A Phonological Analysis of Sergian: Learnability of the Ludling

by

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A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial fulfillment of the requirements for the degree of

Master of Arts

in

Linguistics

Carleton University

Ottawa, Ontario

Abstract

This study observes the Sergian ludling, focussing on its learnability. This study completes a phonological analysis of the language, observing and applying the rule created to explain the rule's role in the ludling's formation. Participants were split into two groups where one had data useful to specific patterns of sesquisyllables withheld, to observe whether the rule they create with the minimal data exposure can extend to data beyond basic epenthesis. The key questions this paper aims to answer are how much data is needed for an individual to be considered exposed to a crucial rule of the language and to what extent do they acquire it. This paper seeks to answer these questions by analyzing participants' audio-recorded responses. Results showed the more exposure one receives, the more likely they are to acquire and correctly apply the rules; having data useful to specific patterns increased chances of participants obtaining higher scores.

Acknowledgements

The completion of my master's thesis would not have been possible without my committee and the participants that volunteered to take part in my study. Therefore, I wish to extend a thank you to all.

I would like to personally acknowledge and give my sincerest gratitude to my thesis supervisor, Professor Lev Blumenfeld, who played a significant role in the outcome of this thesis. He guided me through the writing and research processes, and provided continuous support, expertise, and advice, all of which helped to shape the overall outcome of this paper. All his efforts are very much appreciated, and I am beyond grateful to have had the opportunity to have him as my supervisor.

I would also like to personally thank Professor Karen Jesney who served on the advisory committee. Her feedback during the writing stage was one which helped enhance my work. Her continuous advice, knowledge, and direction throughout this process will not be forgotten.

A final thank you goes out to my family for the constant support and inspiration throughout this process.

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1.0 Introduction

Delving into the roots of human communication, you find yourself at the acquisition of language. According to Pinker (2009), infants are equipped with a learning algorithm that guides the development of language, beginning with childbirth. One of the first tasks of an infant is to acquire aspects of their target language's phonology, including active or productive rules (Friederici, 2005; Pinker, 2009). These rules include patterns of sound sequences and stress. Since it is from the earliest stages of life that one acquires language, it is not unusual that there is the ability to learn and create language, even when an individual has already acquired one or more. To communicate through language, linguists such as Bloomer et al. (2005) explain that the final results of using and understanding language, starts by accepting linguistic and non-linguistic properties of the language. In some instances, languages can come with a secretive component to conceal or disguise the meaning of the language in use (Botne & Davis, 2000) with a specific group of individuals, and these pseudo languages are called ludlings, or language games (Phelan & Simpson, 2020). In these secret languages, there is usually phonological manipulation of a pre-existing language. Understanding the manipulation of phonological properties is significantly important as it is the key to comprehending the formation of the language being used and the meaning it conceals.

Ludlings make use of the same phonological structure as regular phonology. In both the base language and ludling, the sound structure will distinguish the linguistic item, meaning it will inform which sound structure belongs to which language. This is not unusual as language games will use a pre-existing language as a base (Yip, 1982; Bagemihl, 1989; Botne & Davis, 2000; Vaux, 2011), making it easily known as to which sound structure belongs to which language. This means that the forms that are used for communication with language games have an underlying form that can be considered a first language. Even with the modifications done to the base language, Yip (1982) and Bagemihl (1989) both state that there is no radical difference between the operations of the ludling and its base language, despite surface appearances. Therefore, the ludling must respect the rules of the pre-existing language, while functioning as its own. For example, if a sequence of phonemes were to be inserted, these phonemes must be found in the base-language's inventory, or the sequence must not be one that is not common in the language. According to Ntihirageza (2007), language games provide evidence for phonological structure. While language games closely follow the formal constraints of their base language, they may apply more processes and do so in more ways, resulting in significant modification of base forms. Ntihirageza (2007) explains that by observing similarities between the language game and its source language, phonological rules are revealed about the source language. Since the modifications done to the original language to obtain the secret language must interact with the source language, Ntihirageza (2007) discusses that there is acceptability of what may and may not be included and this is evidence for phonological structures and rules in languages.

This paper aims to present general properties of ludlings, and the phonological modifications, rules, and patterns that result in Sergian, a previously unanalyzed ludling invented by several children in the early 2000's, which I made contributions to. There will first be a presentation of general information on ludlings. Second, since ludlings involve processes that look like natural phonology, an interesting question arises as to how they are acquired. In particular, how much evidence do learners need to establish a rule of a ludling. Vaux (2011) explains that there has been substantial evidence for the existence of phonemes, syllable structures, underlying forms, and psychological reality of rules in language games, since the beginning of work on ludlings in the

1900's. Through this work, there have been findings that have been a crucial aid for linguists to transfer their knowledge to understand acquisition and cognitive processes of language more generally, because secret languages are controllable in experimental work. Therefore, the various questions that this paper aims to answer are: what amount of data is needed to be considered exposed to a specific phonological rule in a language when given full exposure versus partial exposure to the effect of the specific rule? To what degree are the rules of this ludling acquired? These will be answered through an analysis of the patterns that derive Sergian forms from their base forms in English. In the study, subjects unfamiliar with Sergian were exposed to data in two conditions, one where there was full evidence of the patterns and one where evidence was insufficient. As this language is sensitive to the distinction between full syllables and sesquisyllables, the group with minimal exposure had data relevant to the sesquisyllable pattern withheld from them. They were then tested on a novel set of tokens, revealing the degree to which they acquired the rules. Participants who received substantial exposure scored higher than the group that received limited exposure. Although there were certain rules that both groups were able to acquire, the group with substantial exposure better acquired them.

2.0 Background on Ludlings

Languages can be "secret" (shared by a small number of individuals), and "games" (used for play). Those are separate properties, which sometimes coincide and sometimes not. Laycock (1972) coined the term *ludling* with all other possible terms being synonyms of each other. However, later in the paper it will be explained how the terms cannot always be used as synonyms since the language falling under the category of language games does not automatically entail that it is a secret language. Secret languages illustrate a form of creativity in human language use. This is evident as they are what Aikhenvald and Dixon (2017) describe as "ritual communication" (p.

22), where the language is limited to a specific group or excludes of unwanted individuals and groups to maintain secrecy. When secret languages or language games are created, they use a pre-existing language as a base; therefore, embodying a kind of native linguistics (Yip, 1982). This means that the language game will follow the rules of the base-language, with the addition of the reformed portion that conceals the meaning. According to Phelan and Simpson (2020), the concealing of meaning characterizes secret languages. This can be done by manipulating the phonology of the base language. The work of researchers, including Laycock (1972), Bagemihl (1989), Lefkowitz (1991), and Botne and Davis (2000), shows that there are two most common types of ludlings: syllable transposition games involving movement of a sound or sequence, and games which rely on the insertion of sound and sequences in a word. In both these ludling types, one can find that the syllables of the base languages are in some way disrupted. This will be further discussed in section 2.1 below. Each of these possibilities regarding the formation of a new, invented language, can be identified as phonological changes to a pre-existing language.

2.1 Common Types of Language Games

In the following sections, the various types of language games will be discussed. In order to better understand each of these language game types, each will have its own heading with examples to assist in unravelling the phonological modifications that occur.

2.1.1 Syllable Transposition Games

In syllable transposition games, the order of syllables is inverted. With syllable inversion, one can decide to invert the syllables of a single word in a sentence or invert the syllables of the entire sentence (Lefkowitz, 1991). An example of this is a Tagalog language game, from Botne and Davis (2000), where the inversion of syllables is evident in the following three syllable word:

(1) kapatid 'sibling'

1 2 3

ka pa tid

Syllables 1 and 3 exchange positions in the Tagalog language to form the following Tagalog language game word:

tidpaka 'sibling'

(Botne & Davis, 2000).

As is evident in example (1) above, the first and third syllables have exchanged positions, which is not unexpected. According to Vaux (2011), the most common language games that fall under the syllable transposition type require every second syllable to invert. Since the first syllable in the Tagalog language game has been inverted, the second syllable would remain as is, and the third syllable would be inverted (/123/→[321]). In a four-syllable word, the first and third syllables (/1234/→[3214]) can invert or the second and fourth (/1234/→[1432]). With the inversion of syllables in (1), it is evident that this Tagalog language game functions on the alternation of the phonological sequence of the base language. With this example requiring inversion for there to be a language game, it can be said that this language game is rule-governed on this phonological process of syllable order switching, resulting in the new output. There are various ways to reverse language to achieve secrecy; however, simpler transposition can achieve the goal of secret languages quicker when in the process of creating and learning the new language (Bagemihl, 1989), as it requires for less modification to the base-language and quicker to produce when speaking; it is more efficient. What differentiates the simpler transposition games from the segments reversals is the complexity. For this reason, total segment reversals are rarer. Although total segment reversal is rarer, Bagemihl (1989) presents an example, which is illustrated below is an example in New Guinea Pidgin.

(2) mumut ‘opposum’

1 2

mu mut

All syllables are pronounced in a reverse order.

tumum ‘opposum’

(Bagemihl, 1989).

Although there is more than syllable transposition occurring in (2), examples (1) and (2) are both categorized as transposition games and result in the concealing of a meaning. According to Bagemihl (1989), the more complex transposition games, such as example (2), are rarer since they can output consonant clusters, which may not be otherwise allowed in the language. These non-permitted outputs would therefore result in unattested forms of reversal, making examples like (2) less preferred than the simpler transposition type as in example (1). An example of this is illustrated Bagemihl’s (1989) work and can be found in (3) from a Luganda language game.

(3) kutegeeza → zageteeku ‘to inform’

Bagemihl (1989).

Example (3) is an example of false syllable reversal. While syllables appear to be moving, the pattern for vowel lengthening is not included in this move (Clements, 1986; Bagemihl, 1989). According to Bagemihl (1989), when there is vowel lengthening in a word, there is a timing pattern. If this ludling is to be considered maintained, then it must be stated that there is syllable reversal, with the timing properties being exempt. Ultimately, the concept of total reordering of segments is unlike what can commonly be found in ordinary language (Bagemihl, 1989) and as mentioned previously, language games must abide by the rules and patterns of the base language.

2.1.2 Insertion-Type Games

The second type of games involve insertion of syllables. According to Botne and Davis (2000), insertion-type games can fall under one of two categories: imposition-type games or insertion games. Syllable – imposition games are considered under the category of insertion games; however, Botne & Davis (2000) inform that they fall under a different sub-category due to location where the insertion occurs. With imposition games, the insertion does not occur after an onset. For the purpose of a clear understanding of these sub-categories of insertion-type games, syllable imposition will be referred to as insertion between syllables, while the sub-category of insertion will be referred to as insertion within syllables. What distinguishes the insertion game type from transposition-type games is that there is no movement of syllables but rather affixation, which can ultimately lead to the disruption of a syllable. With syllable insertion games, the affixation involved can be syllable prefixing, suffixing, or infixing. However, that is dependent on the sub-category of insertion-type games. Insertion between syllable requires prefixing, which involves affixation of a CV- sequence to the initial syllable or to all syllables of a word (Botne & Davis, 2000), or suffixing, which usually involves a -CV syllable to the end of the first syllable or to all syllables of a word. Infixing will occur for the game-type insertion within syllables. Although various language games inform of a consonant insertion, there will usually be reduplication of the vowel that the insertion precedes to avoid consonant clusters.

2.1.2.1 Insertion Between Syllables

The first sub-category of insertion type-games is insertion between syllables. Syllable prefixing involves affixation of a CV sequence to the initial syllable or to all syllables of a word (Botne & Davis, 2000). An example found in the work of Aikhenvald and Dixon (2017) is demonstrated in the following Kano Hausa language game:

(4) dà - + tone polarity

/dáudàa/ 'David'

[dà -dáu-dà -dáa]

(Aikhenvald & Dixon, 2017).

Tone polarity refers to the property that a syllable will have the opposite tone from some adjacent syllable. Based on this definition, it should not have its own underlying tone. However, tone polarity in (4) behaves differently. The da - is the prefix and comes with tone polarity. The second line is "David" in Hausa, and the third line in the prefix inserted before each syllable in the word and since the tone on the prefix is identical to the tone on the vowel in the second syllable, the final form, the Kano Hausa form, has the vowel in the second syllable change tone, so that the tones are opposite, since the prefix and vowel are adjacent. In example (4), the CV sequence dà- gets inserted before every syllable of the Kano Hausa word /dáudàa/ 'David'. This insertion makes the CV sequence the prefix of all syllables of the word. This means that this prefixing is also a syllable insertion.

Another type of affixation is suffixing, usually of a -CV(CV) sequence, where C can refer to more than one consonant (Botne & Davis, 2000). This affixation, just as with the prefixing, can occur to either the final syllable or all syllables of a word. An example of how this may appear is the following in Cypriot Greek:

(5) -kVkVrdVrV(C)kVkV(C)

/alékos/ 'Alec'

[a-kakárdarakaká -le-kekérderekeké-kos-kokórdoroskokós]

(Aikhenvald & Dixon, 2017).

The inserted suffix in (5) is not basic, but rather intense. With intense sequences, such as with the example above, there comes a difficulty for individuals alien to the group using this ludling, to understand the meaning in speech because of the insertion's level of difficulty. This, therefore, achieves what Aikhenvald and Dixon (2017) discuss as the strategy for the effective concealing effect. In this example, the inserted sequence is unusually long, but in many other ludlings it can be shorter. Another example of insertion between syllables is illustrated in a suffixing Hungarian language game in example (6).

(6) /soha/ 'never, ever'

-v- imposition

[so -v- oha -v- a]

(Botne & Davis, 2000).

Example (6) presents a Hungarian word, where insertion between syllables occurs with the consonant /v/. The consonant is epenthesized following each vowel, which happens to be the most sonorous sound in the syllable and the end of the syllable. When this type of game occurs, the vowel in which the inserted sound follows gets reduplicated. This is seen in example (6) where the inserted [v] occurs after [o] in soho, and then another [o] appears. This also occurs with the second vowel in the word – [a]. The work of Botne & Davis (2000) supports this claim in language games with insertion between syllables, stating that the vowel that preceded the insertion duplicates and then this identical vowel will follow the consonant imposed. This is shown in example (7).

(7) $CV_i\,MV_i\,CV_j\,MV_{j.}$

Example (7) illustrates a sequence similar to the one in (6). Here, C refers to the consonant in the base language that remains in the language game, V refers to the vowel, M refers to the consonant inserted after the vowel, and the subscripts refer to the duplicated vowel that appears after M. In examples (6) and (7), reduplication is occurring with a vowel and not a consonant. It may be the case that it is more common for reduplication to occur with vowels; however, according to Botne & Davis (2000), no insertion game, with insertion between syllables, has been identified where there is reduplication of consonants. If there is to be reduplication of consonants, it would be under the condition that a vowel gets inserted as well. An example of this is illustrated in (8), under the sub-category of insertion within syllables. In the sub-category of insertions games between syllables, examples such as (6) are more common than those like (5) as explained by Botne and Davis (2000) because of their simpler change. Syllable insertion games that fall under the sub-category of games of insertion within syllables are more common, however.

2.1.2.2 Insertion Within Syllables

The second sub-category for insertion-type games, insertion within syllables games, is another phonological phenomenon that is common for language games. According to Aikhenvald and Dixon (2017), insertion of an element into the base-language to create a language game is a type that is common world-wide.

With insertion within syllables type games, there is syllable infixing. This game type will be discussed throughout this paper as it is an explanation to the language in analysis, Sergian. As a result of syllable infixing, there is a disruption to the integrity of the syllable. This disruption is what Aikhenvald and Dixon (2017) explain will create difficulty for listeners unfamiliar with the language to decipher; Botne and Davis (2000) refer to this as a deeper disguisability of a word. The result is a break of the input syllable to insert a sequence in the nucleus and the insertions are not inserted in at random. From the work of Hayes (1989), it states that determining the place of insertion of an infix is based off the syllable structure, where the likelihood of the infixation occurring after the onset is high. Aikhenvald and Dixon (2017) support this claim based off their work around 30 years later. Although Hayes (1989) has explained where infixation can occur and received support from Aikhenvald and Dixon (2017), Botne and Davis (2000) suggest that the most common place for insertion is after the onset of a syllable and less common between moras. Just as with suffixes and prefixes, insertion of infixes can occur once or multiple times, depending on the rules of the language game. A language game requiring infixation, discussed in 2.1.2.1 as being an uncommon form of consonant reduplication, is illustrated in (8) in a Mandarin Chinese game where the insertion is a consonant reduplicating from the onset of the onset in the base-language, but must insert a schwa before the reduplicated consonant. This is illustrated in example (8).

(8) lùo tà rèn/ 'personal name'

[l-əl-ùo t-ət-à r-ər-èn]

(Botne & Davis, 2000).

The language game in (8) is not common (Botne & Davis, 2000) since it requires the reduplication of a consonant, which is not common across language games. Language games attempt to avoid consonant clusters, which Bagemihl (1989) explains are not always favoured in pre-existing languages.

A language game with a more common presentation of infixation in language games is illustrated in the following Hühnersprache word.

(9) /hau/ 'hit!'

[hau-haudefau] ~ [ha-hadefa-ʔu-hudefu]

(Storch, 2017).

Noticeably in (9), the second variant of the insertion is breaking up the syllable. Storch (2017) explains the infixation as CV_1-X-V_1 in a CV sequence. With a diphthong in the V position, the infixation slightly differs, which is evident in (9); the diphthong is associated with two moras (Storch, 2017), where the insertion is realized after the first mora. The vowels in the infix differ from one another but correspond to the vowel in the syllable preceding. For example, the first syllable is *ha*; therefore, the first and last vowels in the infix match the diphthong in the input syllable. Example (9) is different to that of (5). While Cypriot allows for insertion to occur to either the end of the final syllable or the end of all syllables of a word, Hühnersprache deals with infixing, meaning the insertion occurs post-onset and between moras.

With insertion games more specifically, it is rare to find what linguistics previously considered phonologically abnormal. According to Bagemihl (1989), there has been a reluctance, when it comes to the creation of language games, to include clicks and what is considered as mundane articulations such as ejectives into the insertion, as these are "extreme" phonological phenomena. They are characterized as such since they "challenge existing notions of what linguistics is" (Bagemihl, 1989, p. 486). It is more common to have sounds and sequences in language games that are more common across all languages. Therefore, when exposed to the language game in question, the difficulty in acquiring the phonological aspects is not high since the sounds in the sequence getting inserted are common across a vast number of languages.

Another language game where there is insertion within syllables and is similar to Sergian is the Spanish -f- insertion game. An example of this game is below.

(10) a. /grande/ 'big'

(gran) (de)

[gra-f-ande-f-e]

b. /baɪle/ 'dance'

(baɪ) (le)

[bafaɪlefe]

(Botne & Davis, 2000).

In (10), there is -f- insertion occurring in both a. and b. In a., the -f- insertion is either occurring after the vowel in the input syllable and reduplicating its vowel after the insertion, or vice versa, where the insertion occurs after the onset and before the nucleus and reduplicates the vowel before the -f- insertion. In both instances, the insertion is within the syllable, which contradicts what Botne and Davis (2000) have stated. With another example from this game in b., it becomes clearer that the insertion occurs after the onset and before the nucleus. The diphthong [aɪ] appears after the insertion, which remains within the syllables, and the vowel gets reduplicated minus the off-glide. This is quite similar to Sergian, which has insertion within syllables, insertion before the nucleus, and reduplication of the vowel in the input syllable, minus the off-glide when a diphthong is present. Therefore, illustrating a -Vf- infixation.

2.2 Summary of Secret Language Game-Types

Overall, language games fall under two main categories: syllable transposition and syllable insertion. As seen through various examples in 2.1.1, syllable transposition requires the inversion of syllables in a language. The most common is the simpler transposition (Bagemihl, 1989), where every second syllable in the word inverts. However, there are also less common transposition games such as total syllable reversal, where every syllable inverts but so does the ordering of the segments in each syllable. As discussed, it is less common due to the chances that this could cause consonant cluster, which Bagemihl (1989) explains may not be permitted in languages.

Syllable insertion games fall under two sub-categories: insertion between syllables and insertion within syllables. With insertion between syllables (see 2.1.2.1), a consonant will usually be epenthesized after one syllable or all syllables in a word, as seen with the word /soho/ in the Hungarian language game. With this insertion after each syllable, the vowel in which the insertion follows will get reduplicated to avoid consonant clusters, a sequence not favoured by many languages (Bagemihl, 1989). Insertion within syllables (see 2.1.2.2), is more common than insertion between syllables (Botne & Davis, 2000). This language game-type inserts a sound or sequence after an onset or nucleus in a word or after each onset or before each nucleus in the word. During the latter increases the level of difficulty of concealed meanings. This is evident in Aikhenvald and Dixon's (2017) Cypriot Greek example of the word *Alec*, which illustrated a 13-sound sequence insertion. Both language game types, syllable transposition and syllable insertion, are common across language games.

2.3 Short-Way Language

Although there has been interchange between the terms *language games*/*ludlings* and *secret languages*, there are language games that are not meant for concealing meaning. While Bagemihl

(1989), Botne and Davis (2000), and Aikhenvald and Dixon (2017) discuss language games that are used for secrecy of communication, Langlois (2006) discusses language games that do not operate to mask communication. Instead, they are to create efficiency in speech. An example of this is teenaged speakers in Areyonga, an Aboriginal community, which use Pitjantjatjara as a base-language to form their Short-way language. An example of this language is the following:

(11) /kutjara/ 'two'

[tjara] 'two'

(Langois, 2006).

Teenage speakers of Pitjantjatjara have manipulated the speech of the base form as illustrated in (11), to receive an output that is forming Short-way language. Essentially, what is occurring is the drop of the first syllable of the Pitjantjatjara word to form the Short-way language word. It is also possible for more than just the first syllable to be dropped. Although it is not meant for secrecy, Langois' (2006) study revealed that those who mainly spoke the language (older teenagers aged 14-19), would use the language in front of the younger misbehaving students. This would serve as a form of punishment as the younger ones not familiar with the language would not understand the older teenagers and understood it as being teased. However, the overall purpose is shorter speech and not secrecy.

Secret languages and language games are commonly associated with syllables, whether it is transposition, insertion, or deletion of syllables. The secret language for discussion in this paper, Sergian, seems to portray an insertion type game, specifically infixing of syllables. This will be discussed in 3.2. However, it is first important to understand the background of the language. This will be discussed in section 3.0 below.

3.0 Sergian

This section will give a brief description on the background of the Sergian language game. It will further discuss which language game type it is categorized as, with various examples and datasets to support this claim. These datasets are crucial as they help to create a rule that satisfies the phonological manipulation to form this language.

3.1 Background

In 2006, a group of elementary school students in Ottawa had mastered Pig Latin, a famous language game known to many in North America. The difficulty with using Pig Latin was that others who did not associate with this clique, knew it as well. For this reason, this group of students decided to create a language game of their own. The purpose of the secret language game was to conceal meaning from those outside the group, specifically teachers and parents. There were strict rules regarding speaking about topics that the adults deemed unimportant or inappropriate. To avoid having notes that are passed around being taken or overhearing of conversations, this language came to be. The inspiration came from Pig Latin and therefore, the base-language chosen at the time was English; this is also considering it is the language that all the members spoke. The language game is still used for secrecy of communication but generalized more to the topic discussed and the audience. Currently, the users of the game have no knowledge as to the steps taken to create the secret language nor the rules that an individual wanting to use the language must master. This language game has no name so far. As I have been part of the process of its creation, I will refer to it as Sergian. There has also been no analysis done on the language game. For this reason, there will be a phonological analysis of Sergian to better understand the syllable insertion occurring between the input and output.

3.2 Language Game Type

Sergian is a within-syllable insertion game. As previously mentioned, the type of insertion occurring can be prefixing, infixing, or suffixing. Sergian is an example of infixing, and it will be important to understand where the infixing occurs. The infix is a -VdVg- sequence after each onset, immediately before every vowel.

3.2.2 Basic Epenthesis with Vowel Reduplication

The dataset below illustrates monosyllabic English words and their Sergian form.

Dataset 1: Monosyllabic English Words and Sergian

Eng. transcription	**Sergian transcription**	**gloss**
kæt	k-ædɪg-æt	‘cat’
skɪp	sk-ɪdɪg-ɪp	‘skip’
min	m-idig-in	‘mean’
drɛs	dr-ɛdɪg-ɛs	‘dress’
hʌg	h-ʌdɪg-ʌg	‘hug’
frut	fr-udɪg-ut	‘fruit’

The table above illustrates monosyllabic English words and their form in Sergian after the insertion of the infix. The infix is always appearing before the vowel, where the V_1 in the -V_1dV_2g- sequence is identical to the vowel that the sequence precedes, in such a way that there is reduplication of said vowel. While V_1 is unstressed, the original vowel remains stressed. To better display how the change occurs, an example with *cat* appears below.

(12) kæt ‘cat’

Each set of brackets below illustrates a syllable.

(kæt)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(k ↓ æt)

This results in the final form – Sergian:

k**ædɪg**æt

Example (12) represents the insertion of the infix before vowels. This sequence can appear more than once, and the number of times it gets inserted is dependent on the number of syllables in the underlying form. An example of this is illustrated in Dataset 2 below.

Dataset 2: Disyllabic English Words and Sergian

Eng. transcription	Sergian transcription	gloss
wɔtəɹ	w-ɔdɪg-ɔt-ədɪg-əɹ	'water'
d͡ʒækɪt	d͡ʒ-ædɪg-æk-ɪdɪg-ɪt	'jacket'
t͡ʃɪkɪn	t͡ʃ-ɪdɪg-ɪk-ɪdɪg-ɪn	'chicken'
mʌni	m-ʌdɪg-ʌn-idig-i	'money'
bɔksɪz	b-ɔdɪg-ɔks-ɪdɪg-ɪz	'boxes'
ʌðəɹ	ʌdɪg-ʌ-ð-ədɪg-əɹ	'other'

From Dataset 2, it is noticeable that this ludling does not only have insertions occurring once, but rather once before each nucleus that appears, since the insertion still occurs in onsetless syllables. In the disyllabic words found in Dataset 2, epenthesis transpires twice. With epenthesis and the reduplication of the first vowel in the sequence in mind, example (13) below will demonstrate the steps as to how the process of phonological modification takes effect for disyllabic words in English to Sergian.

(13) bɔksɪz 'boxes'

Each set of brackets below illustrates a syllable.

(bɔk) (sɪz)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(b ↓ ɔk) (s ↓ ɪz)

This results in the final Sergian form:

b**ɔdɪg**ɔks**ɪdɪg**ɪz

Evident in example (13) is epenthesis occurring twice with V_1 being a reduplicate of the vowel that followed each onset in the underlying form. A rule that can be written for this phonological change is the following: insert -V_1dV_2g- before every vowel, where V_1 is a copy of the vowel that it gets inserted before. However, this same process does not always apply for all words, which is illustrated in section 3.2.3.

3.2.3 Epenthesis and Semi-Reduplication

Diphthongs behave differently compared to monophthongs. The dataset below provides examples of monosyllabic English words that contain diphthongs and their Sergian form.

Dataset 3: Monosyllabic English Words with Diphthongs and Sergian

Eng. transcription	**Sergian transcription**	**gloss**
ka͜ɪt	k-ʌdɪg-a͜ɪt	'kite'
fe͜ɪs	f-ɛdɪg-e͜ɪs	'face'
la͜ʊd	l-ædɪg-a͜ʊd	'loud'
go͜ʊt	g-odɪg-o͜ʊt	'goat'
ʧo͜ɪs	ʧ-odɪg-o͜ɪs	'choice'

In Dataset 3, the data provides examples of monosyllabic English words that contain one of the five diphthongs in the English language, with each word's Sergian form. Unlike in Table 1 where the – V_1dV_2g- sequence consisted of vowel reduplication, the data above shows that only the nucleus without the off-glide is copied, resulting in the need to modify the rule. The rule is instead, the insertion is a – V_1dV_2g- sequence before every vowel, where the first vowel (V_1) in the sequence is a copy, minus the off-glide. It is also possible to form a rule where the sequence is -dVgV-; however, the first rule was opted for as it better accounts for both words with and without diphthongs, especially with where the location of the diphthong is when the insertion occurs. With this insertion, V_1 is stressed along with the original vowels in the input form, whereas V_2 is not stressed. Table 1 below displays the diphthong and the possible option(s) for the reduplicated vowel minus the off-glide, when there is a diphthong in a word.

Table 1: Reduplication Minus Off-Glide

Diphthong	Copied Nucleus
eɪ	ɛ
aɪ	ʌ, ə, a
aʊ	æ, ɛ
oʊ	o
oɪ	o

An example illustrating that the sequence gets inserted before a vowel (nucleus) and not after an onset, is where there is an onsetless syllable and that is presented later in (15). If the word does not contain a diphthong, then the part of the rule that does not include the off-glide will not alter the target Sergian surface form. This rule is now inclusive of both pure vowels and diphthongs. This rule can be demonstrated by using the example of *face*.

(14) fe͜ɪs

Each set of brackets below illustrates a syllable.

(fe͜ɪs)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(f ↓ e͜ɪs)

This results in the final Sergian form:

f**ɛdɪg**e͜ɪs

In example (14), the infix is still inserted before each vowel, with the addition of the first vowel in the infix sequence being a copy without the off-glide. The vowel following the insertion is the diphthong [e͜ɪ], while the vowel being copied and losing the off-glide is [ɛ]. Noticeable in the data is that *goat* does not always behave as the other diphthongs do. In fact, [oʊ] and [o] are interchangeable because they are the same sound with different transcription conventions and therefore, can behave either as a vowel or diphthong in words. Regardless of the writing convention for each sound, when transcribing the underlying form, the rule will still apply and if the choice is to use the diphthong, then the first vowel of the inserted sequence will copy minus the off-glide. Since monophthongs and diphthongs can co-occur in a word, each syllable in longer words just follows the rule that has already been introduced.

The data in Dataset 4 below provides examples of English words that contain more than one syllable, with monophthongs and diphthongs co-occurring.

Dataset 4: Multisyllabic Words and the Application of the Rule

Eng. transcription	gloss	Sergian transcription	gloss
ʌɹɑʊnd	‘around’	-ʌdɪg-ʌɹ-ɛdɪg-ɑʊnd	‘around’
ətɛnʃɪn	‘attention’	-ədɪg-ʌt-ɛdɪg-ɛnʃ-ɪdɪg-ɪn	‘attention’
kʌpæsɪti	‘capacity’	k-ʌdɪg-ʌp-ædɪg-æs-ɪdɪg-ɪt-idig-i	‘capacity’
æntɪsɪpe͜ɪt	‘anticipate’	-ædɪg-ænt-ɪdɪg-ɪs-ɪdɪg-ɪp-ɛdɪg-e͜ɪt	‘anticipate’
lɛksɪkɔgɹʌfi	‘lexicography’	l-ɛdɪg-ɛks-ɪdɪg-ɪk-ɔdɪg-ɔgɹ-ʌdɪg-ʌf-idig-i	‘lexicography’
ɔnɪstli	‘honestly’	-ɔdɪg-ɔn-ɪdɪg-ɪstl-idig-i	‘honestly’
a͜ɪdɛntɪfa͜ɪd	‘identified’	-ʌdɪg-a͜ɪd-ɛdɪg-ɛnt-ɪdɪg-ɪf-ʌdɪg-a͜ɪd	‘identified’

Dataset 4 demonstrates that the rule is valid for longer words. Regardless of the number of syllables, the infix always comes before a vowel. An example of how this rule gets applied to words with larger number of syllables is illustrated in (15) below, where there are both vowels and diphthongs in the word *anticipate,* and the rule interacts with both to give the Sergian form.

(15) æntɪsɪpe͜ɪt ‘anticipate’

Each set of brackets below illustrates a syllable.

(æn) (tɪ) (sɪ) (pe͜ɪt)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(↓ æn) (t ↓ ɪ) (s ↓ ɪ) (p ↓ e͜ɪt)

This results in the final Sergian form:

ædɪgænt**ɪdɪg**ɪs**ɪdɪg**ɪp**edɪg**e͜ɪt

Additionally, example (15) demonstrates that the insertion will always be before the nucleus in a syllable. According to Hayes (1989), with infixation, the insertion will usually come after the onset. This applies to many words in Sergian; however, when there are words with onsetless syllables, this does not hold true. Therefore, it is best to generalize for this to apply to all the words and simply state that the insertion occurs before the nucleus.

3.2.4 Sesquisyllables

Words that can be realized as either monosyllable or disyllable are called *sesquisyllables*. Sesquisyllables usually occur where there in a diphthong or tense vowel followed by a liquid in coda position. From Lavoie and Cohn (1999), results revealed that dialectal variation played a role in a participant's tendency to monophthongize or diphthongize the diphthongs in the presented sesquisyllables. Lavoie and Cohn (1999) explain that these words fall between a clear monosyllable and a clear disyllable, where a schwa will usually be between the nucleus and liquid coda.

Sesquisyllables occur when there is a diphthong followed by a syllabic [l] or [ɹ] in coda position. According to Lehiste and Peterson (1961), a diphthong's termination of the off-glide influences the duration of the vowel. Concluding that there is a longer duration to the diphthong in a word, where [l] or [ɹ] are present in coda position, then the longer duration plays a role in an individual's tendency to realize the word as disyllabic rather than monosyllabic, when viewing a transition from the target, which is the diphthong, to the associated consonant, the glide (Lehiste & Peterson, 1961). When a word contains a diphthong, the off-glide's longer duration results in the perception of an additional glide following, [w] or [j]. While [w] appears in words where the coda has the liquid [ɹ], [j] appears where the coda is [l]. A reason as to why this occurs specifically where the coda is a liquid is due to the sonority of the consonant. Proctor and Walker (2012) explain that their MRI study displayed that these liquids have phonetic characterizations, while their lexical corpus analysis demonstrated phonotactic properties, that give them higher sonority.

An example of this is their location in the syllable structure; liquids will always appear closer to the nucleus, the most sonorous part of a syllable, when in consonant sequences (Proctor and Walker, 2012). Additionally, Proctor and Walker (2012) state that there is more lingual posture stability across contexts with [Vɹ] than [Vl], which assists in explaining why various [Vɹ] sequences can not be considered sesquisyllables, even though they contain a diphthong, or their counterpart [Vl] does get realized as a sesquisyllable. Therefore, an individual's perception of the word, alters their production. This is evident in Table 2 below.

Table 2: Sergian and [l]/[ɹ] Phonemes in Coda

	ENG.	**Monosyllabic**	**Disyllabic**	**Gloss**
i + l	fi(jə)l	f-idig-il	f-idig-ij-ədɪg-əl	feel
i + ɹ	fiɹ	f-idig-iɹ	X	fear
aɪ + l	aɪ(jə)l	-ʌdɪg-a͜ɪl	-ʌdɪg-a͜ɪj-ədɪg-əl	aisle
aɪ + ɹ	fa͜ɪ(jə)ɹ	f-ʌdɪg-a͜ɪɹ	f-ʌdɪg-a͜ɪj-ədɪg-əɹ	fire
eɪ + l	te͜ɪ(jə)l	t-ɛdɪg-e͜ɪl	t-ɛdɪg-e͜ɪj-ədɪg-əl	tail
eɪ + ɹ	le͜ɪ(jə)ɹ	l-ɛdɪg-e͜ɪɹ	l-ɛdɪg-e͜ɪj-ədɪg-əɹ	lair
eɪ + ɹ	fe͜ɪɹ	f-ɛdɪg-e͜ɪɹ	X	fair
aʊ + l	a͜ʊ(wʊ)l	-ædɪg-a͜ʊl	-ædɪg-a͜ʊw-ʊdɪg-ʊl	owl
aʊ + ɹ	a͜ʊ(wʊ)ɹ	-ædɪg-a͜ʊɹ	-ædɪg-a͜ʊw-ʊdɪg-ʊɹ	hour
oʊ + l	boʊl	b-odɪg-oʊl	X	bowl
oʊ + ɹ	soʊɹ	s-odɪg-oʊɹ	X	soar
ɔɪ/oɪ + l	o͜ɪ(jʊ)l	-odɪg-o͜ɪl	-odɪg-o͜ɪj-ʊdɪg-ʊl	oil
ɔɪ/oɪ + ɹ	X	X	X	X

Apart from [i], in Table 2, the tokens in the set all contain a diphthong with [l] or [ɹ] in coda position. For most of the data, there are two entries of the same word, yet each one is in a different cell because despite some English words seemingly being monosyllabic, an individual's abstract understanding of the word may increase the syllable count originally assumed.

Examples of the interpretation of syllables and the insertions when there are diphthongs and [l] or [ɹ] in coda position in a word, can be demonstrated in (16) and (17) below.

(16) a͜ɪl ‘aisle’

Each set of brackets below illustrates a syllable.

(a͜ɪl)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(↓ a͜ɪl)

This results in the final Sergian form:

ʌdɪga͜ɪl

Based of Lehiste and Peterson's (1961) work, (16) has a shorter or "normal" duration of the off-glide than that of (17), meaning the transition from the off-glide will follow to the [l] or [ɹ] in coda position. Therefore, (16) is a clear monosyllable suggested by this shorter transition, meaning it will have a single insertion of the infix. The vowel that is copied minus the off-glide as the rule states is [ʌ] or [a] (refer to Table 1) in this instance [ʌ]. Although a diphthong is the combination of a monophthong plus a glide, when the nucleus is copied minus the off-glide, we are not necessarily left with the vowel that remains in the vowel-glide combination. This is because Lehiste and Peterson (1961) explain that it is not identifiable as such because the symbols are simply adopted as labels for these diphthongs, without a commitment to them being a clear split between the monophthong and glide we see; it is about the sounds we perceive in that combination instead. Therefore, for examples (16), it may be that another individual's pronunciation is [a], which is why the diphthong's written convention is solely a label. Example (17) portrays a transition from a diphthong to a glide, with an additional vowel following and a liquid in the coda. In simpler terms, (17) illustrates the Sergian surface form of 'aisle' when it is realized as a disyllabic word.

(17) a͜ɪjəl 'aisle'

Each set of brackets below illustrates a syllable.

(a͜ɪ) (jəl)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(↓ a͜ɪ) (j ↓ əl)

This results in the final Sergian form:

ʌdɪga͜ɪj**ədɪg**əl

Distinct from (16), for (17) the pronunciation of *aisle* with [j] permits the insertion of two -VdVg- sequences because the underlying form is disyllabic. With (16) being an option, those who pronounce *aisle* as illustrated in (17) may also pronounce it as is displayed in (16) to shorten the word during fast speech. However, there is an instance where a diphthong + [ɹ] in coda position in the underlying form can only be viewed as a monosyllabic word. In Table 2, there is an example of this, which is *fair*. The word *fair* in English can be transcribed as [fe͜ɪɹ]. Based on the patterns and rules of diphthongs that are followed by [l] and/or [ɹ] in coda position, it would be expected that an identical example of 'aisle' would be for that of *fair*. However, it can only be assumed as a monosyllabic word in the underlying form, with epenthesis occurring only once to derive the surface form. The process from the underlying form to the surface form is displayed in (18) below. Observing a word with a similar sequence as *fair*, which is *lair*, one can be considered a sesquisyllable, *lair*, while the other can only be realized as monosyllabic, *fair* (refer to Table 2). This is not the only instance for the diphthong [e͜ɪ] + [ɹ] in coda that behaves this way. This is related to Walker and Proctor's (2012) discussion on certain [Vɹ] sequences having more lingual posture stability. Also noticeable is that although both *fair* and *lair* are transcribed with the diphthong [e͜ɪ], the realization is different.

(18) fe͜ɪɹ 'fair'

Each set of brackets below illustrates a syllable.

(fe͜ɪɹ)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(f ↓ e͜ɪɹ)

This results in the final Sergian form:

f**ɛdɪg**e͜ɪɹ

This is the only acceptable surface form for *fair* in Sergian. Depending on the speaker's pronunciation, the vowel copied minus the off-glide may slightly differ from one individual to another. As a native speaker of English, it is difficult to have *fair* transcribed as a two-syllable word. This would appear as the following.

(19) *fe͜ɪjəɹ 'fair'

Each set of brackets below illustrates a syllable.

* (fe͜ɪ) (jəɹ)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

* (f ↓ e͜ɪ) (j ↓ əɹ)

This results in the final Sergian form:

*fɛdɪge͜ɪjədɪgəɹ

The underlying form is ungrammatical in (19); therefore, resulting in an ungrammatical Sergian surface form. According to Lavoie and Cohn (1999), words containing a diphthong followed by [ɹ] that cannot be considered as disyllabic, will lack a glide in the onset of the second syllable. Example (18) illustrates a grammatical example of *fair*, while (19) shows that forcing a glide in the onset of the second syllable in the underlying form will only result in an ungrammatical Sergian surface form as well. Words similar to example (18) are, *hair*, *tear*, *bear*, and *care*. Each of these words have the diphthong [e͜ɪ] followed with [ɹ] in coda, but the pronunciation of the diphthong in these words resembles [e], whereas diphthongs are the combination of a full vowel plus a glide (Lehiste & Peterson, 1961). This indicates that words may not always be recognized as having the diphthong [e͜ɪ], and when followed by [ɹ] in coda, they may not behave similar to those that fit into what Lehiste and Peterson (1961) classify as proper diphthongs, which are [a͜ɪ], [a͜ʊ], and [ɔ͜ɪ]/[o͜ɪ]. However, there are examples where [e͜ɪ] is followed by [ɹ] in coda, and the word can be realized as monosyllabic or disyllabic. An example from Table 2 is *lair*. By looking at the data presented throughout this paper, the three diphthongs that are considered true diphthongs, are consistent with the pattern where [l] or [ɹ] are in coda, while [e͜ɪ] and [o͜ʊ] have deviated from them. Another explanation to the behaviour of the diphthong [ɹ] sequence that does not allow for these words to be realized as sesquisyllables is the potential second syllable as discussed previously.

Also noticeable in Table 2 is the pure vowel [i]. From previous datasets not containing diphthongs, it is evident that [i] behaves in a similar manner to other monophthongs, but only in the instance where [l] is in coda does it behave in the manner that a true diphthong would. Examples of this are in the following for the word *feel*:

(20) fil ‘feel

Each set of brackets below illustrates a syllable.

(fil)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(f ↓ il)

This results in the final form – Sergian:

f**idig**il

In this example, [i] is acting similar to what is seen in the datasets in section 3.2.2. However, this next example shows the patterns evident from Dataset 5, on words behaving as both monosyllabic and disyllabic in their underlying form.

(21) fijəl ‘feel’

Each set of brackets below illustrates a syllable.

(fi) (jəl)

The arrow pointing downwards informs where the insertion is occurring within each syllable.

(f ↓ i) (j ↓ əl)

This results in the final form – Sergian:

f**idig**ij**ədɪg**əl

What is evident from (21) is that although there is no diphthong, the phoneme [j] may be realized as a sound that follows the high front unrounded vowel [i], causing the underlying form to be realized as disyllabic. Therefore, just as is seen in (17), there is epenthesis of the infix twice, each time before the nucleus. The reasoning as to why [i] behaves in such manner may be due to the duration of the vowel. A longer duration suggests an [ij] sequence. Lehiste and Peterson (1961) discuss that based off various recorded and analyzed words from their study, some words are realized as [i] plus an off-glide when the duration of the vowel exceeds the vowel's "normal" duration. Despite this tense vowel having a diphthongal off-glide, Lavoie and Cohn (1999) stress the importance of not referring to it as a diphthong and rather reserving this term for true diphthongs only. However, data from this study on Sergian contradicts Lavoie and Cohn's (1999) work, and [il] behaves as a diphthong would. Based on Lavoie and Cohn's (1999) study, the sesquisyllables are noticeable where there is a diphthong and a non-low tense vowel, with the exclusion of [o], which has previously been discussed; their study illustrates a heavier syllable for the words that fit under this category. As mentioned previously, it is the glide and liquid combination that affects whether a word is realized as monosyllabic versus disyllabic. Regardless of the data, the rule that continues to hold true is that when using English as the base-language, insert -VdVg- before every vowel, where the first vowel is a copy minus the off-glide. The question to which I turn in this study is how the various sub-patterns discussed above can be acquired, and how much evidence learners need to acquire them?

4.0 Research Questions

There are two questions that this study aims to answer. The first question is: how much data is needed to be exposed to a language, in order to learn its rules and patterns. With the controversial argument for poverty of the stimulus, which explains that linguistic input received by young children is insufficient on its own to explain the detailed and rich knowledge they have of their first language, and therefore, they must be born with an innate ability for language learning, there is an interest in how the degree of the exposure affects the participants' learning of a main phonological rule of this language. The second question this study aims to answer is: to what degree are the rules of Sergian acquired? To better answer this second research question, there are three sub-questions to help answer this main question. The first sub-question is observing how participants treated words that required regular or basic epenthesis. These words fall under the category of non-sesquisyllable words. The second part of this question observes how the rule is applied to sesquisyllables, and how participants represent and realize words containing [Vl] and [Vɹ] sequences when in coda position of the underlying form, specifically the high front tense vowel [i] and the diphthong liquid distinction. Answering this question assists in observing whether individuals need exposure to sesquisyllable patterns and rules to acquire them, or whether they can extend the pattern from non-sesquisyllable patterns and the rule to sesquisyllables. The sub-question of research question two aims to answer whether one rule, non-sesquisyllable versus sesquisyllable, is easier to acquire than the other.

5.0 Methodology

The methodology will cover six sections. The first section gives a brief overview of the study, while section two briefly discusses the groups of which this study is compromised. The third section covers the main details of the learning component of the stimuli. This includes details on the tokens that are used for the exposure and the purpose behind specific decisions. The fourth section consist of the testing component of the stimuli. This section discusses the task that the participants have completed for the analysis portion of this study. Section five has more in-depth discussion on the participants and their background and the collection of data. Lastly, the sixth section presents personal predictions and expectations of each group based off the stimuli and previous, relevant work. These predictions and expectations are discussions relevant to the research questions from 4.0.

5.1 Overview

The study consisted of two components, learning and testing. In the learning component, subjects were exposed to English words and their Sergian equivalents. In the testing component, subjects were tested on Sergian productions of novel English words.

5.2 Groups

Participants were separated randomly into two groups, A and B, which differed in the learning component of the study. In group A, participants were given substantial exposure to all aspects of the Sergian pattern. In group B, they were given a smaller amount of information, with some parts of the pattern withheld.

5.3 Stimuli: Learning Component

Each group was exposed to different stimuli during the learning component. Group A participants were exposed to the stimuli in Table 3.

Table 3: Group A Exposure

		Consonant	/l/	/ɹ/
Lax Vowels	ɪ	rich, alphabetical, wish	pill	
	ɛ	friend, attention, alphabetical, vet, fret	well	spectacular
	æ	cat, map, laugh, spectacular, grass	alphabetical, gal	
	ə	water, attention, around	alphabetical	spectacular, hire, fir
	ʌ	attention, alphabetical, sun, fun	lull	
	ʊ	book	full	
	ɔ/a	water	fall	car
Tense Vowels	i	peek, key	peel	fear
Diphthongs	aɪ	kind, my, pine, ice	vile	hire
	eɪ	plain, tame	tail	hair
	oʊ	road, home	bowl	four
	aʊ	around, out	owl	hour
	ɔɪ/oɪ		oil	

Group A gets exposed to a total of 47 words. For the performance criterion to be met in the testing phase, the participants will need to be exposed to data containing tokens that will provide them with various information about the language and not only information useful to answer one of the many research questions. For this reason, Group A is given data that has no consonant in coda or a consonant not [l] or [ɹ] in the coda (labelled as Consonant in Table 3 above), and data with both liquids in coda (refer to Table 3). The data that is used for each analysis will be discussed in section 6.0. The gaps that are present in the table are due to the absence of words that follow such sequences. Those in Group A were exposed to data where the initial syllable could be either a vowel (nucleus) or consonant (onset), exposing participants to a larger quantity of data to achieve their realization of the location of the insertion. They were also exposed to monosyllabic, disyllabic, and multisyllabic words, where the vowels in the words varied with both monophthongs and diphthongs. Since one of the goals of this study is to determine how participants apply the rule to English words with diphthongs and [l] or [ɹ] in the coda, Group A was presented with this data, along with data that has diphthongs but no [l] or [ɹ] in the coda. When hearing the Sergian form of the diphthong-liquid data, participants were exposed to it as a two-syllable word when possible.

The data exposure for Group B differs quite a bit from that of Group A. Group B were exposed to the following stimuli in the learning component.

Table 4: Group B Exposure

		Consonant	**/l/**	**/ ɹ /**
Lax Vowels	ɪ	rich, pin	pill	
	ɛ	friend, deck	well	
	æ	cat, map, laugh, grass, hat		
	ə	button		
	ʌ	fun, sun		
	ʊ	book		
	ɔ/a	hop, dog		
Tense Vowels	i	peek		
Diphthongs	aɪ			
	eɪ			
	oʊ	home		
	aʊ			
	ɔɪ/oɪ			

Group B is exposed to only 20 words. Therefore, there is minimal exposure to the language and the application of the rule. Group B participants are mostly exposed to monosyllabic words, apart from two disyllabic words. The stimuli list contains only pure vowels, with no data to aid in the diphthong-liquid distinction. The two instances of [l] in coda, are associated with lax vowels, not even the high, front, tense vowel [i], which sometimes behaves like the diphthongs. This is not beneficial data for the distinction. Withholding data from this group assists in finding whether it can be acquired simply by extension of the more general pattern. The data for this group does not include diphthongs or sesquisyllables that would allow participants to notice other patterns in the language.

The goal of the exposure for both groups is to provide the participants with information on the language's phonotactics to prepare them for the second task, where they will try out the language game. There are many differences between the groups though, beginning with the amount of exposure. Group B has limited exposure in comparison to Group A. While Group A was exposed to mono, di, and multisyllabic words, Group B was mainly exposed to monosyllabic words, with two instances of disyllabic words. Group B also had no nucleus initial syllables, or words with diphthongs. Overall, Group B had limited data in various places compared to Group A.

5.4 Stimuli: Testing Component

Participants were tested on a novel set of tokens, revealing the degree to which they acquired the rules from their exposure task. Both Groups A and B were tested on the same stimuli, illustrated in Table 5 below.

Table 5: Task 2 Stimuli Testing List

		Consonants	/l/	/ɹ/
Lax Vowels	ɪ	exciting, superstitious, invisible, women, entail, grip	bill, skill	
	ɛ	exciting, bet	spell, tell	
	æ	math, path	alpine, pal	
	ə	agree, about	invisible, manual	superstitious, sir, blur
	ʌ	hunt, bunk	dull, null	
	ʊ	women, look	wool, pull	
	ɔ/a	cough, rock	hall, stall	star, par
Tense Vowels	i	ski, plea, agree	feel, wheel, teal	deer, clear, gear
Diphthongs	aɪ	exciting, write, alpine	file, aisle, style	squire, choir, wire
	eɪ	day, cake, reign	fail, whale, entail	lair, pear, care
	oʊ	though, globe, comb	sole, coal, mole	more, core, store
	aʊ	cloud, house, about	howl, foul, growl	tower, sour, cower
	ɔɪ/oɪ	coin, noise	coil, soil	

Just as with Tables 3 and 4, there is data meant to test for the realization of tokens where /l/ and /ɹ/ are in coda positions, and data meant to serve as both filler words and as the data for analysis of the application of basic epenthesis. There are three tokens per cell for tense vowels and diphthongs, whether they contain [l] or [ɹ] in coda or not (ɔɪ excluded and only contains two per cell as it is not a very common sound in English). The decision behind this is to have more data for what is being analyzed, which is the realization of the diphthong-liquid distinction based off the learning stimuli of each group.

There are no tokens with the sound [u]; the sound is excluded from the discussion since there is various individual and lexical variation. With this variation, the data may not be useable. With [u + ɹ], individuals realized this sequence as [əɹ], [oɹ], or [uɹ], making it difficult to accurately classify it. For example, *pure* can be pronounced as [pjəɹ] or [pjuɹ] and for *sure*, it can be pronounced as [ʃəɹ], [ʃoɹ], or [ʃuɹ] depending on each individual's lexical variation. The stimuli list for the second task consists of data, where there are three tokens per cell for tense vowels and diphthongs, regardless of if they contain [l] or [ɹ] in coda or not. Diphthong [ɔɪ]/[oɪ] is excluded from having three tokens per cell and instead contains two per cell as it is not a very common sound in English. The decision in which cells contain two versus three words is based off what the goal of the analysis is, which is observing the proportion of participants that choose one syllable versus two syllables in a sesquisyllable, and how this gets realized based off intuition. This means, there are more tokens for the aspect that is being tested for and is of focus. Although this language is an artificial language, it is beneficial as it allows for the manipulation of patterns and rules to learn more about the base-language that has already been internalized by the participants (Pycha et al., 2003), suggesting that what is observed and learned about the artificial language can be transferred to learn about its underlying form and base-language.

5.5 Participants and Tasks

This study consists of participants who were randomly assigned to Group A or Group B (n=14), with an even split between the groups. The choice in the number of participants is due to the time available to complete the study. Therefore, it is best to minimize the number of participants, especially with the study being smaller-scale and the first study done on this language. Even with a small number of participants, systematic differences are still evident. Participants were required to be L1 English speakers 18 years of age or older. The reason for selecting English as the participants' first language is that Sergian is using English as the base-language, meaning the participants need to be aware of English pronunciations, patterns, and rules. All participants are post-secondary school students within the Faculty of Arts and Social Sciences at Carleton

University in Ottawa, Ontario, Canada. Before commencing the study, they filled out a background questionnaire answering the following questions:

a) How old are you?
b) What degree program are you from?
c) Is English your first language?
d) Other than English, what other languages do you speak?
e) Have you ever learned a second/another language?
f) Have you ever played a language game?

This information not only gives confirmation that the participants' met the requirements of the study, but it also provides information that may aid in explaining the results gathered from the analysis. Based off the questionnaire, about 86% (12/14) of participants stated that they are bilingual/multilingual, 100% (14/14) of participants have learned a second language or are learning one, and around 64% (9/14) of participants have played/used a language game.

Each participant was assigned a code to conceal their identity and keep the results as anonymous as possible. However, their code does provide essential information; it identifies to which group and what recording they belong to. The same code placed on the questionnaire is used for the participant's audio-recording in the final task. Since there are two groups, A and B, this help identify to which group they belong, without the participant being identifiable.

Participants were told that this is a two-phase study, where in the first phase they are exposed to data in Sergian, and the second phase is where they get to attempt Sergian words themselves; both phases taking place over Zoom in the same session. Group A is the group that receives substantial exposure in the first of two phases, while Group B is the group that receives minimal exposure to Sergian data in the first phase of the study. Both groups were only presented with grammatical forms and all data was randomized in both phases for both groups.

The first phase is the exposure of the data. Participants observe a screen that displays an English word. They see the word and they hear the word. It is followed by a recording of the word in Sergian, and after hearing it, participants are required to repeat the word. This same process occurs once again for the same word. What this means is that the participants hear the English word twice and the Sergian word twice, the first instance of each is slowed down and the second instance of each is natural. The words presented to Group A in this first task are provided in Table 3. The words presented to Group B can be found in Table 4.

Once the exposure phase is completed, participants were then tested on a novel set of tokens, revealing the degree to which they acquired the rules from their exposure phase. Here, they are attempting the Sergian form of the provided English tokens (refer to Table 5), based on their intuition. Over Zoom, the PowerPoint presentation with the testing stimuli was shared with the participants. Participants were in front of their computer monitors with their microphones on to be audio-recorded. Before beginning the slideshow, the participants are informed that they will see the English token, where they are only required to provide their intuition of this word in Sergian, with seven seconds to attempt each token, with their intuition of the word being what is of interest. The first slide simply included the title *Your Turn*. Participants were on this slide for seven seconds before the slide automatically switched to begin the testing. Recording of the session took place over Zoom, commencing when instructions were given. The recording downloaded after each session and the sound file is renamed as the participant's code and later used for analysis. The goal was to gather responses as to whether the participants applied the rule and then how they realize the diphthong-liquid syllable distinction. Both groups were presented with a total of 77 tokens to attempt. A list of the tokens is presented in Table 5. In total, each participant spent 9 minutes on this task.

5.6 Predictions

Based off the exposure for each group, I expected Group A to have had enough data to be considered exposed to the phonological rule in discussion, where they well acquire and apply the rule to the various token types, mono-, di-, and multisyllabic. There is only a specific type of data as well as a limited amount of data that Group B had exposure to; therefore, I do not believe that they have enough data to be considered as familiar with the phonological rule like Group A would be. Even with this limited data, I expect that both groups should be able to apply the basic rule of epenthesis to monosyllabic words, whereas I would expect Group A to further apply the rule to disyllabic and multisyllabic words, as well as words beginning with vowels. This is hypothesized based off the data in their exposure task. As for the learning of the sesquisyllable sub-pattern and the application of the rule for this, I believe that Group A will realize [Vl] and [Vɹ] sequences mainly as disyllabic rather than monosyllabic since they are exposed to it as such in the first phase of the study, while Group B will realize the sesquisyllables as monosyllabic since the limited data they are exposed to is mainly monosyllabic and they have no exposure to the diphthong-liquid distinction, meaning they received no exposure to sesquisyllabic data. This means they may overgeneralize the rule they acquire. However, this will be dependent on what the rule is that they learned from the exposure. Based off previous work done on ludlings, I would expect participants of Group A to realize the true diphthongs as disyllabic when followed by a liquid in coda. Not only are they exposed to this data as disyllabic in their exposure, but true diphthongs' behaviour is more consistent with the sesquisyllable pattern. Regarding the difficulty in acquiring one pattern over another, I believe that the group with substantial exposure is more likely to acquire both better than

Group B, but nonetheless, it is expected that basic epenthesis is easier to learn since there are less components to the rule when it is being applied and both groups receive exposure to this.

6.0 Analysis

After completing the study and gathering all the data, the data was analyzed by percent correct responses. Table 5: Stimuli List was used to categorize each token, as all data in the table is used. Almost every cell contains 2-3 tokens and therefore, each participant received a score out of 2 or 3, which got converted into a percentage. Once this was done for all participants, the data was split between the scoring of Group A and Group B to compare. The scores in the cells for each category were added and divided by 7, the number of participants in each group. In doing this, the average for correct responses for each group were derived. The purpose of this was to have a clear table for each group to illustrate a comparison between the number of correct responses and whether there is a noticeable pattern depending on the vowel and the consonant following. This could have been calculated more globally; however, to ensure that the calculations are accurate, an extra step was included. This information is also presented on a bar graph to compare the overall results of the groups' scores side-by-side. From the correct responses, a Chi-Square test was run to inform of whether there is a statistically significant relationship between the groups and their responses.

The data was further analyzed by transcribing all participants' answers on an accuracy scoring sheet. Just as with the percent correct responses, all the data gets used for this analysis. Participants' answers were recorded for the appropriate number of syllables inserted for each token and scored for the appropriate -VdVg- sequence, where each sound in the sequence would amount to one point. For example, the word 'deer' /diɹ/ in Sergian would be [d-idig-iɹ]. Since it is a monosyllabic word in the underlying English form, the sequence gets inserted once. If a participant produces this form, then they receive four points, one point for each appropriate sound in the sequence that gets inserted, as well as in the right order. Taken from the study, a participant produced [d-ɪdɪg-iɹ] for 'deer'. This form receives 2/4 points. The consonants in the epenthesized sequence are the correct consonants and in the right order; however, the vowels, though in the right location of the epenthesized sequence, are the wrong vowels. Had the participant inserted the right sequence but in the wrong location within the syllable, they would not receive any points. More examples of incorrect data and the scores received are illustrated below.

(22) [st-ɔdɪg-ɔl] 'stall' correct Sergian form and English gloss

* [stɔl-dɪg] participant's intuition

0/4 points score received

In example (22), the correct Sergian form for the English word *stall* is presented, followed by the participant's intuition of the English word. The reason this participant did not receive any points, even though there is a -dVg insertion, epenthesis did not take place in the correct location of the word, which is before the nucleus. A participant inserting a -V_1dV_2g- sequence does not mean they acquired the rules and patterns of the language. It is when they produce the sequence before the nucleus of the underlying form, with the reduplicated vowel in V_1 do they display a form of acquisition of the rule.

(23) [gl-odɪg-oʊb] 'globe'

* [gl-od-oʊb]

2/4 points

The participant that produced the intuition in (23) received a score of 2/4. Insertion can only occur once, and therefore, the maximum number of points is four. To begin with, the participant's location of the insertion is correct, meaning they can receive points. The V_1 is a copy of the vowel, which the insertion precedes, minus the off-glide. Although there is the diphthong [oʊ], the second half of the rule does not pertain since it is the same sound, as previously discussed in this paper. From the -V_1dV_2g- sequence, V_1 and [d] are accurate.

(24) [h-ædɪg-aʊs] 'house'

* [h-aʊdɪg-aʊs]

3/4 points

Example (24) observes a word with a diphthong. This means that the rule requires the V_1 of the insertion to be a copy of the vowel the insertion precedes, minus the off-glide. The insertion is before the nucleus and points can be obtained for the insertion. The V_1 in the inserted sequence is a copy of the vowel with the off-glide. For this reason, no points are given for the V_1. The -dV_2g- is correct and for those three segments, the participant obtained three points. The next example also observes a diphthong, but one that is part of a sesquisyllabic word.

(25) [l-ɛdɪg-eɪɹ /l-ɛdɪg-eɪj-ədɪg-əɹ] 'lair'

* [l-ɛdɪg-eɪjəɹ]

4/8 points

Unlike examples (22-24), example (25) is a sesquisyllabic word. If the participants realize the word as monosyllabic, they can receive a maximum of four points; however, if they realize it as disyllabic, they can receive a maximum of eight points. A participant will not lose points if they produce a sesquisyllable as monosyllabic, but rather they gain points if they produce the sesquisyllable as disyllabic. This does not mean however, that producing a sesquisyllable as disyllabic rather than monosyllabic is better. In this example, the participant realized the word as disyllabic but only shows one occurrence of epenthesis. Here the participant loses four points for a null insertion. As for the one occurrence, the participant has inserted the sequence in the right location. The V_1 is a copy of the diphthong [eɪ], minus the off-glide, which receives a point. The -dV_2g- is correct and for those three segments, the participant obtained three points, totalling four points for their intuition of the word *lair* in Sergian. A few more examples of incorrect responses produced by a participant are presented below.

(26) [ɹ-ədɪg-a͜ɪt]   ‘write’

* [ɹa͜ɪt-ig-æt]

0/4 points

(27) [d-ɛdɪg-eɪ]   ‘day’

* [deɪ-dig-æt]

0/4 points

(28) [w-ʊdɪg-ʊm-ɪdɪg-ɪn]   ‘women’

* [wʊm-dig-æt]

0/8 points

In examples (26-28), the participant received no points. Not only is there epenthesis of additional sounds to the word, but the location of the insertion for each example is incorrect, meaning points can not be acquired. Examples (26) and (27) are examples of monosyllabic English words, which require epenthesis of the sequence once to form the surface Sergian form. This explains why the score is out of four, while example (28) is disyllabic in the underlying form, resulting in the requirement of epenthesis to occur twice. This, however, does not occur. The insertion occurs only once, and it is neither correct nor in the appropriate location of insertion for this language game. Therefore, the score is 0/8.

The total a participant could have scored if all their answers were correct is 376 points; however, that is only if they treated the sesquisyllables in the base-language as monosyllabic. If they realized the words as disyllabic and the participant's answers were all correct, then the highest score possible is 460 points. Therefore, the lowest score for 100% accuracy is 376, while the highest score for 100% accuracy is 460. While the first analysis observed and recorded only correct responses, this analysis looks at the accuracy of the inserted sequence. The groups are an essential tool to answer the first research question as to the amount of data required to be exposed to the main rule of the language, hence the presentation of the descriptives for accuracy scoring and percent correct scores.

To answer the second question, the analysis is split into three sections, one for each sub-question. The first sub-question is specifically how participants acquire the rule of epenthesis for words that are not categorized as sesquisyllables, where the insertion is considered simpler. Therefore, the data used included all tokens that are not considered sesquisyllables. The data for this analysis is illustrated in section 7.1. For this, a Chi-Square test has been run to test whether there is a relationship between groups and their responses. To further observe this question, another Chi-Square test is run to examine the relationship between the monophthongs excluding [i] and including [oʊ]) and responses. A statistically significant relationship would indicate that one of the monophthongs is distinct from the others, specifically in the difficulty of its acquisition. The second sub-question to the second research questions aims to answer the degree to which the rule for epenthesis in sesquisyllables is acquired. To answer this question, the data that is used is the data that is considered sesquisyllable. An illustration of the tokens is presented with the inferential statistics. The analysis for this is observing the correct responses for words that are categorized as sesquisyllables and identifying the number of participants that realized the token as one syllable, two syllables, versus realizing it can be either, or whether it is completely incorrect. This was done separately for each group and then a table combining both the results from Group A and B was also produced. It is important to determine if there is a relationship between the responses and the groups. In order to conclude this, a Chi-Square test is run. From these two sub-questions, it becomes interesting and valuable to examine whether there is a relationship between the two epentheses, and whether it is easier to acquire one over the other. To answer this question, a Chi-Square test is run and further analyzed by distinguishing which group contributed more to the Chi-Square statistic if the test proved to be statistically significant, to determine which of the two is easier to acquire. For the analysis, sesquisyllables versus non-sesquisyllables are tested as two separate groups.

7.0 Results

After completing the analysis, results were obtained to answer the various research questions. These are presented in sections 7.1 and 7.2 below. In section 7.1, the descriptive statistics of the analysis are illustrated, while section 7.2 presents the inferential statistics.

7.1 Descriptive Statistics

The full response of each participant has been analyzed to illustrate the percentage of correct responses for each cell, by each group. All data from the testing stimuli (see Table 5) is used to obtain these results. Tables 6 and 7 below display this information. The X in the tables (Tables 6 – 9, 12 – 14) represent that words with such sequences do not exist in the English language. In the graphs (Figures 1 – 4), this non-existent sequence is not included.

Table 6: Percent Correct Response – Group A

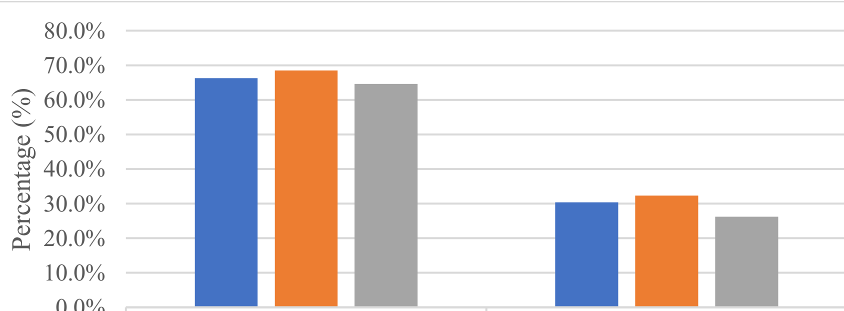
	C		l		ɹ	
i	47.6%	10/21	52.4%	11/21	52.4%	11/21
ɪ	42.8%	18/42	85.75%	12/14	X	X
ɛ	78.6%	11/14	71.4%	10/14	X	X
æ	78.6%	11/14	71.4%	10/14	X	X
ə	57.1%	8/14	21.4%	3/14	28.6%	6/21
ʌ	78.6%	11/14	71.4%	10/14	X	X
ʊ	78.6%	11/14	71.4%	10/14	X	X
ɔ/a	71.4%	10/14	71.4%	10/14	71.4%	10/14
aɪ	47.6%	10/21	71.4%	15/21	71.4%	15/21
eɪ	71.4%	15/21	71.4%	15/21	76.2%	16/21
oʊ	71.4%	15/21	71.4%	15/21	71.4%	15/21
aʊ	66.6%	14/21	80.9%	17/21	80.9%	17/21
ɔɪ/oɪ	71.4%	10/14	78.6%	11/14	X	X

Table 7: Percent Correct Response – Group B

	C		l		ɹ	
i	23.8%	5/21	33.3%	7/21	33.3%	7/21
ɪ	11.9%	5/42	50%	7/14	X	X
ɛ	42.9%	6/14	57.1%	8/14	X	X
æ	50%	7/14	28.6%	4/14	X	X
ə	0%	0/14	0%	0/14	19%	4/21
ʌ	57.1%	8/14	57.1%	8/14	X	X
ʊ	35.7%	5/14	50%	7/14	X	X
ɔ/a	64.3%	9/14	57.1%	8/14	64.3%	9/14
aɪ	4.8%	1/21	0%	0/21	0%	0/21
eɪ	14.3%	3/21	4.8%	1/21	9.5%	2/21
oʊ	61.9%	13/21	57.1%	4/7	52.4%	11/21
aʊ	14.3%	3/21	9.5%	2/21	4.8%	1/21
ɔɪ/oɪ	14.3%	2/14	14.3%	2/14	X	X

The overall scores of each category from Tables 6 and 7 have both been plotted on a bar graph in Figure 1 below. The total for each cell is out of 14 or 21. This is due to the number of words in each cell, which is 2-3, multiplied by the number of participants in each group (n=7). Each row does not necessarily total to 14 or 21 because the results illustrate only the correct responses. For all cells in Table 6, the percentage of correct responses is greater than the corresponding cells in Table 7. This means that Group A had more correct responses than Group B. In saying this, it can be concluded that Group A established, learned, and applied the rule of inserting -VdVg- before every vowel, where the first vowel is a copy minus the off-glide, better than Group B. With participants in Group B overgeneralizing the rule to diphthongs and reduplicating the vowel as is done with pure vowels, without following the second part of the rule meant for words with diphthongs, where the off-glide does not get included, it resulted in lower accuracy scores. This is because the tables illustrate the overall accuracy of the attempted token; it is either produced correctly or incorrectly. A difference of 57 tokens between groups in the exposure task resulted in differences between corresponding cells of accuracy as high as 71%. For consonants, Group A and B had a range difference of 35.8% and 64.3% respectively, for [l] in coda 64.35% and 57.1% respectively, and for [ɹ] in coda 52.3% and 64.3% respectively. The difference in means between groups for consonants or the absence of is 35.9%, for [l] in coda 36.2%, and for [ɹ] in coda 38.4%.

Figure 1: Graph for Overall Percent Correct Responses Between Groups



	Group A	Group B
C	66.3%	30.4%
[l]	68.5%	32.3%
[ɹ]	64.6%	26.2%

The bar graph in Figure 1 further illustrates that Group A scored higher than Group B overall. The statistics show that Group A did almost twice as better or more for each category.

Aside from analyzing the percent correct responses, the -VdVg- insertions and their accuracy for each group were analyzed, as it became easier to observe where there were errors, specifically with what vowels and what following consonant.

Table 8: Group A Accuracy Scoring of Epenthesized Sequence

	C		l		ɹ	
i	67.90%	57/84	73.30%	85/116	69%	58/84
ɪ	51.20%	129/252	89.30%	50/56	X	X
ɛ	85.70%	48/56	80.40%	45/56	X	X
æ	85.70%	48/56	78.60%	44/56	X	X
ə	78.60%	44/56	14.30%	8/56	54.80%	46/84
ʌ	87.50%	49/56	85.70%	48/56	X	X
ʊ	83.90%	47/56	80.40%	45/56	X	X
ɔ/a	76.80%	43/56	80.40%	45/56	80.40%	45/56
aɪ	70.20%	59/84	87.80%	130/148	82.40%	122/148
eɪ	83.30%	70/84	83.10%	103/124	79%	79/100
oʊ	82.10%	69/84	84.50%	71/84	89.30%	75/84
aʊ	79.80%	67/84	89.70%	140/156	90.80%	138/152
ɔɪ/oɪ	85.70%	48/56	85%	68/80	X	X

Table 9: Group B Accuracy Scoring of Epenthesized Sequence

	C		l		ɹ	
i	60.70%	51/84	67.90%	57/84	66.70%	56/84
ɪ	21.80%	55/252	78.60%	44/56	X	X
ɛ	55.40%	31/56	76.80%	43/56	X	X
æ	69.60%	39/56	39.30%	22/56	X	X
ə	10.70%	6/56	5.40%	3/56	45.20%	38/84
ʌ	71.40%	40/56	71.40%	40/56	X	X
ʊ	58.90%	33/56	78.60%	44/56	X	X
ɔ/a	80.40%	45/56	76.80%	43/56	80.40%	45/56
aɪ	39.30%	33/84	47.20%	51/108	39.70%	46/116
eɪ	64.30%	54/84	40.20%	37/92	32.60%	30/92
oʊ	81%	68/84	72.60%	61/84	77.40%	65/84
aʊ	57.10%	48/84	54.50%	61/112	51.70%	60/116
ɔɪ/oɪ	55.40%	31/56	62.50%	40/64	X	X

Noticeable from Table 8, there is an overall high accuracy scoring for the tokens in each cell, whereas there are much lower accuracy scores for Group B (refer to Table 9). The scores from these tables have both been plotted on bar graphs below (refer to Figures 2-4).

Figure 2: Accuracy Scores Between Groups for Consonants in Coda Position

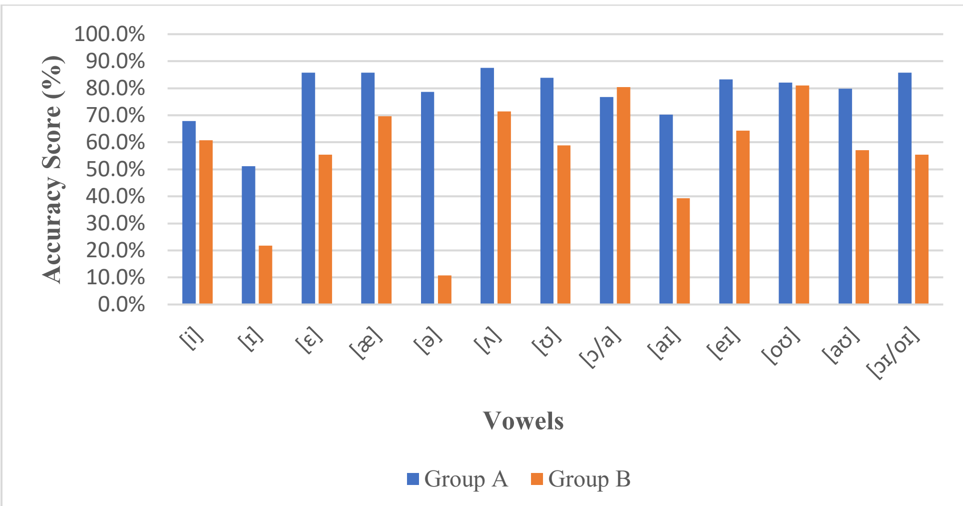
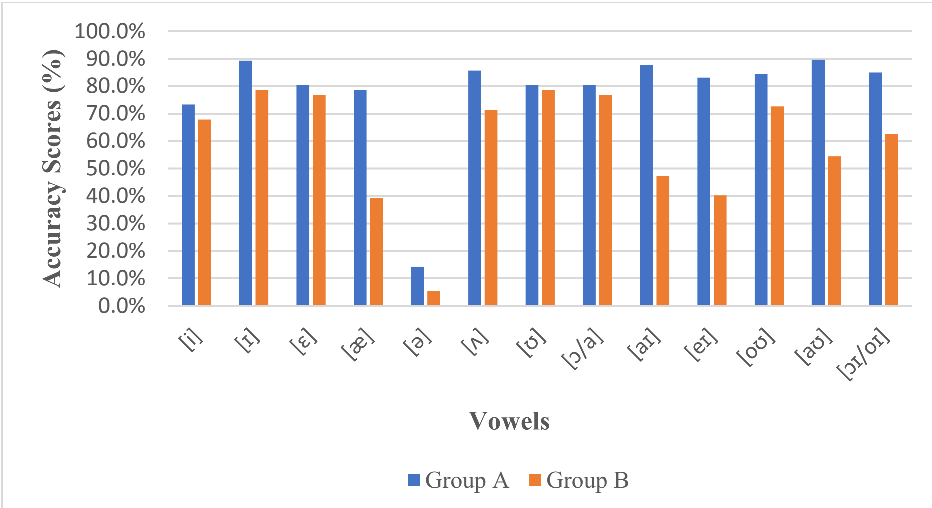


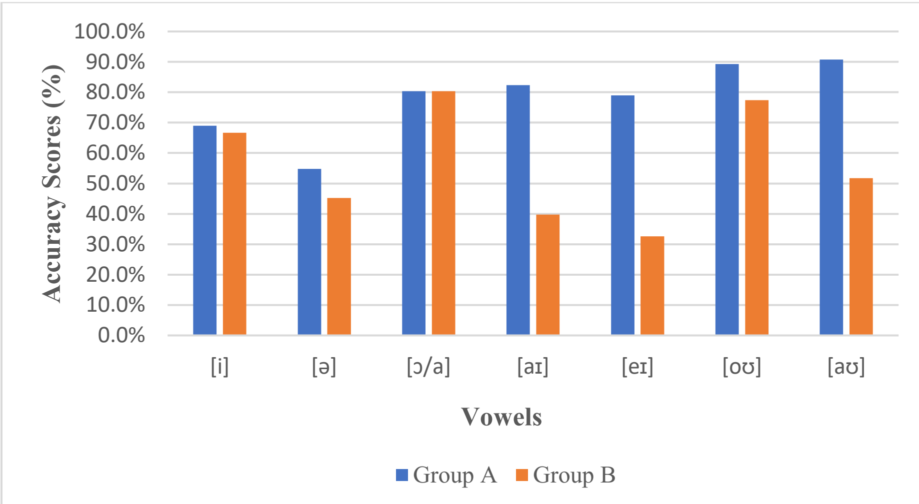
Figure 2 illustrates the scores between groups when observing the consonants column. Including [oʊ] since it behaves as the monophthong [o], as discussed previously in the paper, Group B generally have their higher accuracy scores for words with monophthongs. This is not unusual since in their exposure task, the limited exposure they received only contained pure vowels. However, for this analysis, participants received partial points. Each accurately inserted sound in the sequence received a point, meaning that if participants treated a monosyllabic word containing a diphthong as they would a monosyllabic word with a pure vowel, and not removing the off-glide in the vowel's reduplication as the rule states, they can still receive 3/4 points for the -dVg- portion. Figure 3 illustrates the accuracy score for the [l] column for both groups.

Figure 3: Accuracy Scores Between Groups for [l] in Coda Position



Evident in the Tables (8 and 9) and from Figure 3, both groups appeared to score low for accuracy of [əl]. A reason for this is that the tokens to test for this sequence were multisyllabic, which both groups had no exposure to very limited exposure to. This sequence also appeared word-finally, meaning that if a participant is attempting this token, they may not get through half the word before the next token appears. Even though participants were informed that they could give their intuition for parts of a token, participants always started at the beginning of the word regardless of if anything got produced. The accuracy scores between the groups for [ɹ] were also graphed.

Figure 4: Accuracy Scores Between Groups for [ɹ] in Coda Position



There are only few vowels displayed in Figure 4 because of the responses marked as X in Tables 8 and 9, which as previously mentioned, represent a non-existent sequence in the English language. From this graph, it appears that both groups equally scored on [a + ɹ] sequences. Otherwise, Group A scored higher than Group B for all other vowels preceding [ɹ].

To assist in answering the research question regarding sesquisyllables and participants' realization when the word contains [Vl] and [Vɹ] sequence in coda position, two tables have been drawn out to illustrate the difference between groups. Both correct and incorrect responses are recorded. However, it is first important to present the data that was used to obtain these results. Table 10 below displays the tokens that did not belong to the category of sesquisyllables, whereas Table 11 displays the sesquisyllable tokens. Tables 10 and 11 are subsets of the testing stimuli from Table 5.

Table 10: Non-Sesquisyllable Stimuli

		Consonants	/l/	/ɹ/
Lax Vowels	ɪ	exciting, superstitious, invisible, women, grip	bill, skill	
	ɛ	exciting, bet	spell, tell	
	æ	math, path	alpine, pal	
	ə	agree, about	invisible, manual	superstitious, sir, blur
	ʌ	hunt, bunk	dull, null	
	ʊ	women, look	wool, pull	
	ɔ/a	cough, rock	hall, stall	star, par
Tense Vowels	i	ski, plea, agree		deer, clear, gear
Diphthongs	aɪ	exciting, write, alpine		
	eɪ	day, cake, reign		pear, care
	oʊ	though, globe, comb	sole, coal, mole	more, core, store
	aʊ	cloud, house, about		
	ɔɪ/oɪ	coin, noise		

From this table, it is evident that most of the diphthong-liquid sequences are not included. The sequence of [i] + [l] is also not included as it behaves similar to a diphthong as discussed previously in the paper. Noticeable are two tokens for [eɪ] + [ɹ]. These two tokens are not sesquisyllables, which is not unusual since Proctor and Walker (2012) discussed that [Vɹ] contexts have more lingual posture stability than [Vl], and words with the diphthong [eɪ] followed by [ɹ] will sometimes lack a glide in the diphthong (Lavoie and Cohn, 1999), meaning it cannot be realized as disyllabic. A table illustrating the sesquisyllable stimuli is illustrated in Table 11.

Table 11: Sesquisyllable Stimuli

		Consonants	/l/	/ɹ/
Lax Vowels	ɪ ɛ æ ə ʌ ʊ ɔ/a			
Tense Vowels	i		feel, wheel, teal	
Diphthongs	aɪ		file, aisle, style	squire, choir, wire
	eɪ		fail, whale, entail	lair
	oʊ			
	aʊ		howl, foul, growl	tower, sour, cower
	ɔɪ/oɪ		coil, soil	

Table 11 displays the tokens used for analysis of the sesquisyllable pattern. This data is used to observe each group's realization of the number of syllables for each diphthong/tense vowel. A table illustrating the combined answers of both groups is presented below.

Table 12: Sesquisyllable Realization – Groups A and B Combined

	[l]							
	1 syll.		2 syll.		both		Incorrect	
i	31%	13/42	7.1%	3/42	4.8%	2/42	57.1%	24/42
aɪ	2.4%	1/42	28.6%	12/42	2.4%	1/42	66.7%	28/42
eɪ	21.4%	9/42	11.9%	5/42	2.4%	1/42	64.3%	27/42
aʊ	4.8%	2/42	40.5%	17/42	0.0%	0/42	54.8%	23/42
ɔɪ/oɪ	28.6%	8/28	17.9%	5/28	0.0%	0/28	53.6%	15/28
	[ɹ]							
	1 syll.		2 syll.		both		Incorrect	
	X	X	X	X	X	X	X	X
	2.4%	1/42	31%	13/42	0.0%	0/42	66.7%	28/42
	21.4%	3/14	21.4%	3/14	0.0%	0/14	57.1%	8/14
	4.8%	2/42	35.7%	15/42	0.0%	0/42	59.5%	25/42
	X	X	X	X	X	X	X	X

Table 12 illustrates the combined responses from both Group A and Group B for the number of correct sesquisyllables and their distribution between participants' realization of them as monosyllabic, disyllabic, or both. There is also a column for incorrect responses to better illustrate the total number of sesquisyllables attempted for each vowel. Incorrect responses were any and all sesquisyllable data that did not match one or both of the correct surface forms. The X in the table represents that either words with such sequences do not exist in the English language or that that words with that sequence are not sesquisyllables. The diphthong [oʊ] is not included since as mentioned previously, it behaves as a pure vowel; the writing convention is the sole difference between [o] and [oʊ]. From this combined table, it appears that most correct instances of the true diphthongs [aɪ] and [aʊ] are realized as disyllabic whereas [eɪ], the pure vowel [i], and the true diphthong [ɔɪ/oɪ] are mostly realized as monosyllabic. Evident in the table is that there are fewer words for the [eɪ] + [ɹ] sequence. This is because although there were three tokens in that cell per group, only one, *lair* (refer to Table 11), has the characteristics of a sesquisyllable (1 sesquisyllable word x 7 participants = 7 (double to account for the two groups = 14) possible attempts for the [eɪ] + [ɹ] sequence). Splitting the table between the two groups will better help to understand the choices of each group and essentially answer the research question as to the realization of sesquisyllables when there is a [Vl] and [Vɹ] sequence in coda position. Table 13 below illustrates the data extracted from Table 12 for Group A.

Table 13: Sesquisyllable Realization – Group A

	[l]							
	1 syll.		2 syll.		both		Incorrect	
i	28.6%	6/21	14.3%	3/21	9.5%	2/21	47.6%	10/21
aɪ	4.8%	1/21	57.1%	12/21	4.8%	1/21	33.3%	7/21
eɪ	38.1%	8/21	23.8%	5/21	4.8%	1/21	33.3%	7/21
aʊ	0.0%	0/21	81%	17/21	0.0%	0/21	19%	4/21
ɔɪ/oɪ	42.9%	6/14	35.7%	5/14	0.0%	0/14	21.4%	3/14
	[ɹ]							
	1 syll.		2 syll.		both		Incorrect	
	X	X	X	X	X	X	X	X
	4.8%	1/21	61.9%	13/21	0.0%	0/21	33.3%	7/21
	42.85%	3/7	42.85%	3/7	0.0%	0/7	14.3%	1/7
	4.8%	1/21	71.4%	15/21	0.0%	0/21	23.8%	5/21
	X	X	X	X	X	X	X	X

Table 13 shows that there were many correct responses from Group A with more participants realizing true diphthongs as disyllabic even though all diphthongs and [i] followed by [l] and [ɹ] in coda were presented as disyllabic in the first phase, the exposure phase. The true diphthong [ɔɪ/oɪ] has almost an even split between the responses being monosyllabic versus disyllabic; ultimately, there is a 5% higher instance of the words being realized as monosyllabic. Only in the [Vl] sequence were there four instances where there is realization that the token can either be monosyllabic or disyllabic, and both forms are produced correctly. This means that a participant identified four [Vl] tokens where it is categorized as sesquisyllable and realized it as both monosyllabic and disyllabic in the testing. Between Group A, there is variation in the realization of sesquisyllables, unlike Group B. Table 14 below presents the correct responses for Group B and the realization of these sesquisyllables.

Table 14: Sesquisyllable Realization – Group B

	[l]							
	1 syll.		2 syll.		both		Incorrect	
i	33.3%	7/21	0.0%	0/21	0.0%	0/21	66.7%	14/21
aɪ	0.0%	0/21	0.0%	0/21	0.0%	0/21	100%	21/21
eɪ	4.8%	1/21	0.0%	0/21	0.0%	0/21	95.2%	20/21
aʊ	9.5%	2/21	0.0%	0/21	0.0%	0/21	90.5%	19/21
ɔɪ/oɪ	14.3%	2/14	0.0%	0/14	0.0%	0/14	85.7%	12/14
	[ɹ]							
	1 syll.		2 syll.		both		Incorrect	
	X	X	X	X	X	X	X	X
	0.0%	0/21	0.0%	0/21	0.0%	0/21	100%	21/21
	0.0%	0/7	0.0%	0/7	0.0%	0/7	100%	7/7
	4.8%	1/21	0.0%	0/21	0.0%	0/21	95.2%	20/21
	X	X	X	X	X	X	X	X

Evident in Table 14, the number of correct responses is quite low. Even with the insignificant response numbers, all are realized as monosyllabic regardless of if the vowel is considered a true diphthong or not. This shows that the participants simply overgeneralized since most data that they were presented with in the exposure phase was monosyllabic and all with pure vowels. There are also no instances of participants realizing that the sesquisyllable token can be both mono and disyllabic. The limited exposure with lack of variation can be a play a role in explaining the meager responses.

7.2 Inferential Statistics

A Chi-Square test is illustrated below for the percent correct responses. This test observes results, the $(\frac{Observed}{Expected})$ ratio (in parentheses), and the chi-square statistic for each cell (in square brackets), while it compares the results between the two groups, A and B, and informs if there is a statistically significant relationship between the groups. Since the sum of each cell's chi-square statistic gives the total chi-square statistic, each cell's contribution is calculated using the formula

χ^2=($\frac{Observed}{Expected}$)^2. The contingency table below illustrates the results of the test. The assumptions for this test, which are met, are that the data is a random sample, there is independence between each observation recorded in the contingency table, and that the expected frequency for each category is at least 5.

Table 15: Chi-Square Test for Overall Responses

	Responses		
Group	Correct Responses	Incorrect Responses	Total
Group A	393 (1.4) [49.6]	146 (0.6) [52.05]	539
Group B	159 (0.6) [49.6]	380 (1.4) [52.05]	539
Total	552	526	1078

The chi-square statistic is 203.2945. The p-value is < 0.00001. Significant at p < .05.

The results of this Chi-Square test indicate a statistically significant relationship between groups and responses (χ^2 = (1, N=14) = 203.29, p < .00001). Therefore, saying that the number in correct responses does not depend on the group and that there is no correlation between the two can be rejected. To answer the first research question, this Chi-Square test shows that the more data a participant is exposed to, the higher the likelihood of producing a correct response; Group A is more likely to receive a higher number of correct scores than Group B.

The second research question asks about the degree to which the rules are acquired. For all tokens that do not fall under the category of sesquisyllables, words with monophthongs (excluding [i], including [oʊ], and including *pear* and *care* which fall under the diphthong [eɪ]), a Chi-Square test is provided below that observes the relationship between groups and non-sesquisyllable tokens.

Table 16: Chi-Square Test for Groups and Non-Sesquisyllable Tokens

	Responses		
Group	Correct Responses	Incorrect Responses	Total
Group A	216 (1.3) [12.4]	120 (0.7) [12.75]	336
Group B	124 (0.7) [12.4]	212 (1.3) [12.75]	336
Total	340	332	672

The chi-square statistic is 50.3881. The p-value is < 0.00001. Significant at p < .05.

The results of this Chi-Square test indicate a statistically significant relationship between groups and responses for non-sesquisyllable tokens (χ^2 = (1, N=14) = 50.39, p < .00001). The number of correct responses has a relationship to a participant's group. Based off this test, it is evident that while both groups can learn the epenthesis rule for non-sesquisyllable words, Group A will learn it better; therefore, having a higher likelihood of obtaining more correct responses than incorrect responses than Group B. It is also interesting to observe whether one monophthong is easier to acquire than the others. For this reason, a 2x8 contingency table is displayed below in Table 17.

Table 17: Chi-Square Test for Monophthongs and Responses

	Monophthong								
	[ɪ]	[ɛ]	[æ]	[ə]	[ʌ]	[ʊ]	[ɔ/a]	[oʊ]	Total
Correct	42 (0.7)	35 (1.2)	32 (1.1)	21 (0.4)	37 (1.3)	33 (1.1)	56 (1.3)	81 (1.2)	337
Incorrect	70 (1.3)	21 (0.8)	24 (0.9)	77 (1.6)	19 (0.7)	23 (0.9)	28 (0.7)	45 (0.7)	307
Total	112	56	56	98	56	56	84	126	644

The chi-square statistic is 69.58682505469154. The p-value is 1.791e-12. Significant at p < .05.

From the contingency table above, it is evident that there is a statistically significant relationship between responses and monophthongs (χ^2 = (7, N=14) = 69.59, p = 1.791e-12). With the p-value extremely close to zero, the chance of rejecting a correct H_0 is small; therefore, it is more probable to support the hypothesis that there is at least one monophthong that is either easier or harder to acquire than the rest. By analyzing the *Observed* and *Expected* columns below each monophthong, the vowel with the largest difference is the schwa, making it the potentially harder vowel to acquire. Reasoning as to why this monophthong is different from the rest could be the length of the word and location of the vowel in that word. Schwa appears as the first syllable or the last syllable in the words from the stimuli list (refer to Table 5). The data collected here is for all participants. Participants in Group B did not have any exposure where the first syllable is a vowel and therefore, almost all the answers for said vowel were incorrect. As for when the schwa appears as the last syllable, the words are mostly multisyllabic, which means that if a participant does not complete their intuition of the word within the seven seconds given, the answer is not considered correct for that monophthong.

Furthermore, a Chi-Square test was run for sesquisyllables, looking for a relationship between groups and correct and incorrect responses. The results are displayed in Table 18 below.

Table 18: Chi-Square Test for Sesquisyllables Responses Between Groups

	Responses		
Group	Correct Responses	Incorrect Responses	Total
Group A	103 (1.8) [34.91]	44 (0.5) [22.75]	147
Group B	13 (0.2) [34.91]	134 (1.5) [22.75]	147
Total	116	178	294

The chi-square statistic is 115.3332. The p-value is < 0.00001. Significant at p < .05.

The contingency table above observes the relationship between Group A and B and their correct and incorrect responses. This table illustrates a statistically significant relationship ($\chi^2 = (1, N=14) = 115.33, p < .00001$). Therefore, from both the descriptive tables and contingency table, it is possible to state that Group A has a higher chance of obtaining correct responses for words that fall under the category of sesquisyllables than Group B.

There is also the question of whether one of the rules is more difficult to acquire, the one for non-sesquisyllables or the one for sesquisyllables. To answer this question, a contingency table is presented below.

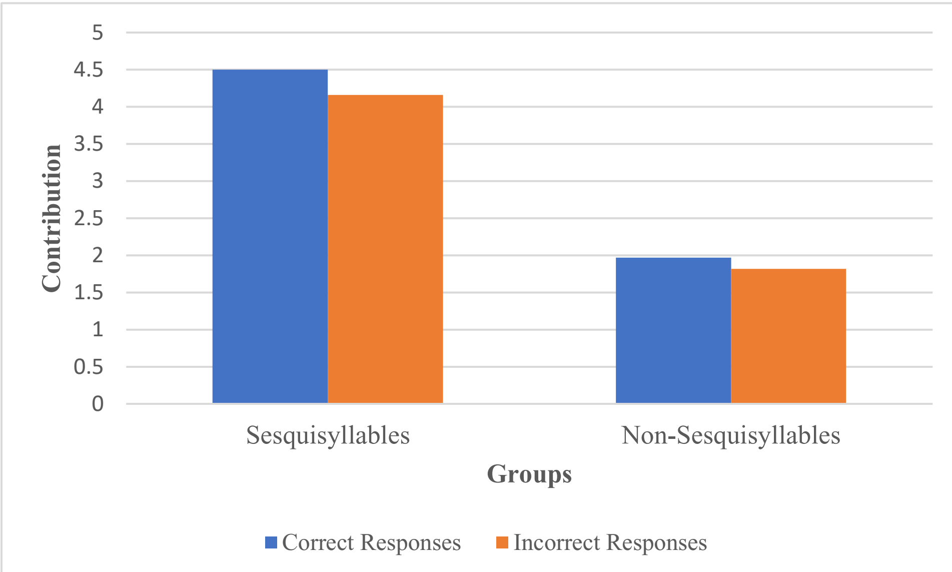
Table 19: Responses for Sesquisyllables and Non-Sesquisyllables

	Responses		
Group	Correct Responses	Incorrect Responses	Total
Sesquisyllables	116 (0.8) [4.5]	178 (1.2) [4.16]	294
Non-Sesquisyllables	348 (1.1) [1.97]	324 (0.9) [1.82]	672
Total	464	502	966

The chi-square statistic is 12.4564. The p-value is .000417. Significant at $p < .05$.

From Table 19, it is noticeable that there is a statistically significant relationship between the variables (χ^2 = (1, N=14) = 12.46, p = .000417). This significance demonstrates that one group's data is harder to acquire than the other because the null hypothesis, which states that there is no difference between the groups, gets rejected. By testing sesquisyllables against data with monophthongs that follow the more basic epenthesis rule, results are obtained as to provide an answer to the difficulty in acquiring one over the other. To illustrate what group contributes the most to the chi-square statistic, the calculation for each cell's contribution has been recorded and displayed in the table between squared brackets and graphed in Figure 5 below. Table 19 illustrates the existence to an interaction between groups and their responses, providing an answer to this question that there are more proportionally incorrect responses for sesquisyllables.

Figure 5: Bar Plot for Cell Contribution to Chi-Square Statistic



Sesquisyllables contributed more to the Chi-Square statistic (∑=8.66) than non-sesquisyllable words ((∑=3.97), meaning it produces the statistical significance seen in Table 19. Figure 5 illustrates these results in a bar graph. In the statistical output, the observed count for sesquisyllables' incorrect responses is greater than the expected count, while the observed count for incorrect responses for non-sesquisyllable words is less than the expected count. This suggests that sesquisyllables are more difficult to acquire than non-sesquisyllable words, further supporting the information presented in Table 19.

8.0 Discussion

The more exposure to data that a participant received, the higher their scores are for accuracy as well as their overall percent correct responses. Participants mainly recognized sesquisyllables as disyllabic for true diphthongs and when there is no exposure to data like this, participants showed small correct response numbers. Ultimately, the acquisition of sesquisyllables demonstrated to be more difficult than that of the basic epenthesis seen with monophthongs. This study is important as it assists in learning about the English language, specifically how individuals represent and realize syllables and diphthongs based off their intuition. Illustrated in this study is that diphthongs are not the split between vowel and glide that is represented in their label, and an individual's interpretation of the diphthong can change with the change in consonant or lack of consonant that follows. Proctor and Walker's (2012) work support this as they display that a diphthong followed by a liquid can add an additional syllable to a word because the diphthong is realized as a vowel-glide combination, followed by another glide. Overall, the hypotheses in section 4.0 were proved correct and are supported by statistical means.

A limitation to this study is the online component. The study moved from in-person to online and while participants were informed that a quiet environment is important to focus, I could not ensure that. Therefore, background noise, or other forms of potential distraction could have affected the results. Another limitation is the methodology, specifically the testing stimuli. No methodology is flawless; however, having a better balance between the vowels would have been beneficial. Schwa + [l] sequences were always tested for in multisyllabic words and appeared word-finally. This most likely influenced the results for the monophthong most difficult to acquire. If the participant did not get through the entirety of their attempt of the token in Sergian for the testing, then they would not have had an opportunity to receive a score for the schwa + [l] sequence. As for the calculation of the accuracy scores, the method used to calculate the scores is not as ideal as it could have been and could in fact result in errors because of its lengthy process. If future work requires a larger sample size, the analysis for accuracy scores would need to be changed

To expand on this work, an intriguing angle would be to present one group with appropriate sequences, while a second group is presented with one or two correct forms but mainly words with sequences that do not respect the rules of the base-language and observing whether the participants will attempt to alter the sequence to respect the base-language's rules. Both groups would be receiving the same amount of exposure but by doing this, we can observe how individuals treat forms that are uncommon in their first language when exposed to them. It would also be interesting to observe how early on the manipulation gets done. When discussing pre-existing languages, there are rule that take place to get from the underlying form to the surface form. Therefore, the question that arises is how early or late does the rule of manipulation occur? It seems to apply early on, but it would still be informative to know when this occurs.

The bigger picture of this study is observing what Sergian informs us about the English phonology. This study illustrates that sesquisyllables are difficult to acquire in comparison to other words. This due to their ambiguity between a clear monosyllable and a clear disyllable (Lavoie & Cohn, 1999). Although the pattern shows that this occurs with the tense vowel [i] + [l] and diphthongs with a liquid in coda, there are exemptions, more specifically with the voiced alveolar approximant [ɹ]. Since there is more lingual posture stability with [Vɹ] sequences (Proctor & Walker, 2012), some words, which we would believe to be sesquisyllable because they fit the pattern, are not. They can only be realized as monosyllabic; therefore, not falling under the category of sesquisyllables, regardless if another identical [Vɹ] sequence does, as seen in Table 2 with 'lair' and 'fair'. Ultimately, the behaviour of the tense vowel [i] and diphthongs followed by a liquid in coda, create more difficulty in the acquisition of sesquisyllables.

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