher than CONTIGUITY. This makes candidate (*b*), which undergoes word medial epenthesis, the winner, as it satisfies the higher ranked ANCHOR-R.

Tableau 4: Parse of a Non-occurring Form /katl/, with Word Medial Epenthesis

/katl/	SON	DEP-IO	ANCHOR-R	CONTIGUITY	*COMPLEX
a. [.katl.]	*!				*
☞ b. [.ka.təl.]		*		*	
c. [kat.lə]		*	*!		

The next tableaux illustrate the high ranking of *Plosive + [PERIPH] in English. In tableau 5, the optimal candidate is (*b*). The faithful candidate (*a*) violates the higher ranked constraint *Plosive + [PERIPH]. This makes candidate (*b*) the winner, as it satisfies the higher ranked *Plosive + [PERIPH].

Tableau 5: Parse of a Non-occurring Form /natk/

/natk/	*Plosive + [PERIPH]	SON	DEP-IO	*COMPLEX
a. [.natk.]	*!			*
☞ b. [.na.tək]			*	

The winner in tableau 6 is candidate (*a*) since it only violates *COMPLEX, which is ranked below DEP-IO. Both (*a*) and (*b*) satisfy *Plosive + [PERIPH], but candidate (*b*) is not the optimal candidate since it violates DEP-IO, which is ranked higher than *COMPLEX.

Tableau 6: Parse of the Word act /ækt/

/ækt/	*Plosive + [PERIPH]	SON	DEP-IO	*COMPLEX
☞ a. [.ækt.]				*
b. [.æ.kət.]			*!	

Tableau 7 demonstrates how *[N + PERIPH] is ranked above IDENT[PLACE]. Candidate (*b*), the faithful candidate, fatally violates the high ranked *[N + PERIPH]. The winning candidate is (*a*), which undergoes place assimilation between the nasal and the velar plosive, as this candidate satisfies *[N + PERIPH].

Tableau 7: Parse of the Word tank /tæŋk/

/tænk/	*[N + PERIPH]	IDENT[PLACE]	*COMPLEX
☞ a. [tæŋk]		*	*
b. [tænk]	*!		

The constraint ranking for English thus far is SON, *Plosive + [PERIPH], *[N + PERIPH] >> DEP-IO, MAX-IO, IDENT[PLACE], *COMPLEX.

3.5. French Constraint Rankings

For the French grammar, distinct constraint rankings will be needed to account for the larger number of legal clusters. See Tranel (2000) and Côté (2004) for other analyses of French syllable structures.[8] For one, French allows more clusters of rising sonority, which violate SON. Therefore, this constraint will have to be low ranked to account for these clusters. This is shown in tableau 8, with a legal French coda cluster [-dr]. In this tableau, the faithful candidate (*a*) violates SON and *COMPLEX, but satisfies the higher ranked MAX-IO, making it the optimal candidate. Candidate (*b*) fatally violates MAX-IO.

Tableau 8: Parse of the Word cadre (frame) /kadr/

/kadr/	MAX-IO	SON	*COMPLEX
☞ a. [.kadr.]		*	*
b. [.kad.]	*!		

As in English, the constraint *Plosive + [PERIPH] is undominated in French, given that clusters that violate this constraint are illegal in French. Also similar to the English ranking, the constraint *COMPLEX is ranked low in French, as French allows complex clusters. Tableau 9 illustrates this with a parse of a non-occurring form. In this example, the faithful candidate (*a*) violates *Plosive + [PERIPH] fatally. Candidate (*b*) violates DEP-IO which is ranked lower than *Plosive + [PERIPH], making this the optimal candidate. As in the section above, the winning candidates shown in the evaluations of non-occurring input forms are only potential repairs for the unattested clusters. Other repairs may be possible.

[8] Other researchers have developed constraint rankings for French coda clusters (Tranel 2000; Côté 2004), and while such accounts propose rankings of constraints to encompass the French coda cluster restrictions, the constraints introduced in this section are more uniform with the constraints used in the previous section.

Tableau 9: Parse of a Non-occurring Form /natk/

/natk/	*Plosive + [PERIPH]	DEP-IO	*COMPLEX
a. [.natk.]	*!		*
☞ b. [.nat.kə.]		*	

The example of epenthesis repair that is used in tableau 8 differs from the one given in the English constraint ranking examples in the site of the epenthesis. French has variable word-final epenthesis, which gives reason to predict that epenthesis repairs in illegal clusters would occur word-finally as well. To have the site of epenthesis occur after the cluster, the constraints ANCHOR-R and CONTIGUITY are ranked differently than in the English rankings above.

Tableaux 10 demonstrates the ranking of CONTIGUITY over ANCHOR-R to allow for word final epenthesis. Candidate (*a*) fatally violates *Plosive+ [PERIPH], as in tableau 9 above. Both candidates (*b*) and (*c*) violate DEP-IO, but candidate (*c*), which undergoes word medial epenthesis, fatally violates CONTIGUITY. This makes candidate (*b*), which undergoes word final epenthesis, the winner, as it satisfies the higher ranked CONTIGUITY.

Tableau 10: Parse of a Non-occurring Form /natk/, with Word Final Epenthesis

/natk/	*Plosive + [PERIPH]	DEP-IO	CONTIGUITY	ANCHOR-R	*COMPLEX
a. [.natk.]	*!				*
☞b. [.nat.kə.]		*		*	
c. [na.tək]		*	*!		

The constraint *[N + PERIPH] is also ranked high in French, so that coda clusters such as*[-np] and *[nk] are not allowed. Legal plateau clusters in French are similar to those in English except that French allows one plateau cluster consisting of two nasals [-mn]. The constraint *[N + PERIPH] also allows the cluster [-mn] while prohibiting *[-nm]. Ranking of this constraint is shown in tableaux 11 and 12 below. In tableau 11, the winner is the faithful candidate (*a*), as it

satisfies the high ranked *[N + PERIPH], as well as MAX-IO. While candidate (*a*) does violate SON and *COMPLEX, Candidate (*b*) fatally violates the higher ranked MAX-IO, making (*a*) the winner.

Tableau 11: Parse of the Word hymne /imn/

/imn/	*[N + PERIPH]	MAX-IO	SON	*COMPLEX
☞ a. [.imn.]			*	*
b. [.im.]		*!		

Tableau 12: Parse of a Non-occurring Form /inm/

/inm/	*[N + PERIPH]	MAX-IO	SON	*COMPLEX
a. [.inm.]	*!		*	*
☞ b. [.in.]		*		

The constraint in (10), below, is needed to account for allowable clusters such as [-bl], [-kl], [-ml], while disallowing clusters that are not attested in French such as *[-tl] or *[-sl]. The constraint in (11) prohibits clusters such as *[-mr] and *[-nr], which are illegal in French. These constraints must be ranked above MAX-IO, SON, and *COMPLEX. Note that forms that violate these constraints also necessarily violate the more general constraint SON, which penalizes any sonorant segment preceded by a segment of equal or lesser sonority and which plays an important role in the analysis of English clusters outlined above.

(10) *[COR] + [LATERAL]

A coronal cannot precede a lateral in a coda cluster.

(11) *[N + R]

A nasal cannot precede a rhotic.

Tableaux 13 and 14 demonstrate that *[COR] + [LATERAL] is ranked higher than MAX-IO. In tableau 13, as candidate (*a*) only violates the lower ranked SON and *COMPLEX, it is the optimal

candidate. In 14, the faithful candidate in (*a*) fatally violates *[COR] + [LATERAL], making candidate (*b*), which has undergone deletion, the winner.

Tableau 13: Parse of the Word table /tabl/

/tabl/	*[COR] + [LATERAL]	MAX-IO	SON	*COMPLEX
☞ a. [.tabl.]			*	*
b. [.tab.]		*!		

Tableau 14: Parse of a Non-occurring Form /tatl/

/tatl/	*[COR] + [LATERAL]	MAX-IO	SON	*COMPLEX
a. [.tatl.]	*!		*	*
☞ b. [.tat.]		*		

Tableau 15 below shows the high ranking of *[N + R] in French. The faithful candidate in (*a*) fatally violates the higher ranked constraint *[N + R]. The winner of tableau 15 is the candidate in (*b*) which undergoes deletion, as it satisfies the requirements for *[N + R].

Tableau 15: Parse of a Non-occurring Form /tamr/

/tamr/	*[N + R]	MAX-IO	SON	*COMPLEX
a. [.tamr.]	*!		*	*
☞ b. [.tam.]		*		

The constraint ranking for French thus far is *Plosive + [PERIPH], *[N + PERIPH], *[COR] + [LATERAL], *[N + R] >> MAX-IO, DEP-IO, SON, *COMPLEX. A notable difference between the French and English rankings is that French has SON ranked low, while in English this constraint is undominated.

3.6. Russian Constraint Rankings

For Russian, faithfulness constraints will be ranked higher than most of the constraints listed above, as many of the clusters that violate these constraints are allowed in Russian. For another analysis of syllable structure of Russian, see Zubritskaya (1995).

In tableau 16, MAX-IO and DEP-IO must be ranked above *[COR] + [LATERAL], SON, and *COMPLEX, since coda clusters consisting of coronal + lateral are legal in Russian, unlike French or English. This makes the winner in tableau 16 candidate (*a*) since candidate (*b*) violates MAX-IO and candidate (*c*) violates DEP-IO.

Tableau 16: Parse of the Word мысль (thought) /mɨsl/

/mɨsl/	MAX-IO	DEP-IO	*[COR] + [LATERAL]	SON	*COMPLEX
☞a. [.mɨsl.]			*	*	*
b. [.mɨ.səl.]	*!				
c. [.mɨs.]		*!			

Tableau 17 demonstrates another markedness constraint, *[N+R], that must be ranked below MAX-IO and DEP-IO. The optimal candidate here is the faithful candidate in (*a*), since all the constraints it violates are ranked below MAX-IO and DEP-IO. Candidate (*b*) fatally violates MAX-IO, and candidate (*c*) fatally violates DEP-IO.

Tableau 17: Parse of the Word жанр (genre) /ʐanr/

/ʐanr/	MAX-IO	DEP-IO	*[N + R]	SON
☞a. [.ʐanr.]			*	*
b. [.ʐan.]	*!			
c. [.ʐa.nər]		*!		

The only constraint that dominates MAX-IO and DEP-IO is *Plosive + [PERIPH]. This is needed as sequences such as [-tk] are not legal codas in Russian. This is demonstrated in the tableau below.

Candidate (*b*) violates DEP-IO and SON, but will be chosen as the optimal candidate, as (*a*) fatally violates the higher ranked *Plosive + [PERIPH]. As above, the winning candidate in non-occurring forms in Russian is a proposed candidate, and not based on collected data.

Tableau 18: Parse of a Non-occurring Form /natk/

/natk/	*Plosive + [PERIPH]	MAX-IO	DEP-IO	SON
a. [natk]	*!			*
☞ b. [na.tək]			*	

The constraint ranking for Russian then is *Plosive + [PERIPH] >> MAX-IO, DEP-IO >> *[N + R], SON, *[COR] + [LATERAL]. The major difference between Russian when compared to English and French is that the faithfulness constraints MAX-IO and DEP-IO are ranked high in Russian, while these constraints are ranked lower than the markedness constraints in English and French.

3.7. Summary

This section has detailed relevant coda clusters in English, French, and Russian. It has shown how Russian is a superset to both French and English, as it allows a larger variety of complex coda clusters than both of these languages. It has also demonstrated how French is a superset to English, as French allows a larger variety of codas than English.

In addition, this section has outlined how the relevant constraints in restricting allowable coda clusters are ranked in each language. One notable difference in each ranking is that English has the constraint SON ranked high, while both French and Russian must rank this constraint low to account for their larger set of permitted rising clusters. As well, Russian has the faithfulness constraints MAX-IO and DEP-IO ranked high compared to French and English. The proposed constraint rankings for each language are listed below.

(12) English Constraint Ranking

SON, *Plosive + [PERIPH], *[N + PERIPH], *[COR] + [LATERAL], *[N +R] >> DEP-IO, MAX-IO, IDENT[PLACE] >> *COMPLEX

(13) French Constraint Ranking

*Plosive + [PERIPH], *[N + PERIPH], *[COR] + [LATERAL], *[N +R] >> MAX-IO, DEP-IO, SON >>*COMPLEX

(14) Russian Constraint Ranking

*Plosive + [PERIPH] >> MAX-IO, DEP-IO >> *[N + PERIPH], *[N + R], SON, *[COR] + [LATERAL]

4. Goals, Hypotheses, and Predictions

4.1. The Current Study

This project investigates the influence of the L1 and L2 phonological systems on the acquisition of sound patterns that are novel to both systems. Transfer of grammatical structures has been shown to influence non-native language acquisition and can come from any previously acquired language (Hancin-Bhatt 2000; Llama, Cardoso & Collins 2010), the learner's access to Universal Grammar (Louriz 2007; Özçelik 2018), or a combination of different sources (Barkley 2010). This research project features an investigation of language transfer in the domain of coda cluster constraints at the initial state of learning using an Optimality Theoretic framework.

4.2. Goals of the Study

The main goals of this study are twofold; to explore from where transfer occurs when a bilingual learner parses phonological structures from a novel language, and to interpret why the source(s) of transfer is utilized at the initial stages of the learning process.

The first goal will be addressed by presenting bilinguals with stimuli from a novel grammar that differs from their previously learned languages. This is intended to represent the learner's initial state of acquisition, as this will be their first interaction with the novel grammar. Transfer from previous language knowledge can be identified by investigating the learner's accuracy on the novel stimuli, as well as the errors which they utilize to repair clusters.

The next goal, determining why this source may be used in transfer to the learner's interlanguage, can be addressed with the help of mirror-imaging. With one group having an L1 of English and an L2 of French, with the second group having an L1 of French and an L2 of English, depending

on the source of the transfer, it can be seen why this transfer occurred. Having both languages represented as the L1 and L2 will aid in teasing apart whether transfer occurs due to psychotypology or language status. It may be that both groups transfer the same language regardless of whether it is their L1 or L2, which would indicate that psychotypology plays a role in transfer. Another outcome is that the L2 (or the L1) is transferred regardless of which language is the L2, in which it can be assumed that language status is influencing transfer. This would be more difficult to assume if all participants had the same L1 and L2.

An additional goal is to fill the gap in the literature on coda cluster acquisition in bilingual learners outside of English as a Foreign Language (EFL) studies. The literature on the acquisition of onsets in language acquisition has been substantial in comparison to the literature on coda clusters. As well, while the literature on language acquisition outside of EFL contexts is growing, especially in learners of L3 Portuguese (Cabrelli Amaro 2018), it is important to conduct research that incorporates a variety of linguistic backgrounds. This study will contribute to the growing research on the acquisition of coda clusters by learners of other foreign languages.

4.3. Hypotheses and Predictions of the Study

There are multiple possible outcomes for this study. Potential sources of transfer include the L1, the L2, the learner's access to UG, or a combination of sources.[9] To aid in determining the source of transfer, an OT analysis will be conducted, as the previously described rankings of English and French, which have been already acquired by the learner, can be compared to their interlanguage rankings found within the study. These comparisons can then be used to identify language transfer through similarities between the interlanguage rankings and the previously learned

[9] Language dominance has been noted as a potential source of transfer throughout L3 langauge development (Puig-Mayenco, Rothman & Tubau 2022). While this is an interesting issue, it is beyond the scope of this study due to limitations on participant recruitment.

languages, or transfer from UG influences, which would be shown through rankings that vary from the previously acquired languages. For example, if the constraint SON is ranked high in the interlanguage grammar, this can then be compared to the rankings of French and English. As English has this constraint ranked high, but French has it ranked relatively low, then it can be assumed that the high ranking of SON has been transferred from the learner's English constraint rankings. If instead, the interlanguage shows that SON is ranked low in the constraint ranking, then it can be assumed that the learner is relying on their French constraint rankings for transfer. Another possibility is that the interlanguage rankings do not match the L1 or L2 rankings. For example, if it is shown that the learner has ranked *COMPLEX high, as this constraint is ranked low in both English and French, it may be assumed that the learner is accessing their UG to rank this constraint.

If there is evidence of transfer from the participants' access to UG, this would be support for the Full Transfer/Full Access Hypothesis (Schwartz & Sprouse 1996), which theorizes that learners have access to UG to facilitate their learning of a novel language. Sonority-related accounts, such as the SSP and MSD parameter, would indicate access to UG, and would be seen as the learner resetting sonority parameters to produce more unmarked structures. The constraints of the interlanguage would then be dissimilar from either English or French, as these languages include structures that violate the SSP, such as rising clusters, which are considered more marked.

If there is evidence that both groups have transferred the language knowledge from their L1, it can be assumed that there is an L1 status factor influencing the transfer. This would be shown through transfer of English constraint rankings into the interlanguage grammar in the English L1 group and transfer of French constraint rankings into the interlanguage grammar in the French L1 group.

If the evidence shows transfer by both groups of their L2, it can be assumed that there is an L2 status factor, supporting the findings of Bardel and Falk (2007). This would be shown through the full transfer of French constraint rankings by the English L1 group and full transfer of English constraint rankings by the French L1 group.

It is possible that both groups transfer only their knowledge from English, or solely from their knowledge of French. In this case, further insights into the relationships between English, French, and the novel language, Russian, would be needed to determine the reason for transfer. One possibility is that both groups perceive typological similarities between one of their previously known languages and the novel language. This, in turn, would support the TPM (Rothman 2011), which states that the learner will fully transfer language knowledge based on its similarities to the novel language. Thus, full transfer of French constraint rankings into the interlanguage grammar by both the English L1 group and the French L1 group would be evidence that psychotypology is influencing language transfer.

Psychotypology could be found to be the determining factor of transfer as well in the instance of both L1 groups transferring their English constraint rankings. However, this influence will be less clear in this situation, as English is a subset to French in terms of coda clusters and the Subset Principle (Manzini & Wexler 1987) may be at play. This principle states the most restrictive language (the subset) will be used in the learning of a novel language. Therefore, full transfer of English rankings by both groups could potentially be due to influences of psychotypology or the Subset Principle.

A combination of sources for transfer is another possible outcome. Evidence that both groups use knowledge from both English and French in their learning of an L3 would show support for the

LPM (Westergaard et al. 2017), which predicts transfer on a property-by-property basis and accounts for a combination of sources.

In terms of performance, it can be predicted that both groups will perform well on clusters that are legal in both English and French. Thus, faithfulness constraints such as DEP-IO and MAX-IO will be ranked above *COMPLEX, so that clusters that are legal in English and French are produced accurately.

As well, it can be predicted that both groups will transfer their knowledge from the most restrictive language, English, as per the Subset principle. This in turn predicts that both groups will not perform well on clusters that are legal in French but are not legal in English. If this prediction holds true, then the constraint SON will be ranked higher than faithfulness constraints DEP-IO and MAX-IO, as in the base English rankings outlined above.

It is expected that both groups will not perform as well on clusters that are illegal in both languages, as this will require the reranking of high ranked constraints in their previously learned languages. Such markedness constraints as *Plosive + [PERIPH], *[N + PERIPH], *[COR] + [LATERAL], and *[N +R] are undominated in English and French, as well as SON, which is undominated in English, and the learners may not be able to rerank these constraints lower than the faithfulness constraints DEP-IO and MAX-IO to produce the Russian clusters with accuracy in the short duration of the task.

5. Methodology

5.1. The Study

This study was reviewed by the ICEHR and found to be in compliance with Memorial University's ethics policy (ICEHR #20210684-AR). The study was conducted online and hosted on FindingFive (FindingFive Team 2019), a platform for conducting open, transparent research. Recruitment was done through sending out emails detailing the experiment. Emails were sent to personal contacts and distributed to the Modern Languages, Literatures, and Cultures Department at MUN. The email included a link to the study, along with the access code, so that participants could commence the study at the time of their choosing. Participants were required to sign up for an account using their email and a password. Once signed up and after clicking the link, participants were presented with the consent form to read. After reading, they were prompted to press continue as an indication of their consent.[10]

Participants were then given the eligibility questionnaire. This questionnaire consisted of 6 questions concerning their demographic and language backgrounds. The program was designed to exclude those whose second language was learned before the age of four, so that if this option was selected, after completing the questionnaire they would not be brought to the rest of the study. The other criteria concerning other language knowledge were determined on a case-by-case basis, thus any reports of other language knowledge were not ruled as ineligible by the program.

[10] Appendix A contains the consent form, Appendix B contains the recruitment form, and Appendix C contains the questionnaire.

5.2. Participants

There were 21 participants who completed this task. Table 3 presents the general characteristics of the participants. Notably, 11 participants spoke English as their L1 and French as their L2, and 10 spoke French as their L1 and English as their L2. All the participants reported learning their second language after the age of four. Those who had knowledge of Russian or any Slavic language were excluded from this study. Some of the participants did report some knowledge of additional languages, with none having knowledge of an additional language higher than an intermediate level.

Table 2: Participant Backgrounds

Participant ID	**L1**	**L2**	**L2 Proficiency**	**Age**	**Other Language Knowledge**
KLB	English	French	Intermediate	21	None
CLM	English	French	Intermediate	21	None
MSH	English	French	Intermediate	21	None
ZTB	English	French	Beginner	23	None
JNV	English	French	Advanced	22	None
PRT	English	French	Intermediate	23	None
ETS	English	French	Advanced	21	Japanese
EMF	English	French	Intermediate	18	None
CTH	English	French	Intermediate	21	None
MMP	English	French	Intermediate	21	None
NIL	English	French	Beginner/Intermediate	21	None
GRD	French	English	Advanced	60	None
RLD	French	English	Advanced	54	Spanish/German
MAL	French	English	Intermediate	45	German
NGD	French	English	Advanced	44	None
CBD	French	English	Advanced	39	Spanish
DJS	French	English	Advanced	19	None
DVC	French	English	Intermediate	44	Spanish
LRB	French	English	Advanced	33	None
NTH	French	English	Advanced	33	None
VLL	French	English	Intermediate	65	None

5.3. Materials

The task consisted of 159 monosyllabic nonsense words of the form CVCC.[11] Nonce forms were used in this study to keep all the task items at the same level of complexity, and to eliminate potential effects by equally distributing onsets and vowels with different coda clusters.

The task items were recorded prior to the study by a native Russian speaker. A variety of falling sonority, rising sonority, and plateau coda clusters were used, all of which are legal in Russian. There were 56 different coda clusters used for the task items, with each coda cluster having 2-3 repetitions. Out of the 159 items, 83 were falling sonority, 66 were rising sonority, and 10 had a sonority plateau. 74 of the task items were legal cluster types in both English and French, 36 were legal in French but not legal in English, and 49 were illegal in both languages. Table 3 below shows the division of the clusters by their sonority in each legality type.

Table 3: Amount of Coda Clusters grouped by Sonority and Legality Types

	Legality Type			
Sonority Type	Illegal in Both	Legal in French/ Illegal in English	Legal in Both	Total
falling	19	3	61	83
rising	27	30	9	66
plateau	3	3	4	10
Total	49	36	74	159

Each repetition of a coda cluster had varying onset/nucleus pairings. For all task items, the variation of the onset/nucleus was kept to a minimum. The total number of varying onsets was 15.

[11] See Appendix D for list of practice items and task items.

(15) Onsets used:

a) [su-]	b) [ka-]	c) [gi-]	d) [do-]	e) [ti-]
f) [vi-]	g) [be-]	h) [pu-]	i) [ze-]	j) [ta-]
k) [te-]	l) [-ze]	m) [sa-]		

5.4. Procedure and Analysis

Participants were presented with nonsense words auditorily, and then asked to repeat the word they heard. They had to manually click a button to start and stop their recordings. The study was done at the location and time of the participants' choosing, but they were advised to record in a quiet location. They were given 7 practice items to begin with. After the practice, they were notified that the practice was finished and reminded of the process to quit before proceeding.

Responses were then transcribed in IPA and coded by the author. Each response was coded according to whether it was produced correctly, and in case of error, for the type of repair(s) made. A response was coded as correct if the coda cluster was pronounced the same as the target, regardless of if the onset or nucleus was produced correctly. Errors in the onset or nucleus were coded separately but will not be used in this analysis. Due to technical errors, 8 of the tokens could not be used in the analysis.

6. Results

As the research question deals with how previous language knowledge is transferred into a novel language system, I will begin by investigating the participants' accuracy on the task items and how this accuracy is influenced by legality in English versus French and the sonority profiles of coda clusters (falling, rising, plateau). The participants are divided into two groups by their L1 (French, English). The English L1 group includes the participants who speak English as their L1 and French as their L2. The French L1 group includes the participants who speak French as their L1 and English as their L2. In addition to looking at accuracy, the types of repairs made in the inaccurate productions will be investigated.

In total, there were 3339 responses used in the analysis. Out of these responses, 55% were produced correctly overall, with the English L1 group producing 56% correct responses and the French L1 group producing 53% correct responses. The impact of L1 was analyzed using a one-way ANOVA with the number correct as the outcome variable. The result of this test was not significant ($F(1,19) = 0.868$, $p = .363$). The impacts of L1, proficiency, age, and exposure to a third language were analyzed using linear regression with the number correct as the outcome variable. None of the predictors were significant. These tests indicate that participants did not score significantly differently based on their age, L2 proficiency, or other language knowledge.

While this test indicates no significant effect of the participants' L1 on overall accuracy in the task, investigating the interactions between L1 and the phonological properties of the task items (i.e., sonority type and legality) on accuracy is needed to investigate the influences of potential language sources. The following sections will present these investigations, starting with the interactions of L1 and sonority profile on accurate production, and then looking into the interaction between L1 and legality on accurate production.

6.1. Cluster Sonority Profile Effects

First, I investigated the effects of cluster Sonority type on accurate production for each L1 group. As described in Section 5.3, target clusters were divided into three categories according to sonority profile: falling sonority, rising sonority, and sonority plateau.

The effect of Sonority was analyzed using an ANOVA in which accuracy was entered as the outcome variable and sonority as the within-subjects variable (falling, rising, and plateau). The variable Sonority was significant (F (2, 60) = 26.7, $p < .001$). A Post Hoc test indicated significance in accurate production of falling clusters and rising clusters ($p < .001$), whereby the falling clusters had higher rates of accuracy. Additionally, there was a significant difference between falling clusters and plateau clusters ($p < .001$), where falling clusters had higher rates of accuracy. The rate of accurate production between rising clusters and plateau clusters showed no significant difference ($p = .416$).

Next, I considered the interaction between L1 and Sonority type on accurate production. Table 4 below shows the average correct of each group in each sonority type. Figure 2 displays boxplots by group and sonority type.

Table 4: Average Correct in Sonority Types

Group	**Falling Clusters**	**Plateau Clusters**	**Rising Clusters**
English L1	67%	47%	45%
French L1	64%	31%	43%
Overall	**65%**	**40%**	**44%**

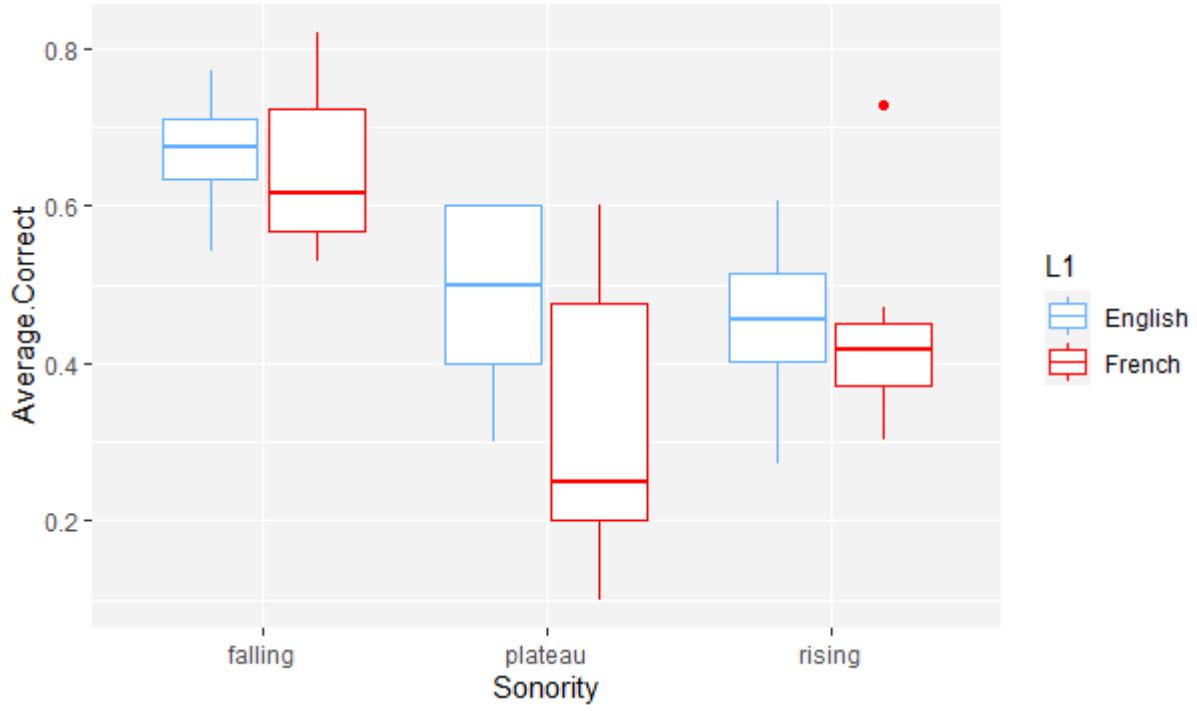

Figure 2: Average Correct by Cluster Sonority Type[12]

The effect of sonority was analyzed using an ANOVA in which accuracy was entered as the outcome variable, L1 as the between-subjects variable, and Sonority as the within-subjects variable (falling, rising, and plateau). The interaction between Sonority and L1 (F (2, 57) = 2.52, p = .089) was not significant. As shown in Figure 2, both the L1 English and L1 French participants perform similarly across sonority categories.

[12] Boxplot graphs are formatted as follows; the length of the box gives the interquartile range (scores between the 25th and 75th percentile), the line inside the box indicates the median value, and the dots above and/or below the box indicate outliers.

6.2. Legality Effects

Next, I looked into the effect of Legality on accurate production. As described in Section 5.3, each cluster is classified as one of three Legality types: Legal in French and Illegal in English, Legal in Both languages, and Illegal in Both languages.

The effect of Legality was analyzed using an ANOVA in which accuracy was entered as the outcome variable, and Legality as the within-subjects variable (Legal French/ Illegal English, Legal in Both, and Illegal in Both). The variable Legality was significant (F (2, 60) = 86.1, p < .001). A Post Hoc test indicated significance in the difference of accurate production between the Legal in Both category when compared to the Illegal in Both category (p < .001), and the Legal in French/Illegal in English category (p < .001), where the clusters that are Legal in Both were produced more accurately than the Illegal in Both and the Legal in French/Illegal in English category. The accuracy rate of the Legal in French/Illegal in English category and the Illegal in Both category showed no significance (p = .224).

Next was to investigate the interaction between L1 and Legality type on accurate production. Table 5 below shows the average correct that each group produced in each category listed, and Figure 3 displays boxplots by group and legality category.

Table 5: Average Correct in Legality Types

Group	**Illegal in Both**	**Legal French/ Illegal English**	**Legal in Both**
English L1	41%	37%	77%
French L1	41%	34%	71%
Overall	**41%**	**36%**	**74%**

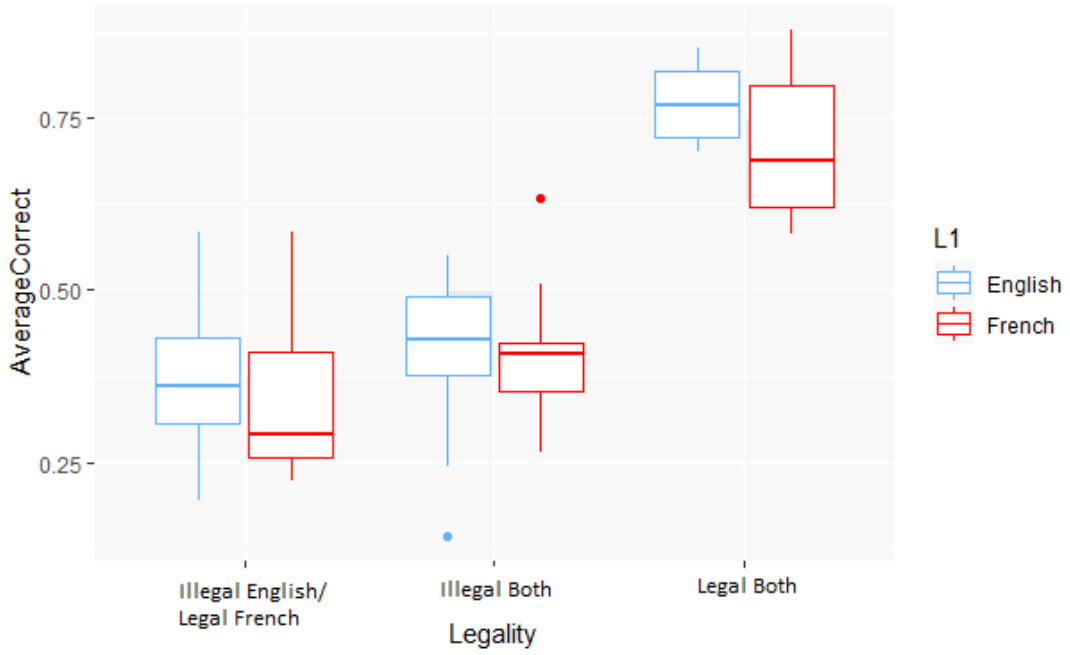

Figure 3: Average Correct by Cluster Legality Type

The effect of Legality was also analyzed using an ANOVA in which accuracy was entered as the outcome variable, L1 as the between-subjects variable, and Legality as the within-subjects variable (Legal French/ Illegal English, Legal in Both, and Illegal in Both). The interaction between Legality and L1 (F (2, 57) = 0.457, p = .636) was not significant. Indeed, as shown in Figure 3, both the L1 English and L1 French participants perform similarly across Legality categories.

What is interesting about these findings is that despite differences in their L1, both groups performed very similarly in each category. It is important to note that both groups performed particularly poorly on the clusters that are Legal in French/Illegal in English. A question that can be asked here is why are both groups, and particularly the group whose native language is

French, doing so poorly on clusters that are legal in French? This question will be further addressed in the discussion section below.

6.3. Accuracy Summary

The previous sections in this chapter investigated the participants' accuracy in their production of the clusters presented in the task. There were no significant statistical findings on the influence of the participants' L1 on their overall accuracy, nor in the interactions of their L1 and varying features of the clusters being tested, including the sonority of the clusters and the legality of the clusters in French and English.

While there were no significant differences between the L1 groups, the similarities between each group's results tell an interesting story. For one, it is evident that transfer is not solely based on L1; since one group has English as their L1 and the other has French as their L1, if L1 was to be the only influence in the transfer of language knowledge, then we would see more differentiation in the groups' accuracy rates. Another interesting note is when looking into the groups' accuracy in the varying legality types of clusters, they both did poorly in the Legal in French/ Illegal in English category, where one could expect the French L1 group would fair well with clusters that are legal in their own language.

The next phase of the investigation is to consider the behaviors of participants in clusters that they produced incorrectly. The following sections describe the results of the repair strategies used by participants during the task.

6.4. Error Types

The main repair strategies found in the incorrect utterances were epenthesis, paragoge, substitution, deletion, and consonant insertion. Other repairs found included vocalization, nasalization, metathesis, and consonant syllabification, which were collapsed into one category "other", to help simplify the analysis.

Some examples of the main repair strategies from the data are exemplified below. Cases of vowel insertion were categorized as different repairs based on the location of the epenthetic vowel, resulting in multiple types of vowel insertion. Repairs in which a vowel is inserted word-finally, after the consonant cluster, are classified as paragoge, and the term epenthesis is used to refer to cases where the vowel was inserted between the first and second consonants of the coda cluster.

(16) Repair Type Examples

a) *Deletion*

i) EMF[13], item 47 /zelm/ -> [zel] ii) CTH, item 155 /vinm/ -> [vin]

b) *Substitution*

i) CLM, item 54 /sumt/ -> [sunt] ii) DJS, item 45 /girn/ -> [giln]

c) *Insertion*

i) CDB, item 65 /virs/ -> [virsk] ii) ZTB, item 22 /bems/ -> [bemps]

d) *Paragoge*

i) MAL, item 47 /zelm/ -> [zel.mə] ii) GRD, item 155 /vinm/ -> [vin.mə]

[13] The initials preceding each example are representative of the participant who produced the error.

e) *Epenthesis*

i) NIL, item 87 /surp/ -> [su.rəp] ii) CTH, item 126 /zepn/ -> [zep.ən]

In some of the incorrect utterances, multiple repairs were used in one item. In the following analyses, each error is counted as an individual repair, including those that co-occur with other errors in a single item. Overall, there were 1731 errors made, with the English L1 group producing 866 errors, and the French L1 group producing 865 errors. Table 6 shows the distribution of error type rates by L1 group, with Figure 3 having boxplots showing error rates by L1 group.

Table 6: Average of Repairs by L1 Group

	Other	Paragoge	Epenthesis	Deletion	Substitution	Insertion
English L1	12%	2%	32%	13%	30%	11%
French L1	13%	9%	22%	13%	35%	8%
Overall	13%	6%	27%	13%	32%	9%

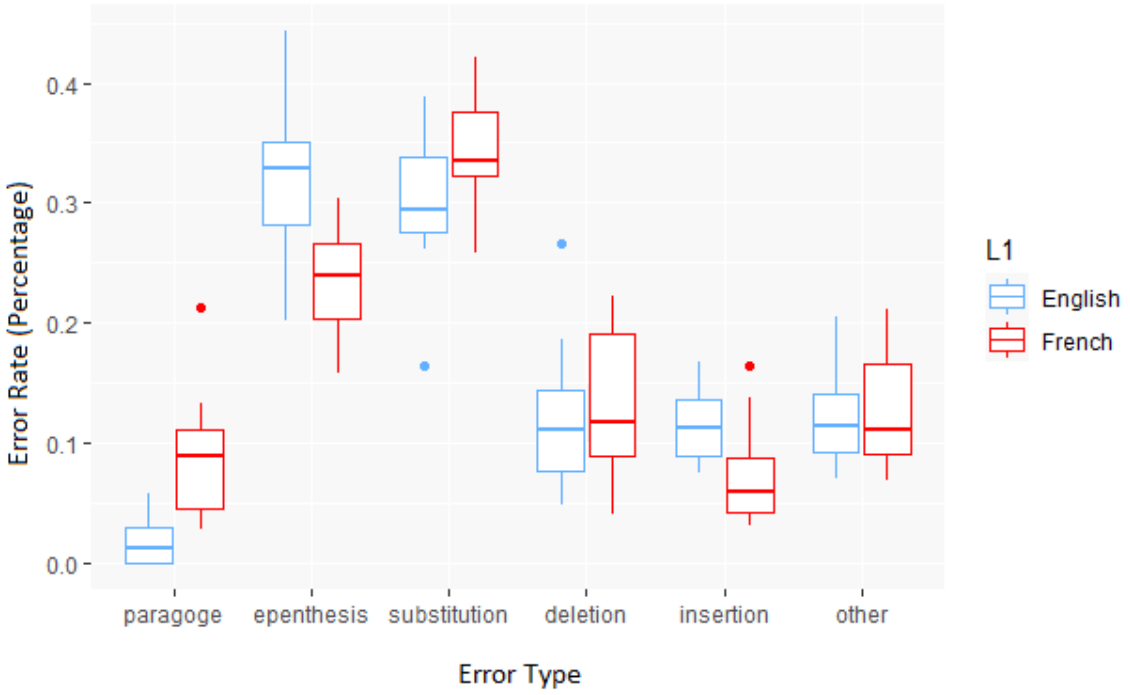

Figure 4: Error Rates by L1 Group

An ANOVA was used to analyze the influence of L1 on the use of the error types, with the rate of error types as the outcome variable and L1 as the between-subjects variable, and the error type as the within-subjects variable. The results indicated a significant effect of L1 group on general error type rates (F (5, 114) = 6.69, p < .001). Post Hoc tests were run to investigate this further. These showed that most of the error types showed no significant effects of L1 including deletion (p = 1), insertion (p= 0.863), substitution (p = .690), paragoge (p = .093), and the grouped error types in the "other" category (p = 1). Epenthesis did show a significant effect of L1 group, at p = 0.005. Indeed, the L1 French group made significantly fewer repairs involving epenthesis than the L1 English group (see Figure 4).

These results suggest that each group is very similar in terms of repairs, except in the instances where epenthesis occurs. This warrants more in-depth exploration as to what types of clusters are repaired by epenthesis, which will be described in the following section.

6.4.1. Epenthesis Usage in Varying Cluster Types

First, I investigated if there were any effects of the Sonority of the coda clusters on the usage of epenthesis. An AVONA Omnibus Test was done with the rate of epenthesis usage as the outcome variable, L1 as the between-subjects variable, and Sonority as the within-subjects variable. This test showed that this effect was significant (F (2, 57) = 9.07, $p < .001$).

A Post Hoc test was used to investigate this further. The rate of epenthesis usage between L1 groups showed no significant difference in clusters of falling sonority or sonority plateaus ($p = 1$). The rate of epenthesis usage between L1 groups for clusters of rising sonority did show a significant effect ($p < .001$), meaning that the L1 groups differed in their usage of this repair for rising sonority clusters, with the English L1 group using this repair more than the French L1 group.

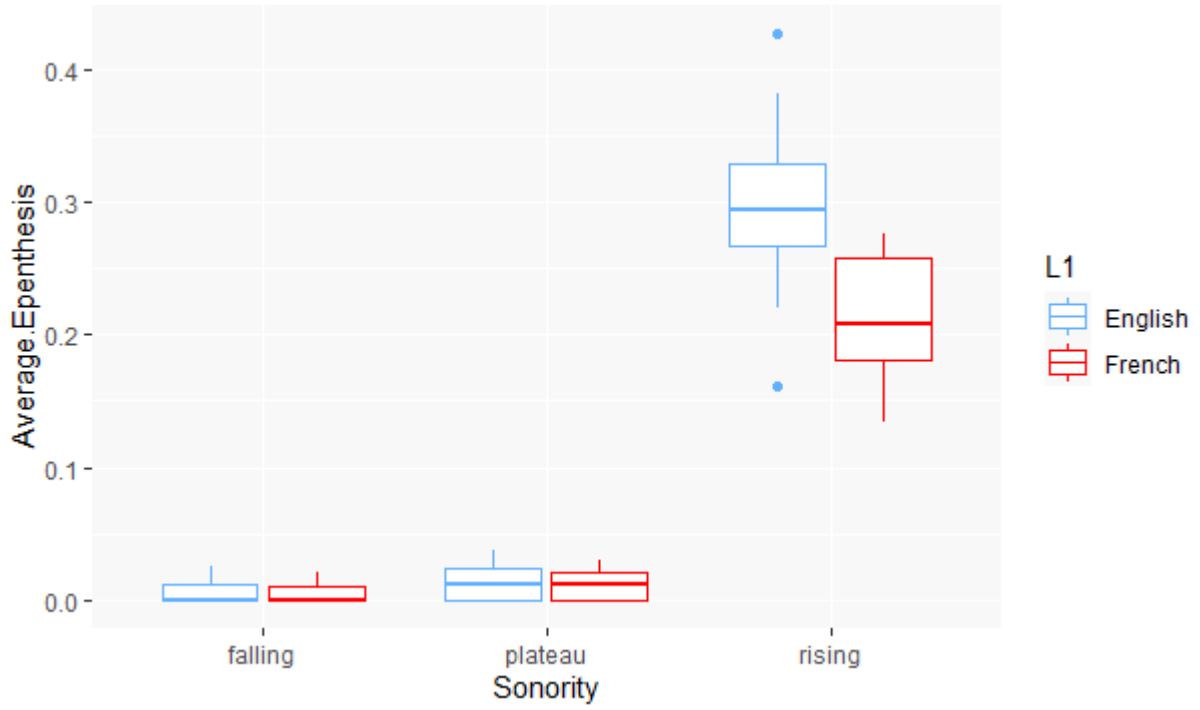

Figure 5: Average Epenthesis Usage by Sonority Type

Next, I investigated if the legality of the coda clusters in addition to L1 had an effect on the usage of epenthesis. Another ANOVA was run to investigate this, with the rate of epenthesis usage as the outcome variable, L1 as the between-subjects variable, and Legality as the within-subjects variable. This test did show a significant effect (F (2, 57) =3.76, p = .029). A Post Hoc test was done to investigate this further, where it was found that there was a significant effect of clusters that are Legal in French and Illegal in English on the usage of epenthesis for each L1 group (p = .002). No other significant effects were found in any other Legality category (Illegal in Both: p = 0.129, Legal in Both: p = 1). The English L1 group used this repair significantly more than the French L1 group in this legality type.

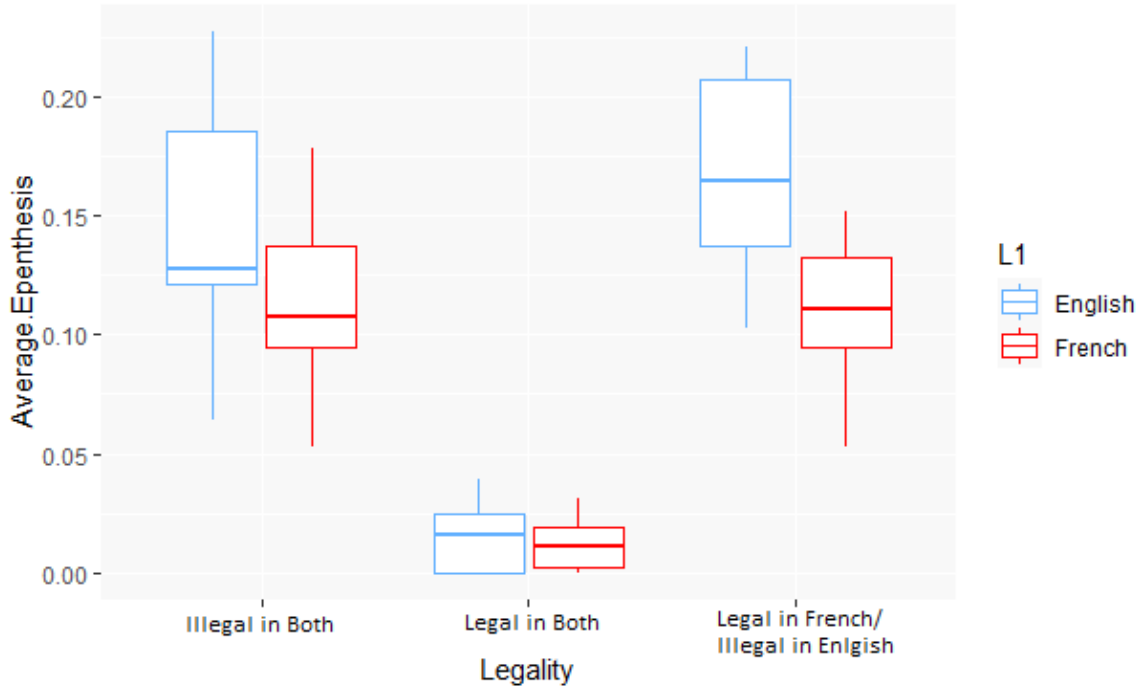

Figure 6: Average Epenthesis Usage by Legality Type

The next question I looked into concerned whether the French L1 group used the other epenthesis repair, paragoge, for more of the clusters that are Legal in French and illegal in English than the English L1 group. An ANOVA Omnibus test was done on the effects of Legality type on rates of paragoge usage, with the rate of usage as the outcome variable, L1 as the between-subjects variable, and Legality as the within-subjects variable. A significant effect was found (F (2, 57) = 0.744, p = .048). A Post Hoc test indicated significant differences between L1 groups in their usage of paragoge in the clusters that are Legal in French and Illegal in English (p = .030). The other cluster Legality types showed no significant effects (Illegal in Both: p = .649, Legal in Both: p = .063). The French L1 group used this repair significantly more than the English L1 group.

What these results show is that when presented with clusters that are Legal in French and Illegal in English, the English L1 group will use more of the repair type epenthesis than the French L1 group, and the French L1 group will use more of the repair type paragoge than the English L1 group. One thing of importance to note is that even though the French L1 group uses more paragoge than the English L1 group in this legality category, it is not the most used repair by the French L1 group in this context. Table 7 below demonstrates that the French L1 group uses more epenthesis than paragoge in clusters that are Legal in French and Illegal in English, but still do use paragoge considerably more than the English L1 group in this category.

Table 7: Average of Epenthesis Repairs by L1 Group in Different Legality Categories

	Legality		
	Illegal in Both	Legal in French/ Illegal in English	Legal in Both
English L1 Group			
Average of Epenthesis	14.90% (124)	17.07% (142)	1.56% (13)
Average of Paragoge	0.72% (6)	0.96% (8)	0.48% (4)
French L1 Group			
Average of Epenthesis	11.19% (94)	10.71% (90)	1.31% (11)
Average of Paragoge	1.90% (16)	4.05% (34)	3.10% (26)

Numbers in parentheses are the raw counts of the repair used in that category. The number of clusters presented to each participant in each category are reported in Section 3.3.2.

6.5. Error Types Summary

When investigating the types of repairs employed by the participants during the task, there were no significant differences between the usages of substitution, deletion, insertion, or the other category, suggesting that both L1 groups used these types of repairs similarly throughout the task.

The results did show that there was a significant difference in the groups' usage of epenthesis, where the English L1 group used this repair type more frequently than the French L1 group.

More statistical tests were run to investigate if the cluster characteristics influenced the usage of epenthesis for the L1 groups. Sonority showed a significant effect of rising clusters on the usage of epenthesis in each group, with the English group using this repair more frequently than the French L1 group in rising clusters. For example, when producing a rising cluster like in the nonce word [tikl], the English L1 group tended to repair by epenthesis, such as in JNV's production [ti.kəl]. The French L1 group used this repair as well, but would also use other repair strategies and produced fewer cases of epenthesis.

Legality had a significant effect on the rates of epenthesis as well, such that in clusters that are legal in French and illegal in English, the English L1 group used this repair more frequently than the French L1 group. In addition to this, there was a significant difference between both groups in the legal in French and illegal in English category when investigating the usage of paragoge, where the French L1 group used this repair more frequently than the English L1 group. For example, when producing the nonce word [zivr] incorrectly, the English L1 group tended to repair using epenthesis, such as in ZTB's production [zi.vər], while the French L1 group produced more cases of paragoge, such as in LRB's production [zi.vrə].

7. Optimality Theory

The next part of this investigation will focus on an Optimality Theory analysis. Constraint rankings will be proposed for the participants' interlanguage. These will then be compared to the rankings of their native languages and the target language, to discern which constraint rankings are being transferred. The constraint rankings for English, French, and Russian have been discussed in Sections 4.4 to 4.6.

This section focuses on the constraint rankings of the participants' interlanguage by analyzing their responses in Optimality Theory. Given the nature of the study and the results, these rankings will not reflect categorical grammars for all speakers or even for individuals. For the purposes of this analysis, it is assumed that all task items were perceived accurately by the listener. The variation in responses across items and speakers requires different constraint rankings between participants as well as constraint rerankings for individuals when presented with different items. The rankings given here instead represent possible interlanguage grammars that can account for particular responses. Rankings associated with interlanguage grammars may be subject to change, both during a more typical language learning process and during the experimental task in this study.

7.1. Falling Clusters

Many of the falling clusters were produced correctly. For falling clusters that are illegal in both English and French, repairs such as substitution and insertion were used. Tableaux 19 and 20 show the evaluation of two items with coda clusters containing a nasal followed by a voiceless obstruent. Examples illustrate productions by speakers with L1 English and L2 French. As shown

in the results section, both groups used substitution and insertion similarly and both groups used higher amounts of substitution than insertion.

The examples presented below show instances where participants used insertion to repair ill-formed falling clusters in English and French. A new constraint is proposed here, to account for the ill-formedness of *[-ms] and *[-mt]. In English, coda clusters that consist of /m/ plus a coronal stop are allowed but only if the stop is voiced, creating [-mz] and [-md], as found in words like *seems* and *assumed*.

(17) *[M+COR[-VOICE]]

/m/ cannot precede a voiceless coronal in a coda cluster.

In tableaux 19, the form produced by the speaker is the winning candidate in (*b*), which has epenthesis of a voiceless stop between the nasal and the following voiceless fricative. The faithful candidate in (*a*) violates *[M+COR[-VOICE]] and candidate (*c*) violates the faithfulness constraint IDENT[VOICE]. A similar repair is illustrated in tableau 20, which shows the production from a different speaker.

Tableau 19: Parse of /bems/ by ZTB (English L1)

/bems/	*[M+COR[-voice]]	IDENT[VOICE]	DEP-IO
a. [bems]	*!		
☞ b. [bemps]			*
c. [bemz]		*!	

Tableau 20: Parse of /sumt/ by ETS (English L1)

/sumt/	*[M+COR[-voice]]	IDENT[VOICE]	DEP-IO
a. [sumt]	*!		
☞ b. [sumpt]			*
c. [sumd]		*!	

These are interesting examples, as the voicing assimilation candidates in (*c*) of both tableaux may be expected for English speakers, considering that voicing assimilation is a common process in English coda clusters. An explanation for this could be that the speakers have noted the absence of final voiced obstruents in the stimuli and promoted a constraint against voiced codas (not shown). Participants retain the high ranking for *[M+COR[-VOICE]] so they opt to insert a consonant that violates the lower ranked DEP-IO.

The following tableaux show some examples of substitutions used by both groups in falling clusters. Tableau 21 illustrates a production of the item [dofk] by an L1 English speaker. This evaluation shows IDENT[PLACE] is ranked below *Plosive + [PERIPH] and DEP-IO. Candidate (*b*) is the winning candidate. This form shows a change from dorsal to coronal for the final stop, reflecting the high ranking of *Plosive + [PERIPH] and DEP-IO relative to IDENT[PLACE]. The high ranking of *Plosive + [PERIPH] is similar to both English and French constraint rankings.

Tableau 21: Parse of /dofk/ by JNV (English L1)

/dofk/	*Plosive + [PERIPH]	DEP-IO	IDENT[PLACE]
a. [dofk]	*!		
☞ b. [doft]			*
c. [do.fək]		*!	

Tableaux 22 and 23 show that IDENT[PLACE] is also ranked below *[N+PERIPH]. The items in these tableaux were produced by two French L1 speakers. In tableau 20, the faithful candidate (*a*) fatally violates the high ranked constraint *[N+PERIPH]. The speaker opted to assimilate the place of articulation of the nasal consonant to the final consonant, demonstrating the higher ranking of DEP-IO relative to IDENT[PLACE]. The speaker who produced the form in tableau 22 has the same constraint rankings, so that the optimal candidate is (*b*), which only violates the lower ranked

IDENT[PLACE]. The high ranking of *[N + PERIPH] is similar to both English and French constraint rankings.

Tableau 22: Parse of /benf/ by NGD (French L1)

/benf/	*[N+PERIPH]	DEP-IO	IDENT[PLACE]
a. [benf]	*!		
☞ b. [bemf]			*
c. [be.nəf]		*!	

Tableau 23: Parse of /vink/ by DVC (French L1)

/vink/	*[N+PERIPH]	DEP-IO	IDENT[PLACE]
a. [vink]	*!		
☞ b. [viŋk]			*
c. [vi.nək]		*!	

These results show the high ranking of *[N+PERIPH] and *Plosive + [PERIPH], which is similar to the rankings for English and French. It is interesting that when repairing nasal + peripheral clusters, the French L1 group produces forms that assimilate the place feature of the nasal to that of the obstruent. French tends to have nasalized vowels in clusters with an underlying nasal (ex. banque [bãk]), so if the participants were to transfer the French knowledge, it would be assumed that they would nasalize the vowel. There were some examples of a nasalized vowel which replaced the nasal in a cluster produced by participants in both groups, yet these instances were few, therefore they will not be included in this analysis. The more frequent use of place assimilation used could be taken as an indication that both groups are transferring their English knowledge.

7.2. Rising Clusters

As noted in the results above, both groups performed poorly on rising clusters. The majority of repairs for rising clusters are epenthesis. Rising clusters ending in /l/ mostly are repaired by epenthesis. This is shown in tableau 24, with a production by an English L1 speaker. In this example, a schwa is inserted between a velar plosive and a liquid. The constraint SON is ranked high, so the faithful candidate (*a*) is not chosen as optimal as this fatally violates SON. Candidate (*b*) violates IDENT[CONSONANTAL], which is ranked higher than DEP-IO by this speaker, making this violation fatal. Candidate (*c*) is chosen instead, as it only violates the lower ranked DEP-IO.

Tableau 24: Parse of /zekl/ by ETS (English L1)

/zekl/	SON	IDENT[CONSONANTAL]	DEP-IO
a) [zekl]	*!		
b) [ze.ku]		*!	
☞ c) [ze.kəl]			*

There were quite a few instances where /l/ in word final position underwent vocalization, as demonstrated in tableau 25. This item was produced by a French L1 speaker. In this example, the syllable-final liquid is produced as a vowel, creating a disyllabic word. The faithful candidate (*a*) is ruled out as it fatally violates SON. Candidate (*c*) fatally violates DEP-IO, which has been ranked higher than IDENT[CONSONANTAL] by this speaker. This makes candidate (*b*) the optimal candidate, as it only violates the lower ranked constraint IDENT[CONSONANTAL].

Tableau 25: Parse of /zekl/ by MAL (French L1)

/zekl/	SON	DEP-IO	IDENT[CONSONANTAL]
a) [zekl]	*!		
☞ b) [ze.ku]			*
c) [ze.kəl]		*!	

The high ranking of SON is different from the French constraint ranking, which has ranked this constraint low to account for legal clusters in French such as [-kl]. This ranking is more similar to the English constraint ranking, which ranks this constraint high, as clusters with rising sonority (with the exception of [-Cs]) are illegal.

The next examples demonstrate the differences in schwa insertion between groups. As mentioned above, both groups used epenthesis differently, specifically in rising clusters that are legal in French and illegal in English. The difference is in where the schwa is inserted, with English L1 speakers more frequently inserting schwa between the consonants in a cluster, and the French L1 speakers more often inserting the schwa following the consonants in the cluster.

In rising clusters ending in /r/, epenthesis is the most used repair, but the French L1 group has a higher usage of the repair paragoge in these clusters, relative to the English L1 group. To account for the differences between the English L1 and French L1 groups, the constraints ANCHOR-R and CONTIGUITY are used to account for the varying locations of epenthesis.

As the French L1 group tended to insert the schwa after the cluster more so than the English L1 group, it can be assumed that English L1 participants are more likely to rank ANCHOR-R higher than CONTIGUITY. In contrast, a number of examples illustrate that French L1 participants can have CONTIGUITY ranked higher than ANCHOR-R. This is demonstrated in tableaux 26 and 27 below.

Tableau 26 illustrates the production of a coda cluster containing a nasal and a rhotic by a French L1 speaker. In this tableau, candidate (*a*) violates *[N+R], which is undominated in the ranking, making this violation fatal. Candidate (*c*) fatally violates CONTIGUITY, leaving candidate (*b*) as the optimal candidate, as CONTIGUITY is ranked higher than ANCHOR-R and DEP-IO.

Tableau 26: Parse of /sunr/ by CDB (French L1)

/sunr/	*[N + R]	CONTIGUITY	ANCHOR-R	DEP-IO
a. [sunr]	*!			
☞ b. [sun.rə]			*	*
c. [sun.ər]		*!		

In tableau 27, the production of a nasal and rhotic coda cluster by an English L1 speaker is demonstrated. In this example, *[N + R] is undominated in the ranking, and the faithful candidate (*a*) violates this constraint fatally. Candidate (*b*) violates CONTIGUITY and DEP-IO, yet is the optimal candidate, as (*a*) fatally violates the higher ranked ANCHOR-R.

Tableau 27: Parse of /zenr/ by JNV (English L1)

/zenr/	*[N + R]	ANCHOR-R	CONTIGUITY	DEP-IO
a. [zenr]	*!			
☞ b. [ze.nər]			*	*
c. [zen.rə]		*!		*

The different rankings of ANCHOR-R and CONTIGUITY between groups is an indication that transfer is occurring from different languages for each group. The French L1 group produced more forms with word-final schwa insertion, showing that CONTIGUITY is ranked higher than ANCHOR-R. Given that this is a phonological process found in French, it could be assumed that this ranking is a result of transfer from their French L1. The English L1 group more consistently ranked ANCHOR-R over CONTIGUITY to allow for medial schwa insertion, evidently showing that transfer for this group is coming from their English L1.

7.3. Plateau Clusters

The results showed that both groups performed poorly on plateau clusters. Both groups did perform well when producing words with the obstruent plateau [-kt] and the liquid plateau [-rl].

However, some speakers did produce [-rl] incorrectly, with the majority of repairs being epenthesis. As the Russian rhotic sound is different from the rhotics in French and English, it is possible that the Russian trill influenced the pronunciations of this cluster.

Where both groups tended to drop in accuracy in plateau clusters was in the nasal plateaus. One of the nasal plateaus, [-mn] is a legal cluster in French but not in English, while the other, [-nm], is illegal in both languages. One repair strategy used by both groups in nasal plateau clusters was epenthesis. While both groups tended to insert the schwa between the consonants of the cluster, the French L1 group would insert after the consonants of the cluster more often than the English L1 group.

In tableau 28, the production of a nasal plateau that is illegal in French and English by a French L1 speaker is demonstrated. This speaker has ranked *[N + PERIPH] high, making the violation of this constraint by candidate (*a*) fatal. As shown above in tableau 25, CONTIGUITY is ranked higher than ANCHOR-R and DEP-IO to allow schwa to be inserted after the cluster, as in candidate (*b*).

Tableau 28: Parse of /kanm/ by CDB (French L1)[14]

/kanm/	*[N + PERIPH]	CONTIGUITY	ANCHOR-R	DEP-IO
a) [kanm]	*!			
☞ b) [kan.mə]			*	*
c) [ka.nəm]		*!		*

Tableau 29 shows the production of the same cluster by an English L1 speaker. The difference between this speaker's constraint ranking and the previous speaker's ranking is that CONTIGUITY is ranked lower than ANCHOR-R. *[N + PERIPH] remains undominated, making the violation of this

[14] The ranking for DEP-IO is unclear, except for the fact that it is ranked below *[N + PERIPH]. It is possible that DEP-IO is ranked above ANCHOR-R, but either way it does not affect the outcome of candidate (b) as the winner. This comment also applies to tableau 29 below.

constraint by candidate (*a*) fatal. Candidate (*b*) is the winner, as candidate (*c*) fatally violates the higher ranked ANCHOR constraint.

Tableau 29: Parse of /kanm/ by MMP (English L1)

/kanm/	*[N + PERIPH]	ANCHOR-R	CONTIGUITY	DEP-IO
a) [kanm]	*!			
☞b) [ka.nəm]			*	*
c) [kan.mə]		*!		*

While epenthesis was used by both groups, this was not the main repair strategy. Deletion was the most common repair for nasal plateaus, with the deleted consonant being the one on the rightmost edge always.

Tableau 30 below illustrates the production of a nasal cluster by an English L1 speaker. Candidate (*a*) fatally violates *[N + PERIPH], which is ranked higher than MAX-IO and ANCHOR-R. This makes candidate (*b*) the optimal candidate. Tableau 31 illustrates the production of the same cluster by a French L1 speaker. The output is the same in both tableaux, therefore the constraint rankings are the same.

Tableau 30: Parse of /kanm/ by CTH (English L1)

/kanm/	*[N + PERIPH]	MAX-IO	ANCHOR-R
a) [kanm]	*!		
☞b) [kan]		*	*

Tableau 31: Parse of /kanm/ by LRB (French L1)

/kanm/	*[N + PERIPH]	MAX-IO	ANCHOR-R
a) [kanm]	*!		
☞b) [kan]		*	*

The high ranking of *[N + PERIPH] is similar to both English and French constraint rankings. As this is similar to both constraint rankings, it cannot be determined which language this ranking is

transferred from. The rankings of MAX-IO and DEP-IO differ between the speakers who produced the items in tableaux 28 and 29 and those who produced 30 and 31. In tableaux 28 and 29, DEP-IO must be ranked below MAX-IO to make the optimal candidate undergo insertion. In tableaux 30 and 31, MAX-IO must be ranked below DEP-IO, so that the winning candidate is the one that undergoes deletion.

7.4. Optimality Theory Summary

Many of the constraint rankings in both groups' interlanguage grammars showed similarities with the English constraint rankings presented in Section 4.4, indicating that both groups are using their English knowledge to facilitate learning. For example, the high ranking of SON in the interlanguage grammars matches the high ranking of this constraint in English. This constraint is ranked lower in the French ranking, as many of the rising clusters containing sonorants that violate SON are legal in French. The high ranking of other constraints, such as *[N + PERIPH], *[N + R], and *Plosive + [PERIPH] in the participants' interlanguage grammars are typical of both English and French rankings. These rankings are not typical of the target language's constraint rankings, so it is shown that the participants have not attained the target language's grammar restrictions.

The rankings for MAX-IO and DEP-IO are ranked differently in different learners' interlanguage grammars. This result is not unexpected, as there is no evidence for the learner to glean the target language's rankings of these faithfulness constraints based on this task alone. These varying rankings are found in participants in both groups, so this is not group-specific. As noted in the varying repairs for /-nm/ clusters, participants repair clusters by insertion as well as deletion. Cases in which the candidate undergoing insertion is optimal require MAX-IO to be ranked higher,

while productions in which the candidate undergoing deletion is optimal would require DEP-IO to be ranked higher.

One ranking in which the L1 groups did differ is the ranking of ANCHOR-R and CONTIGUITY. The English L1 group tended to rank ANCHOR-R over CONTIGUITY, so that the vowel insertion occurred between the consonants in the cluster. While some speakers in the French L1 group also showed this constraint ranking, others in this group instead tended to rank CONTIGUITY over ANCHOR-R, so that the vowel insertion occurred after the consonants in the cluster. This word-final schwa insertion is a process that is found in French, indicating that this ranking is a transfer of their L1 knowledge.

8. Discussion and Conclusions

The goal of this study was to investigate the source of language transfer at the beginning of the learning process, and to determine the reasoning for the transfer that is found. This section will attempt to answer these questions with respect to the results of the study detailed above.

From the results, it is evident that there are many similarities between both groups. It was predicted that participants would perform well on clusters that were legal in both languages, and poorly on clusters in the legal in French/illegal in English category. Both groups show this in their performance, as they performed well on clusters that are legal in English, but performed poorly on clusters that are illegal in English. This can be taken as an indication that both groups are transferring their English knowledge into their interlanguage grammar.

In terms of repairs of clusters that were produced incorrectly, both groups used similar rates of repairs. Epenthesis was one of the main repair strategies used by both groups. The high usage of epenthesis indicates transfer from English. However, the groups differ in rates of repairs, specifically in the rates of epenthesis and paragoge, such that while both groups used epenthesis more than paragoge, the French L1 group used paragoge more than the English L1 group. This difference between groups indicates some influence from the L1, at least in some speakers.

Similarities between groups are also noted in the OT analysis. One similarity is the high ranking of the constraint SON, which is also noted in the proposed L1 English rankings but differs from the L1 French rankings. This can be taken as evidence of transfer from English in their productions in the target language. Yet, the groups differ in their rankings for ANCHOR-R and CONTIGUITY, to account for the different types of epenthesis repairs. Many participants in the English L1 group tended to rank ANCHOR-R over CONTIGUITY, to allow epenthesis to occur

between the consonants in the cluster. Some of the French L1 participants have ranked ANCHOR-R over CONTIGUITY, similar to the English L1 group, but some speakers in the French L1 group have ranked CONTIGUITY over ANCHOR-R, so that schwa is inserted after the cluster. The ranking of ANCHOR-R over CONTIGUITY is an indication that both groups are transferring their English into their interlanguage rankings. The ranking of CONTIGUITY over ANCHOR-R, which resembles French rankings, is found in some French L1 speakers and is an indication that the French L1 group is also transferring their French knowledge in addition to English knowledge.

An interesting note is the fact that the participant did not produce any coda clusters containing voiced word-final obstruents. Russian does not allow voiced obstruents word-finally, and the task items used reflect this. What makes this noteworthy is that, when presented with clusters that are illegal in both English and French, such as in */bems/ (see tableau 19), instead of voicing the final consonant to create /bemz/, which would be a legal form in English and French, they opt to repair in other ways to retain the consonant's voicelessness. It is possible that the participants are using indirect negative evidence to facilitate their learning. It is not clearly indicated to them that voiced obstruents are not allowed in word-final position, yet the lack of voiced word-final obstruents was observed by the participants, in turn aiding in their acquisition of the grammar. More research is needed to determine whether the participants are using this type of evidence, as previous research suggests it tends to be used over a more extended time of exposure (Schwartz & Goad 2017).

8.1. Sources of Transfer

In general, the English L1 group transfers their English knowledge, and the French L1 group transfers a combination of their English and French knowledge. Both groups show transfer from English in the constraints used to govern cluster legality, while the constraints that govern repairs

for illegal clusters are transferred from the L1 by the English L1 group, and a combination of the L1 and L2 by the French L1 group.

The French L1 group is quite interesting in these findings. It is seen that they are transferring their English constraint rankings to produce the novel stimuli. When repairing illegal clusters, they are using processes that are typical of English, but also show some repair strategies that are typical of French. This is an indication that the French L1 group is transferring language knowledge from multiple sources, more specifically their L1 and L2, simultaneously.

Yet, for the English L1 group, there seems to be little to no evidence of transfer from their French L2. There is evidence for the transfer of their English L1, considering their accuracy on clusters that are legal in English, and inaccuracy on clusters that are illegal in their L1. As well, their high ranking of SON in their constraint rankings is similar to their L1.

While it is easy to determine that the participants' English knowledge is a noticeable source of transfer for the development of their interlanguage grammar, it is not as easy to pinpoint why this is occurring. As mentioned before, English is the more restrictive grammar out of the two languages in terms of coda clusters, meaning that English is a subset to French. A potential reason that English is being transferred is because of it being a subset, and the Subset Principle is influencing transfer. Although, another reasoning for this transfer is that English could have been primed throughout the study, as all the study design was presented only in English. As well, some of the French L1 speakers were residing in English-speaking Canada, so it could be that they were speaking English more frequently than French. It may also be that, while English and Russian are not typologically similar, the participants have perceived a typological similarity between English and this novel language, but there is no evidence to determine whether this is the case or not.

8.2. Theoretical Implications

Many of the theories regarding transfer in the L3 are based on syntactic phenomena, yet this study deals with transfer from phonological systems. Even so, interpreting the results in terms of the syntactic acquisition theories outlined above may provide a way for the expansion of such theories to include phenomena found in phonological transfer.

First, these results do not show support for the influence of language status in transfer, such as the L2 status factor. Both groups show significant transfer from English, which is the L1 for one group and the L2 for the other group. In the French L1 group, some transfer for French is noted, indicating a combination of sources for transfer from the L1 and L2. The L2 status factor does not account for L1 transfer nor a combination of sources.

These results do not line up with the predictions for the Cumulative Enhancement Model, which predicts that transfer into the L3 can come from the L1 or the L2 to facilitate learning, or will have no effect. As the resulting transfer from the learner's English is non-facilitative to the learning of the novel Russian clusters, this model does not account for this. The results also do not support the predictions of the Typological Primacy Model, as this model cannot account for the combination of sources for transfer from the L1 and L2 found in the French L1 group. In terms of the Full Transfer /Full Access Hypothesis in L3 acquisition, the L3 initial state will be either the L1 steady state or the L2 steady state. (Leung 2005) This does not, however, encompass transfer from both the L1 and L2 into the initial state, as found in this study.

The Linguistic Proximity Model seems to be the most suitable model for these results, as it can account for the transfer from the L1, as seen in the English L1 group, as well as the combined transfer of the L1 and L2, as seen in the French L1 group, and the facilitative and non-facilitative

influences. However, this model's reasoning for non-facilitative transfer is that the learner either has insufficient input of the L3, or misanalyzes the L3 input, therefore mistakenly transferring properties that do not match the target language. Thus, for the initial state of acquisition, it would prove difficult to distinguish which of these two explanations are the reason for non-facilitative transfer.

8.3. Implications for Future Research

One main reason that the reasoning behind transfer could not be determined is that it was unclear if the participants' transfer of English was due to a misperceived typological similarity between English and the novel language, or if it was due to English being the subset, and the participants were transferring their most restrictive grammar. One way to potentially remedy this would be to have a post-study questionnaire, where one could explicitly ask the participants if the novel language is similar to either previously known language or not. Nelson et al. (2021) offer a way of investigating individual's perception of relatedness of various languages, called the Visualized Language Distance Measure (ViLDiM). This task is done by having the participant draw circles with the language's name it represents inside and arrange each circle next to another based on how similar they perceive them to be in terms of the feature at hand.

Another reason that could explain why English was chosen for transfer is that all of the instructions and forms were written in English, thus potentially priming this language. Future studies could possibly present all study information in both the L1 and L2, so that one language is not primed over the other. It may also be interesting to look into randomizing the languages that the information is given in, so that both L1 groups have an equal number of participants who receive the information in English and participants who receive the information in French, to see if any differences arise in these subgroups.

Another improvement, that this study did not have time or means to incorporate, is to have monolinguals of each language under investigation complete the task. This would give more insights into what is typical of English repairs and French repairs in this specific task, instead of relying solely on general phonological grammar of these languages.

This study was able to provide insights on where transfer in adult successive bilingual learners is sourced. While the goal in determining the source of transfer was achieved, the reasoning that such transfer occurred is left unknown in this study. Nonetheless, some potential reasons for the transfer were explored. One important note is that more studies are needed on phonological transfer into interlanguage grammars that include wider varieties and combinations of languages, and that investigate more phonological phenomena that occur in language.

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Appendix A

Informed Consent Form

Title:	Observing the Transfer of Constraints at the Initial State of Phonological Acquisition
Researcher(s):	Sarah Fradsham, Department of Linguistics at Memorial University, smf251@mun.ca
Supervisor(s):	Sara Mackenzie, Associate Professor, Department of Linguistics at Memorial University, sjmackenzie@mun.ca
	Maureen Scheidnes, Assistant Professor, Department of Linguistics at Memorial University, mscheidnes@mun.ca

You are invited to take part in a research project entitled "Observing the Transfer of Constraints at the Initial State of Phonological Acquisition."

This form is part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. It also describes your right to withdraw from the study. In order to decide whether you wish to participate in this research study, you should understand enough about its risks and benefits to be able to make an informed decision. This is the informed consent process. Take time to read this carefully and to understand the information given to you. Please contact the researcher, Sarah Fradsham, if you have any questions about the study or would like more information before you consent.

It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Introduction:

My name is Sarah Fradsham, and I am a master's student at Memorial University. As part of my master's thesis, I am conducting research under the supervision of Sara Mackenzie and Maureen Scheidnes.

Purpose of Study:

The main purpose of this study is to investigate the role of transfer of previously learned languages when learning a novel language.

What You Will Do in this Study:

You will be presented with a recording of made-up words, and asked to repeat the word you heard. Your responses will be recorded using a microphone.

Length of Time:

Participation in this study will take approximately 20 minutes to complete.

Compensation:

A reward of $10 will be given upon completion of this study. This will be paid through the FindingFive platform to your PayPal account.

Withdrawal from the Study:

You may withdraw your participation at any time during the study. To withdraw at any point while in the study, please exit the browser. Should you choose to withdraw, any data or information gathered in the course of your participation will be destroyed.

Removal of your data will be possible up to three months after data collection. After this time, results from data collection are expected to be submitted for publication and will not be able to be removed. To withdraw from this study, please contact Sarah Fradsham at smf251@mun.ca and provide your name and email.

Possible Benefits:

This study is not expected to be of any direct benefit to you. This study is expected to contribute to scholarly knowledge of language transfer in bilingual language learners.

Possible Risks:

There are no known risks in the participation of this study.

Confidentiality:

The ethical duty of confidentiality includes safeguarding participants' identities, personal information, and data from unauthorized access, use, or disclosure.

If you participate in the study, your identity will be known to the researcher and supervisors involved in collecting the data. After the initial data collection, however, data will be stored according to an assigned reference code and will not be associated with your name. A separate key with participants' identities and their reference code will be stored separately from the data.

Anonymity:

Anonymity refers to protecting participants' identifying characteristics, such as name or description of physical appearance.

Every reasonable effort will be made to ensure your anonymity. You will not be identified in publications without your explicit permission.

Recording of Data:

This study involves audio recording of nonce words. The audio will be recorded through FindingFive. The privacy policy for FindingFive can be found here: https://help.findingfive.com/privacy.html.

Use, Access, Ownership, and Storage of Data:

Data will be kept for a minimum of five years, as required by Memorial University's policy on Integrity in Scholarly Research. Data collected will be stored on a password protected computer. Only the researcher and supervisors will have access to the data.

Reporting of Results:

No identifiable information will be presented with any data presented in the thesis. Upon completion, my thesis will be available at Memorial University's Queen Elizabeth II library, and can be accessed online at: http://collections.mun.ca/cdm/search/collection/theses.

Sharing of Results with Participants:

My thesis will be available at Memorial University's Queen Elizabeth II library. If interested participants would like to inquire more about the results of the study, they may send inquires to Sarah Fradsham, smf251@mun.ca.

Questions:

You are welcome to ask questions before, during, or after your participation in this research. If you would like more information about this study, please contact: Sarah Fradsham, smf251@mun.ca, Sara Mackenzie, sjmackenzie@mun.ca, or Maureen Scheidnes, mscheidnes@mun.ca.

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 709-864-2861.

Consent:

By completing this questionnaire you agree that:

- You have read the information about the research.
- You have been advised that you may ask questions about this study and receive answers prior to continuing.
- You are satisfied that any questions you had have been addressed.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw participation from the study by closing your browser window or navigating away from this page, without having to give a reason and that doing so will not affect you now or in the future.
- You agree to be audio-recorded.

Regarding withdrawal <u>during</u> data collection:

- You understand that if you choose to end participation **during** data collection, any data collected from you up to that **point will be destroyed**.

Regarding withdrawal <u>after</u> data collection:

- You understand that if you choose to withdraw, you may request that your data be removed from the study by contacting the researcher within 3 months of data collection.

By consenting to this online survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities.

Please retain a copy of this consent information for your records.

Clicking 'Participate' **below and submitting this survey constitutes consent and implies your agreement to the above statements.**

Appendix B

Recruitment Form

My name is Sarah Fradsham, and I am a master's student in the Department of Linguistics at Memorial University of Newfoundland. I am conducting a research project called "Observing the Transfer of Constraints at the Initial State of Phonological Acquisition." This study is for my thesis, under the supervision of Sara Mackenzie and Maureen Scheidnes. The purpose of the study is to investigate the influence of previously learned languages when learning a novel language.

I am contacting you to invite you to participate in a study in which you will be asked to listen to a series of words from a novel language you have not encountered, and repeat the word that you heard. Participation will require no more than 20 minutes of your time. You will receive $10 in compensation for your participation. As you will have to listen to audio, headphones are recommended. As well, you will have to record your spoken responses, so a microphone is required.

The study will be conducted online using FindingFive, at the location and time of your choosing. FindingFive is a web platform designed to aid researchers in conducting open and transparent, research online. This website requires you to sign up for an account to participate in the study. The privacy policy can be found here: https://help.findingfive.com/privacy.html. If you are interested in participating, you can use the link below, which will bring you to the study. This link will include a consent form, which will be completed before continuing to the experiment.

To participate, you must be able to speak English and French. To minimize exterior factors that may influence the data, anyone with language experience beyond English and French, or has learned their second language before the age of 12, may not be considered for participation. Before participating in the study, you will be asked to complete a questionnaire to determine your eligibility. This questionnaire is included in the link provided.

If you are interested in participating in this study, you may click on the link provided at any time to begin.

The link to the study is here:

https://www.findingfive.com/study/details/5f9c2381e0b7cb26748cf458

If you have any questions about me or my project, please contact me by one of the methods below.

My contact information is as follows:

By email: smf251@mun.ca

By phone: 709-725-4750

If you know anyone who may be interested in participating in this study, please give them my contact information, so that they may contact me with their inquiries.

Thank-you in advance for considering my request,

Sarah Fradsham

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research, such as your rights as a participant, you may contact the Chairperson of the ICEHR at icehr.chair@mun.ca or by telephone at 709-864-2861.

Appendix C

Participant Questionnaire

Q1: What is you age?

Q2: Which Language did you learn first?

Q3: Did you learn your second language after the age of 4?

Q4: What level are you in your second language? (ex. beginner, intermediate, advanced)

Q5: Do you have any other significant language knowledge?

Q6: If yes, please describe what language(s) and your level. If no, you may leave the box blank.

Appendix D

List of Practice Items

1. [kanf]	2. [gins]	3. [tink]	4. [tirs]	5. [kalʃ]
6. [doms]	7. [bekt]	8. [surl]	9. [zekr]	

List of Task Items

1. [beft]	2. [doft]	3. [kaft]	4. [kafk]	5. [befk]	6. [dofk]
7. [tisp]	8. [kasp]	9. [dosp]	10. [pust]	11. [dost]	12. [gist]
13. [visk]	14. [dosk]	15. [besk]	16. [bems]	17. [kams]	18. [pums]
19. [samf]	20. [domf]	21. [sumf]	22. [temʃ]	23. [kamʃ]	24. [domʃ]
25. [tinf]	26. [benf]	27. [vins]	28. [suns]	29. [sunʃ]	30. [kanʃ]
31. [zenʃ]	32. [tarm]	33. [berm]	34. [virm]	35. [zern]	36. [surn]
37. [girn]	38. [dolm]	39. [zelm]	40. [tilm]	41. [sump]	42. [bemp]
43. [zemp]	44. [bemt]	45. [kamt]	46. [sumt]	47. [zent]	48. [punt]
49. [gint]	50. [punk]	51. [vink]	52. [zerf]	53. [karf]	54. [tirf]
55. [zers]	56. [virs]	57. [karʃ]	58. [girʃ]	59. [surʃ]	60. [pulf]
61. [belf]	62. [vilf]	63. [dols]	64. [suls]	65. [tils]	66. [tirk]
67. [surk]	68. [virk]	69. [girt]	70. [virt]	71. [dort]	72. [zerp]
73. [tirp]	74. [surp]	75. [zelp]	76. [kalp]	77. [belp]	78. [pult]
79. [dolt]	80. [vilt]	81. [pulk]	82. [tilk]	83. [vilk]	84. [beps]
85. [dops]	86. [gips]	87. [puts]	88. [vits]	89. [gits]	90. [doks]
91. [puks]	92. [beks]	93. [vism]	94. [besm]	95. [kasn]	96. [pusn]

97. [tisn]	98. [givm]	99. [kavm]	100. [bevm]	101. [kavn]	102. [puvn]
103.[suvn]	104. [sunr]	105. [kanr]	106. [zenr]	107. [doml]	108. [beml]
109.[suml]	110. [bepn]	111. [dopn]	112. [zepn]	113. [katm]	114. [dotm]
115.[vitm]	116. [kadn]	117. [sudn]	118. [vidn]	119. [zegm]	120. [kagm]
121.[pugm]	122. [sugn]	123. [zegn]	124. [kagn]	125. [tisl]	126. [besl]
127.[dosl]	128. [suvl]	129. [kavl]	130. [puvl]	131. [zevr]	132. [tivr]
133.[zivr]	134. [zetl]	135. [sutl]	136. [vitl]	137. [vitr]	138. [gitr]
139.[vipr]	140. [kapr]	141. [dopr]	142. [vipl]	143. [kapl]	144. [tipl]
145.[bekr]	146. [vikr]	147. [sukl]	148. [zekl]	149. [tikl]	150. [dorl]
151.[tirl]	152. [pumn]	153. [kamn]	154. [zemn]	155. [zekt]	156. [sukt]
157.[kanm]	158. [vinm]	159. [tinm]			