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The Acquisition of English Consonant Clusters by Kurdish EFL Learners

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Abstract

Consonant clusters in Northern Kurdish (NK), also known as Kurmanji, particularly in the Kurmanji dialect spoken in the Kurdistan region of Iraq, are generally described to contain maximally two consonants in syllable-initial (onset) and syllable-final (coda) positions. However, most of the readily accessible literature on this Kurdish dialect phonology provides discrepant descriptions regarding the cluster status of a number of onset and coda combinations, that is, whether the sequences constitute actual clusters or if they are produced with an epenthetic vowel (e.g., Kahn, 1976; Hasan, 2009; Shokri, 2002).

The organisation of consonant elements in a cluster usually tends to be governed by the Sonority Sequencing Principle (SSP, Clements, 1990; Selkirk, 1984). According to the SSP, the sonority of consonants decreases the farther they are from the vowel or syllable nucleus. There are, however, cases of consonant sequences that violate the SSP, despite their universal markedness (Carlise, 2001). Many such examples that violate the SSP are reported for NK onset and coda clusters in Kahn (1976) and Hasan (2009). In contrast, Shokri's (2002) extensive analysis of NK consonant clusters involves only one combination that does not adhere to the SSP, namely the fricative /s/ + stop for onset clusters. This discrepancy in the literature is partly due to differences in the theoretical, impressionistic, and orthography-based analyses of NK clusters given in these works. In fact, different sources also disagree regarding the status of clusters that adhere to the SSP. To date, no experimental research has been conducted to assess the actual status of onset and coda combinations in the Kurmanji dialect spoken in the Kurdistan region of Iraq. The first goal of this thesis is to settle the cluster status of such consonant sequences in NK by providing the first acoustic and impressionistic analysis of these sequences, along with examining how they are perceived by native NK speakers (L1 Kurdish study). To achieve this, a perception experiment was conducted with 15 native NK speakers using a forced-choice goodness task, complemented by two production tasks: a carrier sentence reading task and a picture-naming task.

The perception and production task results were closely aligned, demonstrating that only three sequences – specifically, fricative + stop in both onset and coda positions, and nasal + stop in the coda position – consistently functioned as true clusters. These sequences did not trigger vowel epenthesis in any of the tokens produced by participants, nor were they perceptually perceived as containing vowel epenthesis. The results regarding the remaining sequences tested did not confirm whether these combinations can be actual clusters in NK, suggesting that previous descriptions of NK consonant clusters given in (Kahn, 1976; Hasan, 2009; Shokri, 2002) may need to be revisited. Furthermore, the study found no important role of the SSP or the nature of sequence combination – whether in terms of the frequency of combination use or the homogeneity of the place of articulation among its constituents – in the perception and production of onset sequences, likely due to their mischaracterisation as true clusters in earlier studies, particularly Hasan (2009). However, the influence of the SSP and sequence combinations was more obvious with coda combinations, suggesting that the formation of coda clusters in NK abides by universal constraints (Carlise, 2001).

The findings from the Kurdish study were influential in elucidating the phonological structure of NK consonant sequences. These insights also laid the groundwork for investigating the influence of NK consonant combinations as an L1, along with other factors such as markedness based on sonority (Clements, 1990; Selkirk, 1984) and syllable margin length (Eckman, 1977, 1991), on the acquisition of foreign clusters, particularly in English, which constituted the second main objective of this thesis (L2 English study). To this end, the study investigated the production of 2-member and 3-member English onset clusters in 32 Kurdish learners of English as a Foreign Language (EFL) through two production tasks: a carrier sentence reading task and a verbal fluency task. A control group of five native British English speakers was also included to provide baseline L1 English data for comparison. The L2 study also highlighted the impact of L2 proficiency on Kurdish learners' acquisition of English consonant clusters, a topic that has been underexplored in previous research involving Kurdish EFL learners. Proficiency was assessed using an Elicited Imitation task (Wu et al., 2022) and a vocabulary size test (Meara & Miralpeix, 2016).

The results revealed that Kurdish EFL learners did not generally struggle with producing 2-member English consonant clusters, indicating minimal native language interference. However, markedness based on sonority influenced production, though inconsistently. Notably, the SSP was ineffective, as participants consistently produced fricative /s/ + stop onset clusters in a native-like manner, possibly due to positive transfer from their native language. Markedness effects related to syllable margin length were more impactful, with 3-member clusters proving more challenging than 2-member clusters. Additionally, participants primarily used vowel epenthesis to simplify clusters, and these epenthetic vowels showed distinct acoustic properties, reflecting L1 transfer. Finally, vocabulary knowledge was found to be a more relevant, albeit moderate, factor for L2 cluster production than oral proficiency.

***Keywords**: Kurdish, consonant clusters, production, perception, L2 English production, L2 proficiency, sonority principle, vowel epenthesis.*

Resumen

Los grupos consonánticos de la lengua kurda, en su variedad del norte (NK), también conocida como Kurmanji, hablada en la región del Kurdistán de Irak, aparecen generalmente descritos como grupos de un máximo de dos consonantes en las posiciones inicial de sílaba (ataque) y final de sílaba (coda). Sin embargo, la literatura existente sobre la fonología de este dialecto kurdo presenta descripciones discrepantes con respecto al estado de una serie de combinaciones de ataque y coda; es decir, no hay consenso sobre si las secuencias constituyen grupos consonánticos reales o si se producen con una vocal epentética entre las consonantes (por ejemplo, Kahn, 1976; Hasan, 2009; Shokri, 2002).

La organización de los elementos consonánticos en un grupo suele estar regida por el Principio de Secuenciación de Sonoridad (*Sonority Sequencing Principle*, SSP, Clements, 1990; Selkirk, 1984). Según el SSP, la sonoridad de las consonantes disminuye cuanto más se alejan del núcleo vocálico o silábico. Sin embargo, hay casos de secuencias consonánticas que violan el SSP, a pesar de su carácter universal (Carlise, 2001). Muchos de estos ejemplos que violan el SSP se incluyen en las descripciones de ataques y codas de NK en los trabajos de Kahn (1976) y Hasan (2009). Por otro lado, el extenso análisis de Shokri (2002) de los grupos de consonantes de NK incluye sólo una combinación que no se adhiere al SSP, a saber, la fricativa /s/ + oclusiva para los grupos de ataque. Esta discrepancia en la literatura se debe en parte a diferencias en los análisis teóricos, impresionistas y ortográficos de las secuencias de NK que se dan en estos trabajos. De hecho, distintas fuentes también discrepan sobre el estado de las secuencias que se adhieren al SSP. Hasta la fecha, no se ha realizado ninguna investigación experimental para evaluar el estado real de las combinaciones de ataque y coda en el dialecto Kurmanji hablado en la región del Kurdistán de Irak. El primer objetivo de esta tesis es determinar el estado de tales secuencias de consonantes en NK proporcionando el primer análisis acústico e impresionista de estas secuencias, además de examinar cómo las perciben los hablantes nativos de NK (estudio sobre el kurdo como primera lengua o L1). Para lograr esto, se llevó a cabo un experimento de percepción con 15 hablantes nativos de NK utilizando una tarea de valoración de la percepción (*forced-choice goodness task*), complementada con dos tareas de producción: una tarea de lectura de oraciones y una tarea de denominación de imágenes.

Los resultados de las tareas de percepción y producción estuvieron estrechamente alineados, lo que demuestra que solo tres secuencias (específicamente, fricativa + oclusiva en las posiciones de ataque y coda, y nasal + oclusiva en la posición de coda) funcionaron consistentemente como verdaderos grupos consonánticos. Estas secuencias no produjeron la aparición de vocal epentética en ninguna de las palabras producidas por los participantes, ni se percibió que contuvieran epéntesis. Los resultados con respecto a las secuencias restantes también analizadas no indican que estas combinaciones puedan ser grupos reales en NK, lo que sugiere la necesidad de revisar las descripciones previas de los grupos de consonantes NK presentes en la literatura existente (Kahn, 1976; Hasan, 2009; Shokri, 2002). Además, el estudio no encontró evidencia de que el SSP o la naturaleza de la combinación de secuencias (ya sea en términos de la frecuencia del uso de la combinación o de la homogeneidad del lugar de articulación entre sus constituyentes) jugaran un papel relevante en la percepción y producción de las secuencias de inicio, probablemente debido a su caracterización errónea como verdaderos grupos en estudios anteriores, particularmente en Hasan (2009). Sin embargo, la influencia del SSP y las combinaciones de secuencias fue más obvia con las secuencias de coda, lo que sugiere que la formación de grupos de coda en NK se adecua más a criterios universales (Carlise, 2001).

Los hallazgos de este primer estudio sobre el kurdo como L1 fueron determinantes para definir la estructura fonológica de las secuencias de consonantes en NK. Estos conocimientos también sentaron las bases para investigar la influencia de las combinaciones de consonantes del NK, junto con otros factores como la marcación basada en la sonoridad (Clements, 1990; Selkirk, 1984) y la longitud del margen de la sílaba (Eckman, 1977, 1991) en la adquisición de grupos consonánticos en segunda lengua o lengua extranjera (L2), particularmente en inglés, que constituyó el segundo objetivo principal de esta tesis (estudio de inglés L2). Con este fin, el estudio investigó la producción de grupos de ataque del inglés de dos y tres miembros por 32 aprendices kurdos de inglés como lengua extranjera (EFL) a través de dos tareas: una tarea de lectura de oraciones y una tarea de fluidez verbal. También se incluyó un grupo de control de cinco hablantes nativos de inglés británico para proporcionar datos de inglés L1 como base para su comparación con la producción en L2. El estudio de L2 también destacó el impacto del dominio de la L2 en la adquisición de grupos de consonantes en inglés por parte de los estudiantes kurdos, un tema que ha sido poco explorado en investigaciones anteriores sobre aprendices kurdos de inglés como L2. El dominio se evaluó mediante una tarea de imitación provocada (Wu et al., 2022) y una prueba de vocabulario (Meara y Miralpeix, 2016).

Los resultados revelaron que los aprendices kurdos de inglés como lengua extranjera generalmente no tenían dificultades para producir grupos de consonantes de dos miembros en inglés, lo que indica una interferencia mínima del idioma nativo. Sin embargo, el grado de marcación basado en la sonoridad influyó en la producción, aunque de manera inconsistente. En particular, el SSP no tuvo un efecto claro, ya que los participantes produjeron secuencias de /s/ + oclusiva en posición de ataque de forma nativa, posiblemente debido a una transferencia positiva desde su lengua materna. Los efectos de la marcación relacionados con la longitud del margen de las sílabas fueron más impactantes, dado que los grupos de tres miembros resultaron más dificiles que los grupos de dos consonantes. Además, los participantes utilizaron principalmente epéntesis vocálica para simplificar grupos, y estas vocales epentéticas mostraron propiedades acústicas concretas, lo que refleja la transferencia L1. Finalmente, se encontró que el conocimiento del vocabulario es un factor más influyente, aunque moderado, que la competencia oral en la producción de grupos de L2.

Palabras clave*: Kurdo, grupos consonánticos, producción, percepción, producción en inglés como L2, nivel de L2, principio de sonoridad, vocal epentética*

Resum

Els grups consonàntics de la llengua kurda, en la seva varietat del nord (NK), també coneguda com a Kurmanji, parlada a la regió del Kurdistan d'Iraq, apareixen generalment descrits com a grups d'un màxim de dos consonants en les posicions inicial de síl·laba (atac) i final de síl·laba (coda). Tanmateix, la literatura existent sobre la fonologia d'aquest dialecte kurd presenta descripcions discrepants pel que fa a l'estat d'una sèrie de combinacions d'atac i coda; és a dir, no hi ha consens sobre si les seqüències constitueixen grups consonàntics reals o si es produeixen amb una vocal epentètica entre les consonants (per exemple, Kahn, 1976; Hasan, 2009; Shokri, 2002).

L'organització dels elements consonàntics en un grup sol estar regida pel Principi de Seqüenciació de Sonoritat (*Sonority Sequencing Principle*, SSP, Clements, 1990; Selkirk, 1984). Segons l'SSP, la sonoritat de les consonants disminueix com més s'allunyen del nucli vocàlic o sil·làbic. No obstant això, hi ha casos de seqüències consonàntiques que violen l'SSP malgrat el seu caràcter universal (Carlise, 2001). Molts d'aquests exemples que violen l'SSP s'inclouen en les descripcions d'atacs i codes de NK en els treballs de Kahn (1976) i Hasan (2009). D'altra banda, l'extensa anàlisi de Shokri (2002) dels grups de consonants de NK inclou només una combinació que no s'adhereix a l'SSP, a saber, la fricativa /s/ + oclusiva per als grups d'atac. Aquesta discrepància en la literatura es deu en part a diferències en les anàlisis teòriques, impressionistes i ortogràfiques de les seqüències de NK que es donen en aquests treballs. De fet, diferents fonts també discrepen sobre l'estat de les seqüències que s'adhereixen l'SSP. Fins ara, no s'ha realitzat cap investigació experimental per avaluar l'estat real de les combinacions d'atac i coda en el dialecte Kurmanji parlat a la regió del Kurdistan de l'Iraq. El primer objectiu d'aquesta tesi és determinar l'estat d'aquestes seqüències de consonants en NK proporcionant la primera anàlisi acústica i impressionista d'aquestes seqüències, a més d'examinar com les perceben els parlants nadius de NK (estudi sobre el kurd com a primera llengua o L1). Per aconseguir això, es va dur a terme un experiment de percepció amb 15 parlants nadius de NK utilitzant una tasca de valoració de la percepció (*forced-choice goodness task*), complementada amb dues tasques de producció: una tasca de lectura d'oracions i una tasca de denominació d'imatges.

Els resultats de les tasques de percepció i producció van estar estretament alineats, cosa que demostra que només tres seqüències (específicament, fricativa + oclusiva a les posicions d'atac i coda, i nasal + oclusiva a la posició de coda) van funcionar consistentment com a veritables grups consonàntics . Aquestes seqüències no van produir l'aparició de vocal epentètica en cap de les paraules produïdes pels participants, ni es va percebre que continguessin epèntesi. Els resultats respecte a les seqüències restants també analitzades no indiquen que aquestes combinacions puguin ser grups reals a NK, cosa que suggereix la necessitat de revisar les descripcions prèvies dels grups de consonants NK presents a la literatura existent (Kahn, 1976; Hasan, 2009; Shokri, 2002). A més, l'estudi no va trobar evidència que l'SSP o la naturalesa de la combinació de seqüències (ja sigui en termes de la freqüència de l'ús de la combinació o de l'homogeneïtat del lloc d'articulació entre els seus constituents) juguessin un paper rellevant a la percepció i producció de les seqüències d'inici, probablement a causa de la seva caracterització errònia com a veritables grups en estudis anteriors, particularment a Hassan (2009). Tot i això, la influència de l'SSP i les combinacions de seqüències va ser més òbvia amb les seqüències de coda, cosa que suggereix que la formació de grups de coda a NK s'adequa més a criteris universals (Carlise, 2001).

Els resultats d'aquest primer estudi sobre el kurd com a L1 van ser determinants per definir l'estructura fonològica de les seqüències de consonants a NK. Aquests coneixements també van establir les bases per investigar la influència de les combinacions de consonants del NK, juntament amb altres factors com la marcació basada en la sonoritat (Clements, 1990; Selkirk, 1984) i la longitud del marge de la síl·laba (Eckman, 1977 , 1991) en l'adquisició de grups consonàntics en segona llengua o llengua estrangera (L2), particularment en anglès, que va constituir el segon objectiu principal d'aquesta tesi (estudi d'anglès L2). A aquest efecte, l'estudi va investigar la producció de grups d'atac de l'anglès de dos i tres membres per 32 aprenents kurds d'anglès com a llengua estrangera (EFL) a través de dues tasques: una tasca de lectura d'oracions i una tasca de fluïdesa verbal. També es va incloure un grup de control de cinc parlants nadius d'anglès britànic per proporcionar dades d'anglès L1 com a base per comparar-les amb la producció en L2. L'estudi de L2 també va destacar l'impacte del domini de la L2 en l'adquisició de grups de consonants en anglès per part dels estudiants kurds, un tema poc explorat en investigacions anteriors sobre aprenents kurds d'anglès com L2. El domini es va avaluar mitjançant una tasca d'imitació provocada (Wu et al., 2022) i una prova de vocabulari (Meara i Miralpeix, 2016).

Els resultats van revelar que els aprenents kurds d'anglès com a llengua estrangera generalment no tenien dificultats per produir grups de consonants de dos membres en anglès, cosa que indica una interferència mínima de l'idioma nadiu. Tot i això, el grau de marcatge basat en la sonoritat va influir en la producció, encara que de manera inconsistent. En particular, l'SSP no va tenir un efecte clar, ja que els participants van produir seqüències de /s/ + oclusiva en posició d'atac de forma nativa, possiblement a causa d'una transferència positiva des de la llengua materna. Els efectes del marcatge relacionats amb la longitud del marge de les síl·labes van ser més impactants, atès que els grups de tres membres van resultar més difícils que els grups de dos consonants. A més, els participants van utilitzar principalment epèntesi vocàlica per simplificar grups, i aquestes vocals epentètiques van mostrar propietats acústiques concretes, cosa que reflecteix la transferència L1. Finalment, es va trobar que el coneixement del vocabulari és un factor més influent, encara que moderat, que la competència oral en la producció de grups de L2.

***Paraules clau**: Kurd, grups consonàntics, producció, percepció, producció en anglès com L2, nivell de L2, principi de sonoritat, vocal epentètica.*

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Introduction

The study of consonant clusters has long been a focal point in phonological research, particularly in language acquisition and second language learning. Understanding how different languages handle complex consonant sequences can offer important insights into universal phonological principles and language-specific patterns. This thesis explores these issues through a dual investigation: the first part examines the cluster status of various consonant sequences in Northern Kurdish (NK), a dialect spoken in the Duhok Governorate of the Kurdistan region of Iraq; the second part researches the specific challenges Kurdish learners of English as a Foreign Language (EFL) face when producing English consonant clusters.

The NK study (L1 Kurdish study) represents the first comprehensive perceptual and acoustic analysis of a number of consonant sequences in this dialect. It seeks to clarify whether these combinations are perceived and produced as clusters or if they tend to be broken up by vowel epenthesis. An examination of the syllable structure in NK has revealed discrepancies in the existing literature (e.g., Kahn, 1976; Hasan, 2009; Shokri, 2002) concerning the cluster status of certain onset and coda consonant sequences. Specifically, there is ambiguity regarding whether these sequences constitute actual clusters or if they are broken by a vocalic element. Therefore, one of the main goals of this thesis is to settle the cluster status of these sequences in NK by providing the first acoustic and impressionistic analysis of these sequences, along with examining how they are perceived by native Kurdish speakers. The focus on both onset and coda combinations will allow for a thorough understanding of how these sequences behave in different syllable positions. To achieve the main goal of this study, a perception experiment was conducted with 15 native NK speakers using a forced-choice goodness task, along with two production tasks: a carrier sentence reading task and a picture-naming task. The findings from this study are not only critical for understanding the phonological structure of NK consonant sequences but also serve as a foundation for examining the influence of NK phonology on second/foreign language learning.

In the second part of the thesis, the focus shifts to the challenges Kurdish EFL learners face when producing English onset consonant clusters (L2 English study). This research builds on the findings from the Kurdish study (L1 negative transfer vs L1 positive transfer) and considers universal phonological principles – i.e., the Sonority Sequencing Principle (SSP; Clements, 1990), the Minimal Sonority Distance Principle (MSD; Broselow & Finer, 1991), and markedness constraints (Eckman, 1977, 1991) – to explore how these factors influence Kurdish learners' production of English consonant clusters. To this aim, 32 Kurdish EFL learners enrolled as second-year English-degree students at Zakho University, and a control group consisting of 5 native British English speakers – whose data served as baseline L1 English data for comparison purposes – participated in a production experiment consisting of two tasks: a verbal fluency task and a carrier sentence reading task.

The L2 study has also highlighted the influence of L2 proficiency on the acquisition of English consonant clusters by Kurdish learners, an area that has received little attention in previous research on Kurdish EFL learners (Omer & Hamad, 2016; Keshavarz, 2017). Based on the predictions of the Ontogeny Phylogeny Model (OPM, Major, 2001), as learners' proficiency in their L2 increases, the tendency for transfer from their first language diminishes. As a result, it is anticipated that higher levels of L2 proficiency will correspond to more accurate and native-like production of English consonant clusters. Proficiency in this study was measured using two tasks: an Elicited Imitation task devised by Wu et al. (2022) and a vocabulary size test by Meara & Miralpeix (2016).

The current thesis is organised into 5 chapters. **Chapter 1** offers an overview of the literature relevant to this thesis, highlighting previous studies that have explored the effects of universal constraints and L1 transfer on the acquisition of foreign consonant clusters. Additionally, it outlines the key characteristics of both the L1 and L2 languages in this study, focusing on differences in phonemic and syllable structure inventories. The chapter concludes with a discussion of the various types of vowel insertion. **Chapter 2** details the goals of this thesis, presenting the research questions and formulating hypotheses based on the literature reviewed in the previous chapter. **Chapter 3** (L1 Kurdish Study) provides a comprehensive description of the methodology used to investigate the perception and production of NK consonant sequences. This is followed by the presentation, analysis, and discussion of the results obtained. **Chapter 4** (L2 English Study) explains the methodology employed to examine the production of English onset clusters by Kurdish EFL learners. It then presents, analyses, and discusses the findings of the study. Finally, **Chapter 5** provides a comprehensive discussion of the overall findings, addresses the limitations of the thesis, and proposes directions for future research. It concludes by summarising the key conclusions drawn from the study.

Chapter One

1. Literature Review

This chapter will review aspects relevant to the research topics discussed in this Ph.D. thesis. First, the basic terminologies and general principles that are at work in the learning of a given language will be discussed. Next, previous studies that have shown the effect of L1 transfer as well as markedness – in terms of sonority and syllable margin length – will be discussed. Moreover, this chapter will present the relevant characteristics of the L1 and the L2[1] in this study, i.e., Kurdish and English, paying special attention to differences concerning phonemic and syllable structure inventories. Following this, a section will be dedicated to the notion of vowel epenthesis and its major types. A discussion regarding the distinction between epenthetic and intrusive vowels, as well as epenthetic and true lexical vowels will be provided, followed by a brief discussion of the issue of what constitutes a potential epenthetic vowel in NK. Lastly, the chapter will end with a few studies that have discussed the acquisition of English clusters by Kurdish learners.

1.1. Basic Terminology, Interlanguage and Cross-Linguistic Influence

Two key terms in the field of second language acquisition are native language and target language. The former, also known as a mother tongue, first language, or L1, is defined by Crystal (2008) as the language naturally acquired during childhood. Crystal also asserts that native speakers have the most reliable intuitions about their native language, making their judgments about its usage reliable. In contrast, a speaker's target language (TL), according to

[1] In the Kurdistan region of Iraq, English is mainly taught as a Foreign Language (EFL) alongside Arabic in public schools. The participants in this thesis are EFL learners. While the terms EFL and Second Language (L2) will be used interchangeably for reference to their English proficiency, it is important to note that this does not imply English is their second language in the broader sense.

Crystal, is the language taught to foreign learners or the language into which one is translating or interpreting.

Larry Selinker coined the term ‘interlanguage’ (IL) in 1972 to describe the linguistic system that L2 learners develop, which lies between their native language and the target language. Selinker proposed that when L2 learners try to communicate meaningfully, they create a separate language system that is neither their native language nor the target language (Wang & Fan, 2020). Before Selinker introduced IL, similar ideas were independently described by scholars such as Nemser (1971) and Corder (1971) using different terms. Nemser referred to this phenomenon as the ‘approximation system’ highlighting the transitional linguistic state that is neither fully the learner’s native language (L1) nor the completely developed target language (L2). Meanwhile, in 1972, Corder called it the ‘idiosyncratic dialect’ emphasising the personal and unique aspects of each learner’s language. Corder suggests that this idiosyncratic dialect includes elements from both the native language and the target language, as well as unique linguistic innovations created by the learner. Today, the terms idiosyncratic dialect, approximation system, and interlanguage all refer to the same concept. They deal with the evolving and transitional nature of a learner’s language development in acquiring a second or foreign language, focusing on the individual’s journey towards mastering the target language.

A fundamental concept closely related to IL is the idea of transfer or cross-linguistic influence (CLI), which, as described by (Odlin, 1989: 27) refers to “the influence resulting from similarities or differences between the target language and any other language that has already been previously (and perhaps imperfectly) acquired.” Transfer is subdivided into positive and negative. Positive transfer is in place when the first language is similar to the target language to the extent that learning is facilitated by prior experience. A phonological example would be that an L1 (e.g., Kurdish), which allows aspiration for word-initial voiceless stops as an L2 (e.g., English), would facilitate the production of L2 English /pʰ/ in 'pool', /tʰ/ in 'tool', and /kʰ/ in 'car' by Kurdish learners. In contrast, negative transfer, also known as interference, is obvious when the first language hinders learning the target language, particularly when there are notable differences between the two languages. For example, the aspirated form of an L1 voiceless stop (e.g., English) may be transferred by English learners of an L2 (e.g., Spanish whose voiceless stops are realised without aspiration), resulting in non-target production of the L2 Spanish stops.

The concept of transfer has long been associated with the Contrastive Analysis Hypothesis (CAH), which aimed to explain errors in L2 learners based on differences between their L1 and L2, predicting areas of difficulty accordingly (Lado, 1957, 1964). Specifically, the CAH claimed that L2 phenomena similar to the L1 are easier to acquire while differing phenomena pose greater challenges. However, despite its initial appeal, the CAH failed to fully explain L2 learning processes. It was unable to account for many errors that are not simply a result of L1-L2 differences, and it could not predict what types of errors systematically occurred among L2 learners (cf. Eckman, 2008; Major, 2008). Recognising these limitations, researchers began to acknowledge that L2 learners' interlanguage is influenced not only by transfer but also by general language acquisition principles, such as language universals. These additional factors will now be discussed below.

1.1.1. Language Universals and Markedness

Language universals, that is, linguistic forms that appear consistently across world languages, are considered important factors governing the formation of an IL system, in addition to L1 transfer. Carlisle (1994) highlights that much of the research in IL phonology has focused on the influence of phonological universals. These universals are phonological principles that consistently appear across various world languages. For example, all languages share the property of stops, but not all have stops in the final position.

Two categories of universals have emerged from research language universals: absolute universals and implicational universals (Greenberg, 1965; Carlisle, 1994). Absolute universals refer to linguistic properties that are present in all languages without exception. For example, the existence of CV syllables is considered an absolute phonological universal. Implicational universals, on the other hand, involve conditional relationships between two or more linguistic properties. For instance, the presence of voiced and voiceless obstruents (stops, fricatives, and affricates) in a language exemplifies an implicational universal. Some languages contain both voiced and voiceless obstruents, while others only have voiceless obstruents. However, no language consists exclusively of voiced obstruents. Therefore, the implicational relationship can be described as follows: if a language includes voiced obstruents, it will also contain voiceless obstruents, but the reverse is not true. This relationship suggests that voiced obstruents are linguistically more marked compared to the less marked voiceless obstruent. Markedness is defined thusly: "A phenomenon A in some language is more marked than B if the presence of A implies the presence of B, but the presence of B does not imply the presence of A" (Eckman, 1977: 320).

When introducing the Markedness Differential Hypothesis (MDH) in 1977, Eckman added markedness as an additional factor that could help explain why some forms in L2 are more challenging for learners compared to others. The MDH claims that L2 learning difficulty can be explained based on both the structural differences between the L1 and the L2 (transfer) and typological markedness. Hence, those L2 structures that are different and more marked than L1 structures would be more difficult to acquire. However, L2 forms that differ from, but are not more marked, than the LI forms will not be difficult to learn. For example, Eckman points out that among world languages, a language (e.g., English) that has the obstruent voicing contrast in the word-final position implies the contrast also word-medially and word-initially. A language (e.g., German) that has the obstruent voicing contrast word-medially implies the contrast word-initially, but not word-finally. Therefore, the word-final voicing contrast is the most marked form, followed by the word-medial contrast, and finally by the word-initial contrast as the least marked form. The level of learning difficulty corresponds to the degree of markedness, with word-final contrasts being the hardest to learn, followed by word-medial contrasts, and then word-initial contrasts, in that order.

The concept of markedness was also extended to syllable structures. A typical syllable – following Fudge (1969) and Blevins (1995) – has three essential elements: an onset, a nucleus, and a coda (see Figure 1.1 in 1.2). The degree of markedness is based on the length of syllable margins (i.e., onset and coda). The CV syllable (e.g., 'go' /gəʊ/ and 'bee' /bi:/) is considered the most widely occurring syllable shape (Cairns & Feinstein, 1982; Carlisle, 2001; Clements, 1990; Greenberg, 1965; Tarone, 1972). Therefore, it is considered to be the simplest and is considered unmarked (Carlisle, 2001). The CVC syllable shape (e.g., 'cat' /kæt/ and 'dog' /dɒg/) is more marked than the CV syllable. As the syllable becomes more complex, it increases in markedness so that the CCV (e.g., 'snow' /snəʊ/ and 'spy' /spaɪ/) or CCCVC (e.g., 'street' /stri:t/, 'scream' /skri:m/ and 'split' /splɪt/) syllable shapes are even more marked (Carlisle, 2001; Greenberg, 1965). Research on IL phonology has confirmed that L2 leamers would modify more marked margins more frequently than less marked ones. Carlisle (2001), in his review of research on L2 acquisition, cites several studies (e.g., Weinberger, 1987; Anderson, 1987; Eckman, 1991; Carlisle, 1997, 1998; Abrahamsson, 1999; Hancin-Bhatt, 2000) that support the idea that L2 learners tend to struggle more with syllables containing more marked margins, i.e. longer onsets or codas. These structures were found to be acquired by learners at a later stage than syllables with shorter margins.

Eckman (1991) later developed the Interlanguage Structural Conformity Hypothesis (SCH) to further expand the parameters of the MDH, accounting for both L1/L2 and IL markedness relationships. This hypothesis maintains that language universals that are true for primary languages (established world languages) are also true for non-primary languages (the interlanguages of L2 learners). Eckman (1991) investigated the applicability of cross-linguistic universals to the phonological interlanguages of English second language learners by testing the hypothesis that if an L2 speaker's system includes a triple cluster ($C_1C_2C_3$), then both of the corresponding double clusters (C_1C_2 and C_2C_3) will also be present. In a study involving 11 adult participants who were learning American English as an L2, including four Japanese, four Korean, and three Chinese speakers, Eckman explored the presence of double or triple-onset consonant clusters in their interlanguage systems. None of these participants' native languages allowed for such clusters as found in English. Various tasks were administered, including reading word lists, naming drawings, reading passages, and engaging in conversations. To consider a cluster as part of the interlanguage system, an 80% accuracy criterion was set. The findings revealed that in 74% of the participants' productions when the triple cluster $C_1C_2C_3$ was present, both the corresponding double clusters C_1C_2 and C_2C_3 were also present. In 24% of the productions, when $C_1C_2C_3$ was present, either C_1C_2 or C_2C_3 was produced while the other was absent. Only five cases out of 200 opportunities contradicted the hypothesis, where $C_1C_2C_3$ was present but neither C_1C_2 nor C_2C_3 were produced. These results supported Eckman's SCH in that the interlanguages of these subjects followed universal principles as do primary languages.

1.1.2. Interaction of Universals/Markedness and Transfer

The first model to explicitly describe the development of the influence of L1, L2, and universals/markedness in the establishment of an L2 learner's IL phonology is the Ontogeny Phylogeny Model (OPM) by Major (2003). The OPM is, in fact, a revision of the Ontogeny Model (OM; Major, 1987) which posits that transfer effects are at their peak at the beginning of L2 learning, decreasing in prominence as universal affects first increase in influence and then decrease. Yet, the OM says nothing about the L2 component, which is included in the OPM. While transfer effects are still suggested to be more dominant in the beginning stages of acquisition in the OPM, Major suggests that those features that are unmarked in the L2 are more affected by transfer than those features that are marked. Similarly to the OM, universal effects increase in dominance as transfer effects decrease, and then also decrease. The basic pattern of the OPM for an idealised learner is as follows: at first, the L1=IL, and universals are inactive. As one progresses transfer from L1 will decrease, influence from universals will increase and then decrease and L2 will increase (Major, 2003).

The OPM introduces four corollaries concerning chronology, style, markedness, and similarity (Khalifa, 2017). In the initial stages of L2 learning, chronologically, the OPM suggests that learners heavily rely on phonological transfer from their L1, constituting 100% of their language acquisition process. But, as L2 development occurs, the influence of the L1 decreases while the impact of the L2 strengthens due to increased exposure. Simultaneously, the effect of language universals grows in the early stages of L2 acquisition as learners recognise the limitations of negative L1 transfer but struggle to produce L2 structures similar to native speakers. Over time, the influence of universals declines as learners approach native-like pronunciation. It is worth noting that Major does not assert that all learners will obtain native-like pronunciation, as some may become fossilised at intermediate stages of learning.

The style corollary suggests that in a more formal style of speaking such as reading a word list or a paragraph, learners have more accurate production of L2 structure because they are more conscious of form and carefully monitor their pronunciation. As style becomes less formal as in spontaneous conversation, learners become less attentive to form and more focused on meaning. As a result, target-like accuracy in the L2 tends to decrease with a corresponding increase in L1 transfer.

Of particular interest to this thesis are the markedness and similarity corollaries. In essence, both corollaries follow a similar pattern: a decline in the influence of L1, a subsequent rise and fall in the impact of universal principles, and a corresponding improvement in L2 learning. For marked phenomena, L2 increases slowly, L1 transfer decreases and then decreases slowly and universals increase rapidly and then decrease slowly. Thus, the role of universals is much greater than L1 transfer for marked phenomena than less marked ones. In OPM, the more marked a sound, the slower the learning rate (Khalifa, 2017). For similar phenomena, which are acquired less easily than dissimilar phenomena according to the OPM (see also Flege, 1992, 1995; Best, 1995; Kuhl, 2000) L2 increases slowly, L1 transfer decreases slowly and universals increase slowly and then decrease slowly. Thus, for similar phenomena, the role of L1 is much greater than universals. For dissimilar sounds, on the other hand, progress will be more rapid and universals will have a much greater influence on IL. Markedness and similarity can interact, in which case, the OPM predicts that more similar and more marked sounds will be acquired more slowly than less similar and less marked sounds. This is in line with the predictions of general L2 speech models examining the effect of cross-linguistic similarity that claim that similar phenomena will be less accurately acquired than dissimilar phenomena given that learners will have greater difficulty detecting differences between similar L1 and L2 features than between dissimilar L1 and L2 features (e.g., the

Speech Learning Model, Flege (1995), Flege & Bohn (2021); the Perceptual Assimilation Model, Best (1995), Best & Tyler (2007) or the Native Language Magnet model, Kuhl (2000).

Thus far, frequently cited L2 acquisition models relevant to this study have been presented, including the MDH, the SCH, and the OPM. All three models recognise the significance of markedness constraints and L1 transfer in IL phonology. Eckman's MDH is of particular relevance to this research because it specifically examines the hypothesis that marked structures in a second language are more challenging to learn compared to unmarked structures. Furthermore, the role of L1 transfer (negative or positive), as another component of IL, is also crucial in this study because L1 transfer and markedness jointly account for what constitutes a difficult L2 structure (Eckman, 1977, 1991).

After having presented the main factors that influence L2 learning and the progression of L1 transfer and markedness constraints in the L2 learning process, the following section will provide an overview of what constitutes a syllable and the principle governing the arrangement of its consonantal components, which are the main focus of this study. This will be followed by a review of prior studies that have explored the impact of markedness (in terms of sonority and syllable margins) on the acquisition of L2 syllable structure.

1.2. Syllable and Consonant Clusters

Although a satisfactory definition of a syllable has not yet been found, most authors (Ladefoged, 2001; Cebrian, 2013; Blevins, 1995, among others) tend to define the syllable in terms of the inherent sonority of its parts. The sonority of a sound, according to Ladefoged (2001), is its loudness relative to that of other sounds with the same length, stress, and pitch. Due to their considerably varying degrees of sonority, phoneticians and phonologists have arranged vowels and consonants on a scale from most to least sonorous in what is called a ‘sonority scale’. The sonority scale adopted in this study is Hogg & McCully’s (1987)[2], shown in Table 1.1. While vowel sounds are placed at the most sonorous end of the scale, followed by approximants, stops and fricatives occupy the least sonorous end. If one assumes a binary right-branching syllable structure (e.g., Fudge, 1969; Blevins, 1995 but see Kahn, 1976; Clements & Keyser, 1983 for flat structures without sub-syllabic constituents), vowels occupy the sonority peak of a syllable, known as the nucleus, whereas consonants constitute the onset of the syllable (any consonant(s) that precede the nucleus) and the coda (any consonant(s) that follow the nucleus). The nucleus and coda together form a unit called ‘rime’(Small, 1999). Figure 1.1 illustrates the internal structure of the syllable in the Kurdish word /gul/ ‘flower’.

Of relevance to the current study are consonant clusters (CC), which are formed when onset and coda constituents branch. Languages exhibit varying degrees of complexity in their constituent’s branching (syllable margins). For instance, in some languages like Spanish, branching occurs exclusively at the onset constituent. In contrast, languages such as Finnish allow branching only at the coda constituent. There are also unmarked languages, like Maori, where branching is not permitted in either onset or coda positions (Yaldiz, 2010). English, on the other hand, has a relatively marked syllable structure as all three constituents (onset, nucleus, and coda) can branch. For example, the number of allowable consonants in the onset position is three consonants and up to four consonants can be found in the coda position (e.g., ‘strengths’ /streŋkθs/). The focus of this thesis is on the status of onset and coda clusters in L1 Kurdish and the acquisition of English onset clusters by Kurdish learners of English. The study of how Kurdish speakers deal with consonant clusters may well provide a glimpse into the developing phonological interlanguage of these English L2 learners. The question of what

[2] Glides and affricates are absent from Hogg & McCully’s sonority scale, yet Yavas (2003) suggests that glides be put with high vowels as they are the nonsyllabic versions of high vowels, and affricates be placed between fricatives and stops.

governs consonant cluster construction and what defines a marked consonant cluster will now be discussed in 1.2.1 below.

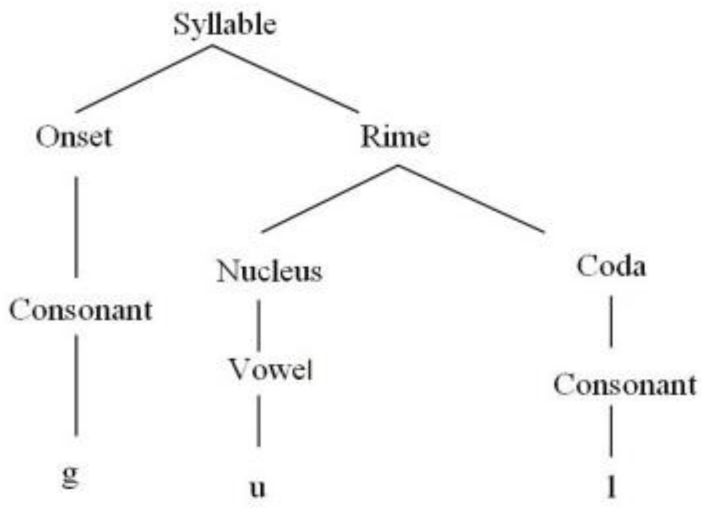

Figure 1.1 Syllable internal structure for the Kurdish word for flower /gul/ following the binary right-branching syllable structure in Fudge (1969) and Blevins (1995).

Sound	Sonority Index
Low vowels	10
Mid vowels	9
High vowels	8
Flaps	7
Laterals	6
Nasals	5
Voiced fricatives	4
Voiceless fricatives	3
Voiced stops	2
Voiceless stops	1

Table 1.1 The sonority scale adapted from Hogg & McCully (1987). See footnote 2 for the position of affricates and glides in the scale.

1.2.1. Sonority Sequencing Principle

The notion of sonority discussed in 1.2 does not simply control what the syllable peak is; differences in sonority among consonants play a role in their distribution in a cluster. The distribution of consonants in a cluster is known to be often governed by the Sonority Sequencing Principle (SSP, Clements, 1990), also known as the Sonority Sequencing Generalisation (SSG, Selkirk, 1984). According to the SSP, the sonority of consonants decreases the farther they are from the vowel or syllable nucleus. Figure 1.2 illustrates the degrees of the sonority of the sounds in the Kurdish words /xæfs/ 'damnation', /ʃkæft/ 'cave', /dæst/ 'hand' and /dæɾd/ 'disease', based on the numerical index given in Table 1.1.

The words /dæɾd/ and /dæst/ exemplify a coda cluster of two consonants following the vowel /æ/, which is the most sonorous element in the given words/syllables. The consonants that are closer to the vowel are of a greater sonority than the consonants at the edge, supporting the SSP. Yet, according to Yavas (2013) the final consonant sequence /-ɾd/ is cross-linguistically more natural and accordingly less marked than the sequence /-st/ because it has a greater sonority distance between its members. That is, the distance of moving from the sonority index 7-2 in /-ɾd/ is greater than in /-st/ (from 3-1). Steriade (1990) suggests that a language permitting sequences with small sonority differences will also allow those with greater sonority differences, but not the other way around, which implies that a sequence with less sonority difference is more marked than one with a greater sonority difference.

In /ʃkæft/ one can find two consonant clusters following and preceding the vowel. It is also obvious that the initial sequence /ʃk-/ does not obey the SSP, as it reveals negative sonority (also known as sonority reversals, Carlisle, 2001) by going from a higher sonority voiceless fricative to a lower sonority voiceless stop. Thus, the sequence /ʃk-/ is a marked cluster in the onset position as it does not obey the SSP, and is also expected to pose a challenge for learners of Kurdish as a second/foreign language. Another example of a sonority reversal is a sonority plateau (Clements, 1991), which is formed when two consonants of the same sonority degree are combined, as in the Kurdish word /xæfs/ 'damnation', in which the final sequences /-fs/ are of equal sonority degree, i.e., both are voiceless fricatives. Carlisle (2001) considers sonority plateaus to be more serious departures from the SSP, and are therefore more marked than negative sonority cases.

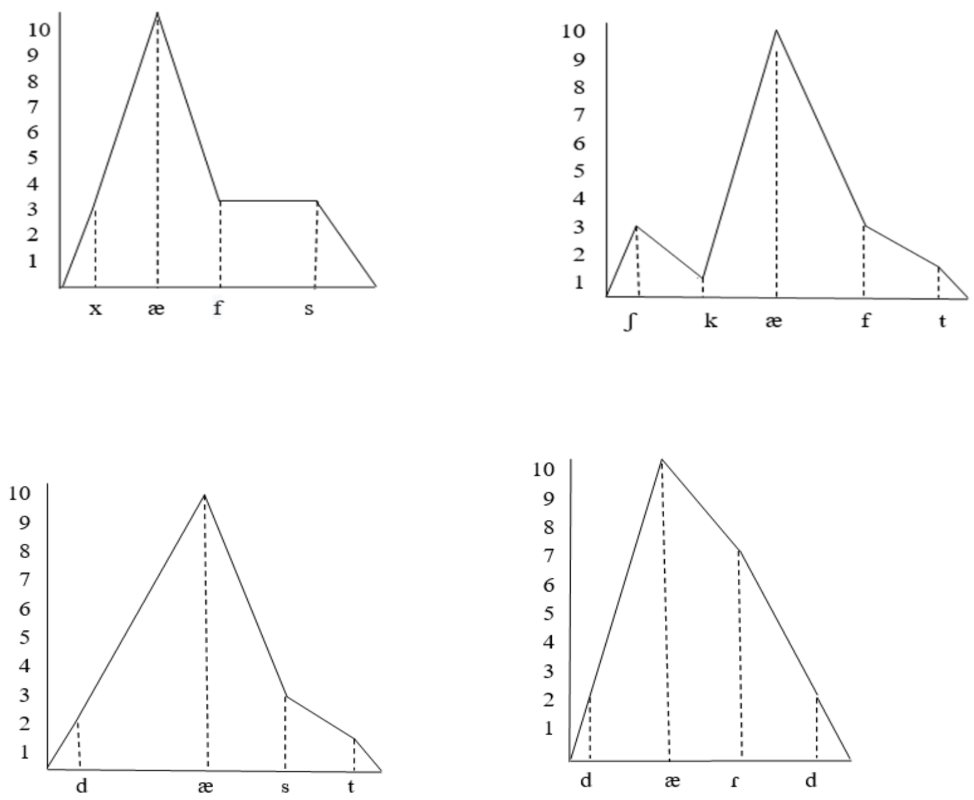

Figure 1.2 Sonority peaks in the Kurdish words /xæfs/, /ʃkæft/, /dæst/ and /dæɾd/.

Related to the SSP, are the Minimal Sonority Distance Principle (MSD, Broselow & Finer, 1991) and the Dispersion Principle (Clements, 1990; also Eckman & Iverson, 1993), which are primarily concerned with 2-consonant onsets that obey the SSP. The MSD predicts that the members of the clusters occurring closer together in sonority will be more difficult to produce (more marked) than those that are further apart on the scale (less marked). Furthermore, Broselow & Finer (1991) observed that languages demanding significant sonority differences between their segments, such as Japanese, do not permit the formation of onset clusters. In contrast, languages like English tolerate smaller sonority gaps between its consecutive segments, allowing for various consonant sequences. To illustrate, using Hogg and McCully's sonority scale, English allows for sonority differences ranging from 2 (as seen in voiceless fricative + nasal onsets like /sm-/ and /sn-/) to 6 (as observed in voiceless stop + alveolar approximant onsets like /pr-/ and /tr-/). This flexibility in sonority differences accounts for the diversity of onset consonant combinations in English. Broselow & Finer (1991) added that sequences with a lower MSD setting than the learners' L1 will be difficult to acquire. As a result, a Japanese learner of English will struggle to master English clusters. In Broselow and Finer's account, what was transferred was the MSD setting from L1 into L2.

Unlike the predictions made by the MSD, the Dispersion Principle suggests that the two consonants in an onset cluster should be evenly dispersed from each other concerning sonority. Using a five-category sonority scale (vowel > glide > liquid > nasal > obstruent), Clements (1990) hypothesised that the combination of an obstruent and a liquid (/k/ + /l/) would be pronounced more accurately than combinations of obstruents and glides (/k/ + /w/). This is due to the smooth and consistent rise in sonority towards the vowel or syllable nucleus that occurs with obstruent + liquid pairs. Therefore, while the MSD prefers glides as the second consonant in a two-consonant cluster, the Dispersion Principle supports a steady increase in sonority, favouring liquids over glide consonants.

1.2.2. Sonority Sequencing Principle and /s/-Clusters

English as well as Kurdish exhibit a contradiction to the SSP in onset clusters beginning with the voiceless fricative /s/, and /ʃ/ in Kurdish, followed by voiceless stops as the second segments (/sp-/, /st-/, and /sk-/ in both English and Kurdish, and /ʃp-/ and /ʃk-/ in Kurdish). These clusters present a voiceless fricative with a sonority value of 3, followed by a voiceless stop with a sonority value of 1, resulting in a difference of -2. This deviation shows a decrease in sonority from the onset towards the syllable peak, contradicting the SSP. Consequently, these clusters are highly marked according to the SSP. Yavas (2003) adds two more exceptional behaviours exhibited by onset /s/-clusters in English. For example, some English /s/-clusters violate the generalisation that prohibits homorganic clusters (e.g. /pw/ and /bw/ are not allowed, but /st/, /sl/ and /sn/ are), while others violate the principle that disallows obstruent + nasal clusters (e.g. /pn/ and /kn/ are not allowed, but /sn/ and /sm/ are). Moreover, the only English onset clusters having three members all begin with /s/: /spr-/, /spl-/, /str-/, /skr-/, and /skw-/.

Due to the varied behaviours of /s/-clusters, researchers have proposed different approaches to explain them. Some scholars, including Giegerich (1992) and Kenstowicz (1994), advocate for a distinctive 'adjunct' status for /s/-clusters. Under this view, /s/-clusters are not syllabified directly under the onset position, but are a direct dependent of the syllable, i.e. they have extrasyllabic status. Other scholars, like Blevins (1995), argue that /s/-clusters share the same structural characteristics as non-/s/-clusters. Finally, some researchers, such as Selkirk (1984), propose an approach that treats /s/-clusters as a 'string of complex segments'. The most widely acknowledged approach to /s/-clusters is the 'adjunct' or extrasyllabic approach. As a result, two categories of cluster types have been identified: 'true clusters' (complex onsets) and 'adjunct clusters' (Giegerich, 1992; Kenstowicz, 1994). These can be shown with the trees in Figure 1.3.

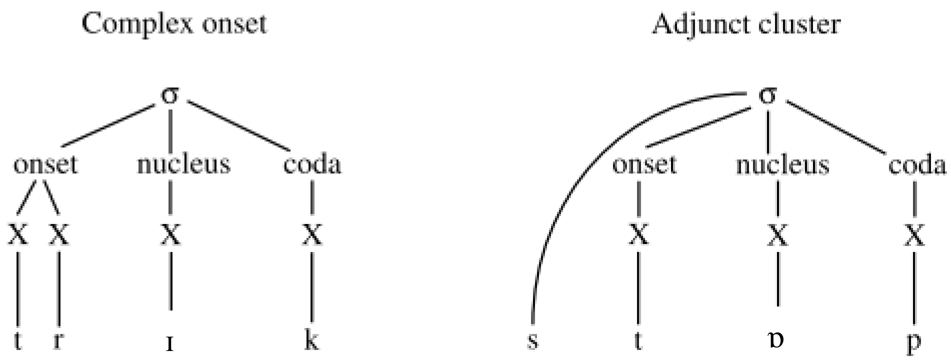

Figure 1.3 The representation of complex onsets and adjunct onsets in English 'trick' /trɪk/ and 'stop' /stɒp/, adopted from Yavas (2003). The syllable's internal structure is represented non-hierarchically in the source.

There are, however, divergent views among researchers on whether to consider only the /s/ + stop clusters or the entire class of /s/- clusters (/s/ + stop, /s/ + nasal, /s/ + /l/, and /s /+ /w/) as 'adjuncts' in English. Considering the SSP, Yavas (2003) argues for separating the /s/ + stop clusters because they are the only onset clusters that violate the SSP in English. In the context of Kurdish consonant clusters, I will argue for assigning an 'adjunct' status to both /s/ + stop and /ʃ/ + stop onset sequences once the status of these combinations along other combinations as actual clusters are determined perceptually and acoustically, which is the main goal of the first study in this thesis (see chapter 3). It is predicted that only these combinations are likely to behave as actual onset clusters in NK. In this context, Kurdish may behave similarly to Mozateco which has only /s/ and /ʃ/- clusters (Blevins, 1995).

1.2.3. Studies on the Role of Markedness by Sonority

As discussed in the section on the Sonority Sequencing Principle, onsets consisting of greater sonority differences between their members are less marked than those with a smaller sonority difference between their members. Several studies in IL phonology provide support for this role of sonority difference in the acquisition of L2 onset clusters. For example, Broselow & Finer (1991) analysed data from 24 native speakers of Korean and eight native speakers of Japanese, focusing on their pronunciation of words containing initial clusters such as /pr-/, /br-/, /fr-/, /pj-/, /bj-/, and /fj-/. In terms of the sonority hierarchy, the obstruent /p/, /b/, and /f/ + liquid /r/ clusters are considered more marked than the obstruent /p/, /b/, and /f/ + glide /j/ clusters, since they are closer together on the sonority scale. In terms of voicing, voiceless stops are less sonorous than their voiced counterparts. The voiceless stop /p/ is, therefore, less marked than its voiced counterpart /b/. The stop class of phonemes is considered less sonorous and less marked than fricatives. The results supported the study's predictions. Participants from both groups, for instance, modified /fr-/ more than /pr-/, which follows what sonority sequencing says about the natural hierarchy relation among members in the cluster. Broselow & Finer (1991) also observed that errors made by participants primarily involved vowel epenthesis, especially when attempting to produce clusters like /br/, /bj/, /pr/, and /pj/.

Another study exploring the predictions of the MSD principle (see 1.2.1) was conducted by Hancin-Bhatt & Bhatt (1997). The two language groups chosen were Spanish and Japanese learners of English as an ESL. The researchers predicted that the Spanish group, whose L1 allows for fricative + liquid and stop + liquid clusters, would make fewer errors than Japanese speakers producing these same onsets in English because Japanese does not have any clusters. For both groups, however, stop + liquid clusters were expected to be less challenging than the fricative + liquid clusters based on predictions of the MSD. The results of the study indicated a positive effect of L1 transfer, as Spanish speakers outperformed Japanese speakers in producing both fricative + liquid and stop + liquid clusters. However, the predictions of the MSD principle, suggesting a decrease in production errors with increased sonority, were only partially supported.

In a series of studies, Carlisle (1988, 1991, 1992, 1994, 2006) examined the difficulties of Spanish speakers in their acquisition of English onset clusters /sm-/, /sn-/, /st-/, /sp-/, /sk-/

and /sl-/. Generally, it was expected that these clusters would be problematic for Spanish speakers learning English. The results from these studies showed that the /sl-/ cluster was the most accurate one that participants produced, followed by /sm-/, and /sn-/. The /s/+ stop clusters were the most problematic ones. Since Spanish does not allow such clusters, L1 transfer could not explain the errors, but rather the SSP explained that. The violation of the SSP in /st-/, /sp-/, and /sk-/ clusters is because of the falling sonority these clusters have, such violation is not found in /sm-/, /sn-/, and /sl-/ clusters because they show a rising sonority. The results of Carlisle's studies supported the predictions that participants will perform better in less marked (SSP-abiding) clusters than they do in more marked (SSP-violating) clusters.

Support for the SSP was also reported in a longitudinal case study by Abrahamson (1999), although to a lesser extent. The study tested the production of the Swedish /s/C(C) clusters, namely, /sl-/, /sm-/, /sn-/, /sv-/, /sp-/, /st-/, /sk-/, /spr-/, /str-/, and /skr-/, by a Spanish beginner learner of Swedish. Unlike Spanish, Swedish allows /s/C clusters. Therefore, it was expected that Spanish L2 learners of Swedish would have difficulty producing these clusters and their performance would vary according to the different degrees of markedness. The results from Abrahamsson's study revealed that the participant produced /sm-/ and /sn-/ clusters most accurately followed by /sp-/, /st-/, /sk/ clusters, and finally /sl-/ cluster with the least accuracy rate. This study yielded partial support for the role of sonority, which suggests that /sl-/ should be the most accurately produced cluster, followed by /sm-/ and /sn-/ clusters, and finally /sp-/, /st-/, and /sk-/ clusters. Abrahamson attributed the unexpected results to the limited number of /sl-/ onset clusters in the selected corpus and to the fact that only one participant was tested in his study, suggesting that some individuals simply do not conform to predicted outcomes.

Rauber & Baptista (2004) examined the production of English /s/C(C) clusters by native speakers of Brazilian Portuguese and Argentine Spanish. The results of the Spanish speakers verified the results found in Carlisle (1988, 1991, 1992, 1994, 2006) in that marked clusters by sonority were modified more than less marked clusters. The order in which clusters were produced was the same order predicted by sonority (where > means more accurate or acquired before): /sl-/ > /s/ + nasal > /s/ + stop. The findings regarding Portuguese speakers paralleled those of the Spanish group and supported the predictions of the SSP while contradicting the findings of Rebello (1997). In Rebello's study, it was noted that Portuguese speakers tended to produce more epenthesis in sequences that did not violate the SSP. Rebello attributed this unexpected finding to participants voicing the /s/ before /s/-nasal and /s/-liquid clusters, a process reflecting voicing assimilation in Portuguese. This resulted in clusters of voiced obstruent + sonorant, which are considered more marked than voiceless obstruent + obstruent clusters. Consequently, Rebello interpreted her results as aligning with the Markedness Differential Hypothesis and Structural Conformity Hypothesis.

Cardoso (2008) investigated the effects of markedness based on sonority against the effect of input frequency in the acquisition of English /s/-clusters in the speech of 10 Brazilian Portuguese learners of English as an L2. Markedness and input frequency make different predictions regarding the order of /s/-clusters acquisition. The sonority predicts that L2 learners will be most successful in producing /sl-/ because it is the least marked cluster among the three, followed by /sn-/ (more marked) and then /st-/ because it is the most marked among all. On the other hand, input frequency predicts, that although /st-/ cluster is the most marked cluster in terms of sonority; it is more common than the other two clusters, therefore, L2 learners will acquire it before the other two clusters. Further, it states that /sn-/ is the second most common and /sl-/ is the least common, making the opposite hierarchal pattern predicted by sonority. Results from Cardoso's study provided support for the predictions based on sonority.

Almalki (2014) tested the production of English /s/-clusters and non-/s/-clusters by Saudi Arabian participants from two proficiency levels: intermediate and advanced. The study aimed to test the role of markedness based on SSP. It also aimed to examine the role of input frequency (cluster frequency) in the acquisition of the tested clusters. A total of 46 people participated in the study (23 in the intermediate group and 23 in the advanced group). Participants were asked to read the target clusters in words embedded in sentences. Results from the /s/-clusters from both participant groups supported the predictions made by markedness based on sonority: clusters violating the SSP were modified more frequently than those that did not in both proficiency groups. Input frequency, which predicts that clusters violating the SSP are acquired first because of their higher frequency of occurrence in English, did not provide a good explanation for the patterns of errors that occurred with /s/-clusters and non-/s/-clusters. The process of simplification of the clusters employed by participants was 100% prothesis. This process was suggested to be a direct transfer of a phonological rule from Arabic.

In summary, the studies reviewed so far provide empirical evidence supporting the absolute or partial role of markedness by sonority in the acquisition of L2 onset clusters. Broselow & Finer (1991) found that clusters with greater sonority differences were less marked and thus easier to acquire, as shown by the pronunciation patterns of Korean and Japanese speakers of English. Similarly, Hancin-Bhatt & Bhatt (1997) found that Spanish learners of English, whose L1 allows for more complex onset clusters, performed better than Japanese learners, indicating a positive effect of L1 transfer. Carlisle's (1988, 1991, 1992, 1994, 2006) studies on Spanish speakers acquiring English clusters further supported the SSP, showing better performance in less marked clusters. Abrahamson (1999) found similar trends in a Spanish learner of Swedish, with accuracy rates partially aligning with sonority-based predictions. Also, Rauber & Baptista (2004) confirmed these findings in Brazilian Portuguese and Argentine Spanish speakers acquiring English clusters. However, Rebello's (1997) contradictory results suggested potential influences of language-specific factors. Finally, Cardoso (2008) and Almalki (2014) investigated the effects of markedness based on sonority against input frequency in Brazilian Portuguese and Saudi Arabian learners of English, providing further support for sonority-based predictions. Overall, these studies collectively highlight the significance of sonority differences in shaping the acquisition patterns of L2 onset clusters.

1.2.4. Studies on the Role of Markedness Based on Syllable Margin Length

It is widely acknowledged that in all established world languages, the markedness of both onsets and codas increases with length, a phenomenon captured by the observation that the presence of onset or coda of length n implies the presence of n-1 in all languages (Greenberg, 1965; Kaye & Lowenstamm, 1981). Results from numerous studies on IL consistently confirm this general hypothesis, demonstrating that longer L2 sequences are acquired later or undergo modifications more frequently than shorter sequences.

In Eckman's (1991) study, the reduction of complex codas and onsets was investigated among 11 native speakers of three languages: Japanese, Cantonese, and Korean, none of which permit complex codas or onsets. The study examined three onsets and eight codas, each consisting of three elements. To determine the presence or absence of a specific structure, the researcher established a criterion of 80% correct production. For example, if a participant correctly produced onsets like /spr-/ 80% of the time, the structure was considered present in their interlanguage phonology. If any of the two sequences (/sp-/ and /pr-/) reached the criterion level, they were also considered present. Eckman's study provided evidence indicating that less marked onsets and codas are acquired before their more marked counterparts, confirming the hypothesis that the less marked elements reach the criterion level before the more marked ones.

Carlisle (1997, 1998, 2002) examined the production of Spanish L1 speakers producing English onsets with different lengths in longitudinal studies. The researcher examined the production of double onsets, /sp-/ and /sk-/, and triple onsets, /spr-/ and /skr-/. In all of the three studies, participants produced less marked ones (double onsets) more accurately than more marked ones (triple onsets). Using Eckman's 80% criterion level, Carlisle found that two-member onsets reached the criterion level (acquired earlier) than the three-member onsets (acquired later). In his longitudinal case study on a Spanish learner of Swedish, previously discussed in 1.2.3, Abrahamson (1999) found a significant effect of cluster length, in that epenthesis occurred more frequently with three-member than with two-member onsets, thereby confirming the predictions of the SCH (Eckman, 1991).

Hancin-Bhatt (2000) investigated the production of English one-member codas, including voiceless stops, voiced stops, fricatives, liquids, and nasals, as well as two-member codas, namely liquid + stop, liquid + fricative, and liquid + nasal, among 11 native Thai speakers of English as a second language. The study revealed that participants accurately produced 84.4% of the one-member coda but only 63% of the two-member onsets. Rauber & Baptista (2004) in their research on how Brazilian Portuguese and Argentinean Spanish speakers produce English initial /s/ clusters, previously cited in 1.2.3, found that both Brazilian and Argentinean participants produced significantly more epenthesis before longer (three-member) clusters, again confirming the MDH (Eckman, 1977).

Finally, Alosaimi (2023) explored how native speakers of Hijazi Arabic acquire English consonant clusters, which are absent in their native language, and how factors such as L1 transfer, cluster-markedness, and input frequency (i.e., word-frequency and cluster-frequency) influence this acquisition process. Three experiments were conducted: (1) a production task that elicited Hijazi speakers' production of English words with consonant clusters, which explored the repair strategies they used in their attempt to produce the target non-native linguistic structures, (2) a lexical decision task that examined the degree of participants' acceptance of unmodified (e.g., 'group' /gɹup/) and modified (e.g., /gʊɹup/) English tokens as real English words, and (3) an AX discrimination task that assessed participants' ability to perceive the epenthetic vowels and to differentiate between two spoken utterances. Thirty non-native English speakers with low proficiency participated in all three experiments, while thirty native English speakers took part in the two perception tasks as a control group. The stimuli consisted of English monosyllabic words containing CCVC and CVCC structures, categorised into high and low-frequency groups. These words included clusters with rising sonority and falling sonority at one edge. The stimuli were manipulated through vowel insertion, either conforming (e.g., /gʊɹup/) or deviating (e.g., /gɪɹup/) from the phonological rules of Hijazi. The results showed that Hijazi speakers tended to use vowels reflecting their L1 phonology when repairing English clusters, and had difficulty rejecting modified words with vowels obeying their L1 rules as real English words. Additionally, less marked clusters were produced and perceived more accurately and quickly than more marked structures which was in line with the prediction suggested by cluster-markedness, while low-frequency clusters were easier to process and produce than high-frequency clusters, contrary to the proposed patterns by cluster-frequency of type and token. Moreover, clusters in high-frequency words showed better performance than those in low-frequency words. It was concluded that L1 phonotactic knowledge, cluster-markedness, and input frequency had robust effects on Hijazi speakers' production and perception of English consonant clusters that are absent in their native language.

In summary, the studies just reviewed exhibit the important role of markedness based on syllable margins in the acquisition of L2 consonant clusters and consistently reveal a common finding: longer consonant sequences undergo modifications more frequently than shorter ones. As a result, second language or foreign learners tend to acquire shorter sequences before mastering the longer ones.

This section has introduced the internal structure of syllables, focusing on the sonority principle that governs how consonants are organised within clusters, which are the main focus of this thesis. Additionally, it has reviewed previous research highlighting the crucial role of sonority and syllable margins in the acquisition of L2 consonant clusters. Although other factors, such as input frequency, play a role, and there are instances where the sonority principle has not consistently explained the production of L2 clusters, these studies generally found that less complex clusters, marked by greater sonority differences or adherence to the sonority principle, are typically learned earlier in L2 acquisition. Moreover, the length-based complexity of syllable margins significantly influences the mastery of L2 clusters, with longer clusters generally being acquired later. In summary, both sonority differences and syllable margin length seem to play key roles in shaping the acquisition patterns of L2 onset clusters. The following section will conduct a contrastive analysis of phonemic and consonant cluster inventories in Kurdish and English.

1.3. Contrastive Analysis of Kurdish and English Inventories

1.3.1. The Kurdish Language

The Kurdish language is predominantly spoken in Turkey, northern Iraq, western Iran, Syria, and parts of Central Asia. Kurdish belongs to the West Iranian language group within the broader Proto-Iranian language family. Estimates of the total number of Kurdish speakers vary significantly, ranging from 15 to 40 million (Hamid, 2016). According to the Ethnologue (2009), Kurdish has 30 million speakers and a substantial diaspora community.

Five distinct varieties are commonly recognised as dialects of Kurdish: Northern Kurdish (NK, also known as Kurmanji), Central Kurdish (CK, also known as Sorani), Southern Kurdish, Gorani, and Zazaki (Fattah, 2000; Öpengin & Haig, 2014). This thesis exclusively focuses on speakers of the NK dialect, also referred to as Bahdini, spoken in the Duhok Governorate in the Kurdistan region of Iraq[3]. The study does not use data from the same dialect spoken in neighbouring Turkey, Iran, and Syria[4]. Despite NK being the most widely spoken dialect of Kurdish among other Kurdish dialects, it is not the dominant dialect in the Kurdistan region of Iraq, where CK is more prevalent. Estimates suggest there are approximately 3,000,000 CK speakers, in contrast to around 1,000,000 NK speakers (Hamid, 2016). Both NK and CK are written in the Arabic script and serve as the language of instruction in the areas where they are spoken in the Kurdistan region of Iraq.

1.3.2. Phonemic Inventory Differences between NK and English

1.3.2.1. Consonants

NK and English share many consonants. See Table 1.2. and Table 1.3 for English and NK consonant inventories. Both languages share six stops, seven fricatives, two affricates, two nasals, two liquids, and two semivowels. Although both languages may be considered to have the /r/ phoneme, the manner of articulation is different in the two languages. In English, the /r/

[3] Duhok Governorate is an administrative region within the autonomous Kurdistan Region of Iraq, with its capital located in the city of Duhok. Duhok governorate is divided into seven districts: Duhok, Zakho, Amedi, Semel, Akre, Shixan, and Bardarash (Tovi & Badi, 2010, cited in Haig & Mustafa, 2016). Only NK speakers in Duhok, Zakho, Amedi, and Semel participated in this thesis.

[4] Speakers of NK in neighbouring Turkey, Iran, and Syria who live in Duhok Governorate were not considered for the L1 Kurdish and L2 English studies.

is a retroflex approximant (Ladefoged & Johnson, 2011) whereas it is trilled or produced as a flap in NK (Shokri, 2002; Hasan, 2009).

There are a few issues to elaborate on regarding NK consonants listed in Table 1.3. The contrast between aspirated and unaspirated voiceless stops in NK is phonemic only syllable-initially as in the examples below reported in Shokri (2002). In other dialects of Kurdish, these consonants function as allophonic variants.

(1) Aspirated and unaspirated stops and affricates in NK (from Shokri, 2002)

	<u>Aspirated phoneme</u>	<u>Example word</u>	<u>Gloss</u>
a.	/pʰ/	/ˈpʰɑːʃi/	later on
b.	/tʰ/	/ˈtʰi/	brother-in-law
c.	/kʰ/	/ˈkʰɑː/	where
d.	/ʧʰ/	/ˈʧʰɨɾ/	gush of milk

	<u>Unaspirated phoneme</u>	<u>Example word</u>	<u>Gloss</u>
a.	/p/	/pɑːʃi/	backside
b.	/t/	/ˈti/	edge
c.	/k/	/ˈkɑː/	straw
d.	/ʧ/	/ˈʧɨɾ/	elastic

The phonemic status of certain consonants in the NK inventory, such as the voiced velar nasal /ŋ/ and the voiceless glottal stop /ʔ/, marked with an asterisk in Table 1.3, is a topic of debate. Some studies, like Marif (1976, cited in Hasan, 2012), consider /ʔ/ a phoneme, while others, like Ways (1984, also cited in Hasan, 2012), do not. Ways argues that /ʔ/ is only pronounced at the beginning of vowel-initial words and does not alter the meaning if omitted, for instance, both /ʔɑːɾ/ and /ɑːɾ/ mean ‘flour’. Similarly, the status of the voiced velar nasal /ŋ/ is questioned. Scholars like Karimi (1996, cited in Rahimpour & Dovaise, 2011) argue that it is a phoneme. They point to minimal pairs, such as /bɑn/ ‘roof’ versus /bɑŋ/ ‘to call out’, to support their claim. This contradicts the view of researchers like Rokhzadi (2000, also cited in Rahimpour & Dovaise, 2011) and Ways (1984), who suggest that /ŋ/ is merely an allophonic variation of /n/. The disagreement among Kurdish scholars regarding the phonemic status of /ʔ/ and /ŋ/ revolves around whether these sounds represent distinct phonemes or are variations of other phonemes within the language. Finally, the pharyngeal sounds /ħ/ and /ʕ/, as well as the voiceless velar fricative /x/ and the voiced velar fricative /ɣ/, have been incorporated into NK due to contact with Arabic. However, in NK, /ħ/ and /ʕ/ are occasionally used interchangeably, as seen in words like /tæħɨl/ and /tæʕɨl/, both meaning 'bitter'(Hasan, 2012).

		Place of Articulation							
		Bilabial	**Labiodental**	**Dental**	**Alveolar**	**Postalveolar**	**Palatal**	**Velar**	**Glottal**
Manner of Articulation	Plosive	p b			t d			k g	
	Fricative		f v	θ ð	s z	ʃ ʒ			h
	Affricate					ʧ ʤ			
	Nasal	m			n				ŋ
	Lateral				l				
	Approximant	w				ɹ	j		

Table 1.2 English consonant phoneme inventory (Roach, 2009).

		Bilabial	**Labiodental**	**Alveolar**	**Postalveolar**	**Palatal**	**Velar**	**Glottal**	**Pharyngeal**
Manner of Articulation	Plosive	p p^h b		t t^h d			k k^h g	ʔ*	q
	Fricative		f v	s z	ʃ ʒ		x ɣ	h	ʕ ħ
	Affricate				ʧ $ʧ^h$ ʤ				
	Nasal	m		n				ŋ*	
	Lateral			l					
	Approximant	w			ɾ	j			

Table 1.3 NK consonant phoneme inventory (Shokri, 2002). Asterisks indicate a lack of agreement regarding the phonemic status of the given consonants.

1.3.2.2. Vowels

The number and features of vowel sounds in Kurdish vary across different Kurdish dialects and even within them. While Hasan (2009) and Shokri (2002) identify eight vowels in NK vowel inventory, Hamid (2016) identifies six vowels in the CK vowel inventory. Unlike in CK, the length distinction of the high back rounded /u/ vowel is considered contrastive in NK. Additionally, the high central /ɨ/ vowel, which is treated as an epenthetic vowel in CK according to Hamid (2016), is considered a regular lexical vowel in NK. In NK, vowel length is described as non-phonemic, meaning changes in vowel length do not result in changes in meaning.

Though Hasan (2009) and Shokri (2002) have assigned an equal number of vowels to NK, they do not include identical vowels. While the former includes a mid-high back rounded /o/ in NK, the latter includes a high front rounded /y/ instead. Shokri believes that /o/ is a pharyngealised realisation of the vowel /u/ in emphaticised syllables, and therefore he does not include it in his list of vowels. As for the high front rounded /y/, I believe that it represents a rounded realisation of the high front unrounded /i/ and is only present in specific regional NK dialects. It falls beyond the scope of this study to further investigate this issue. Therefore, this study will adopt a modified version of the vowels proposed in Shokri (2002) for NK vowel inventory. However, the high front rounded /y/ is excluded from the inventory, but the specification of the /ɨ/ as a lexical vowel, at least in monosyllabic words, is adopted.

Thus, unlike (Standard British) English, which has 12 vowels (Roach, 2009), NK vowel inventory consists of 7 vowels (see Table 1.4. for English vowels and Table 1.5 for NK vowels). Because diphthongs are reported not to exist in NK (Shokri, 2002; Hasan, 2009), they are not included in Table 1.4. for English vowels. Because NK has fewer vowels than English, vowel substitutions are widely observed in the speech of NK speakers of English. Common vowel substitutions include /i/ for /ɪ/, and /æ/ for /ʌ/.

Vowel	Example Word
i:	beat
ɪ	fish
e	bed
æ	man
ʌ	rush
ɜ:	bird
ə	attend
ɑ:	card
ɒ	pot
ɔ:	horse
ʊ	put
u:	moon

Table 1.4 English vowel sounds (Roach, 2009).

Vowel	Example Word	Glossary
i	/biɾ/	memory
ɨ	/sɨk/	market
e	/meɾ/	man
æ	/gæl/	people
ɑ	/gɑv/	step
u:	/ʃu:l/	work
ʊ	/gʊɾ/	wolf

Table 1.5 NK vowel sounds (adopted from Shokri, 2002).

1.3.3. Consonant Cluster Inventory Differences

1.3.3.1. English Consonant Clusters

English syllable structure is relatively flexible, with only one obligatory element: the nucleus. This core element is surrounded by optional components. In the onset position, English permits up to three consonants, allowing for a single consonant, two consonants (double onsets), or even three consonants (triple onsets). Similarly, in the coda position, English syllables can have single, double, or triple codas. With the addition of suffixes, the coda position can accommodate up to four consonants in English (Yavaş, 2020). This thesis will examine the acquisition of English onset clusters by native NK Kurdish speakers, and therefore this section will only analyse English onset clusters. Most researchers, including Clements & Keyser (1983), Borowsky (1986), and Lamontagne (1993), generally agree on the core clusters outlined in (2) and (3) as representing true onset clusters in English. The core clusters are divided into non-/s/+ C clusters and /s/+ C clusters. See section 1.2.2 above for a discussion on /s/- clusters and possible analyses based on the notion of extrasyllabicity.

(2) Two-member non-/s/ core clusters

Cluster combination	Example word
a. stop + approximant	
/pr-/	profit
/tr-/	try
/kr-/	cry
/br-/	brown
/dr-/	dress
/gr-/	grow
/tw-/	twinkle
/kw-/	queen
/tj-/	tune
/kj-/	cute
/pj-/	pure
b. fricative + approximant	
/fl-/	flower
/fr-/	Friday
/ʃr-/	shrub
/θr-/	throw
/fj-/	few

(3) Two-member core /s/-clusters

Cluster combination	Example word
a. /s/ + stop	
/sp-/	spot
/st-/	star
/sk-/	skate

b. /s/ + nasal

/sn-/	snail
/sm-/	smoke

c. /s/ + approximant

/sw-/	sweet
/sl-/	slow

Clusters that are rare (e.g., /sj-/ in suitable or issue) or found mostly in foreign words (e.g., /pw-/ in pueblo, /sr-/ in Sri Lanka) have been omitted. The following section presents the consonant combinations that are found in NK, their status as a true cluster, and their comparison to English clusters.

1.3.3.2. Kurdish Consonant Cluster Inventory

There is a notable contrast between Kurdish and English consonant clusters in terms of length and the sonority make-up of the consonant clusters. Unlike English, consonant clusters in Kurdish have been reported to contain maximally two consonants in onset (e.g., /stiɾ/ 'thick', /steɾ/ 'star') and coda (e.g., /dæst/ 'hand', /gʊʃt/ 'meat') positions (Hasan, 2009; Shokri, 2002; Hamid, 2016; Kahn, 1976). Additionally, Shokri (2002) claims that onset clusters in Kurdish are restricted to sonority reversals, as in /spi/ 'white' and /ʃkæft/ 'cave,' as he claims these are the only actual onset clusters in NK.

Studies available on NK phonology provide discrepant descriptions regarding the cluster status of several onset and coda combinations, that is, whether the sequences constitute actual clusters or if they are broken up by a vocalic element. For example, in Hasan's (2009) classification of consonant clusters in NK, all onset combinations with an asterisk in Table 1.6 are reported as true clusters. These combinations, however, are universally marked structures in terms of the SSP (Clements, 1990; Selkirk, 1984), according to which the general tendency is for the sonority of the consonants to decrease the further they are from the vowel. The onset combinations fricative + stop, nasal + fricative, approximant + fricative, and approximant + stop exhibit a falling sonority pattern, whereas the stop + stop combination shows a sonority plateau. These two patterns contradict the SSP and are considered rare across languages (Carlisle, 2001). This raises doubts about their presence in NK. Unlike Hasan's extensive proposed list of onset clusters in NK, Shokri's (2002) permissible onset clusters in this dialect include only the fricative + stop combination. He gives /steɾ/ 'star' and /ʃkɑnd/ 's/he broke something' as example words. However, Shokri (2002) does not report whether illegal onset clusters such as those reported in Hasan (2009) are broken up by a vocalic element, nor does he specify the nature of the potential inserted vowel; epenthetic or intrusive (see 1.4.1 for the difference between epenthetic and intrusive vowels). In sharp contrast to Hasan (2009) and Shokri (2002), Haig & Opengin (2014) believe that permissible onsets in NK are prone to frequent epenthesis across NK regional variations, for example, /bɾɑ/ and /bɨ.ɾɑ/ 'brother' are interchangeably used in NK. They still, however, do not look into the nature of the inserted vowel, nor do they specify what potential factor(s) govern the presence or absence of a vocalic element in NK's onset clusters.

Regarding coda clusters, Hasan (2009) reports many combinations as actual clusters, some of which violate the SSP. These include sequences exhibiting a rising sonority, such as fricative + nasal, fricative + approximant, stop + nasal, and stop+ approximant, as well as one displaying a sonority plateau – fricative + fricative. In contrast, Shokri presents a more limited list of permissible coda sequences in NK, all of which he assumes adhere to the SSP. Yet, the inclusion of the fricative + fricative combination in Shokri's list constitutes a sonority plateau, which is one type of violation of the SSP (Carlise, 2001).

Sequence Position	Previous Descriptions		
	Hasan (2009)	**Shokri (2002)**	**Example Word**
Onset	fricative + stop*	fricative + stop*	/steɾ/
	nasal + fricative*		/nveʒ/
	approximant + fricative *		/lvin/
	stop + stop*		/pʰtɨɾ/
	approximant + stop*		/wtɑɾ/
	fricative + nasal		/snel/
	fricative + approximant		/sɾuʃt/
	stop + fricative		/pʰʃik/
	stop + nasal		/bnɑɣ/
	stop + approximant		/tri/
	affricate + nasal		/ʧnɑɾ/
	affricate + approximant		/ʧɾɑ/
	nasal + approximant		/mɾiʃk/
	approximant + fricative		/ɾʒɑndɨn/
Coda	fricative + fricative*	fricative + fricative*	/xæfs/
	fricative + stop	fricative + stop	/dæst/
	nasal + stop	nasal + stop	/gʊnd/
	nasal + affricate	nasal + affricate	/penʤ/
	approximant + fricative	approximant + fricative	/biɾs/
	approximant + stop	approximant + stop	/bælg/
	approximant + affricate	approximant + affricate	/mæɾʤ/
	fricative + nasal*		/ʤæʒn/
	fricative + approximant*		/bæfɾ/
	stop + nasal*		/tʰæqn/
	stop+ approximant*		/kæpɾ/
	affricate + stop		/kʊʧk/
	nasal + fricative		/ʃɑns/
	approximant + nasal		/næɾm/

Table 1.6 List of onset and coda clusters in NK, as proposed in Hasan (2009) and Shokri (2002). Clusters violating the SSP are indicated by an asterisk (*). A glossary of the example words is provided in Appendix B.

The existing discrepancy in the literature on NK clusters might be due to the orthography-based, intuitive, and theoretical analyses given in the previous works on consonant clusters in NK. Kurdish has a phonemic spelling system, i.e. each phoneme has a distinct representation in writing. Yet as a result of using the Arabic script, whose short vowels are not orthographically represented, a potential epenthetic vowel in Kurdish, unlike the rest of the short vowels, is left out in the writing system used in the Kurdistan region of Iraq Hamid (2016). Accordingly, it appears that some of the earliest descriptions of NK consonant sequences, particularly those given by Hasan (2009), have largely been based on the way words are spelled, which typically exclude epenthetic vowel representations.

Similarly, and under orthographic influences, a few other studies such as Shokri's (2002) might have been affected by the author's native intuition about the segmentation of words. The majority of native Kurdish speakers do not often include /ɨ/ when they spell a word (Hamid, 2016). For example, the word /bɾɑ/ is typically spelled as /b/, /ɾ/ and /ɑ/ instead of /b/, /ɨ /, /ɾ/ and /ɑ/. Lastly, none of the past works seem to have experimentally investigated, either perceptually or acoustically, the actual cluster status of NK onset and coda combinations, i.e. whether certain combinations constitute actual clusters or if they are broken up by a vocalic element. The first study of this thesis aims to settle the cluster status of several consonant sequences in NK by providing the first perceptual and acoustic analysis of these sequences. This step was deemed essential before investigating the process of how Kurdish learners of English acquire English clusters. Specifically, it aims to explore whether the influence of L1 would aid or impede the acquisition of English double clusters.

Having described the major differences between Kurdish and English phonemic and consonant cluster inventories, this chapter finishes with a discussion on vowel insertion, exploring its types and distinguishing it from true (lexical) vowels. This was particularly important because vowel insertion has been reported as a common strategy employed by L2 learners in acquiring L2 marked clusters (Tarone, 1980; Broselow & Finer, 1991; Hancin-Bhatt & Bhatt, 1997; Yun, 2016). Lastly, the chapter ends with what constitutes a potential epenthetic vowel in Kurdish, and how native Kurdish speakers have employed it as a means to simplify marked L2 clusters.

1.4. Vowel Epenthesis

Vowel epenthesis or vowel insertion, which separates a sequence of consonant segments, is a common simplification strategy used in the acquisition of L2 syllable structures and L1 loanword adaptation (Yun, 2016). This phenomenon occurs particularly when the L1 has a more restricted syllable inventory compared to the L2. Researchers have identified two specific types of vowel epenthesis: anaptyxis and prothesis (Fleischhacker, 2001). Anaptyxis refers to vowel epenthesis occurring within clustered consonant segments, changing the structure from #CCV to CV.CV. Prothesis, on the other hand, involves the insertion of a vowel before clustered consonant segments, changing the form from #CCV to VC.CV. The selection of the inserted vowel location is language-specific. However, in both cases, the addition of the vowel leads to an increase in the number of syllables (Yavas, 2020).

Epenthesis (anaptyxis) is cross-linguistically more commonly observed with initial obstruent (fricatives and stops) + sonorant clusters. Examples include Egyptian Arabic treatment of English ‘translate’ and ‘slide’ as /tirænzleɪt/ and /silaɪd/ (Broselow, 1987), and Hindi speakers’ pronunciation of English ‘fruit’ and ‘please’ as /fɪruːt/ and /pɪli:z/ (Singh, 1985). Prothesis, on the other hand, is prevalent in clusters involving sibilants followed by obstruents (but excluding fricatives). This phenomenon is notably observed in Spanish speakers' adaptation of English words like 'stop' and 'skip', pronounced as /estop/ and /eskip/ (Carlisle, 1991). In the case of English triple consonant clusters, both prothesis and anaptyxis may be employed, as evident in the pronunciation patterns of Persian learners of English. For instance, the word 'scream' is pronounced as /eskeri:m/ (Karimi, 1987).

1.4.1 Differences between Epenthetic and Intrusive Vowels

In Hall's (2003, 2006) classification, inserted vowels are divided into two distinct types: intrusive and epenthetic. The differentiation between these two types is given in Table 1.7, which defines their respective characteristics in terms of vowel quality, the contextual environments governing their occurrence, and their functional roles. Intrusive vowels, according to Hall, can occur due to the timing of articulatory gestures. When the gestures for adjacent consonants do not overlap, an interconsonantal interval resembling a vowel (termed intrusive vowel) can emerge. For instance, in the Scots Gaelic word 'bull' /tar<u>a</u>v/, the underlined /a/ is an intrusive vowel resulting from the articulators' movement between /r/ and /v/. Importantly, this vowel is not epenthetic and does not serve to repair an illegal syllable structure. This is because the sequence /-rv/ is universally acceptable and adheres to the SSP. Hall (2011) further emphasises that intrusively added vowels do not act as syllable nuclei and therefore cannot participate in syllabification.

Epenthetic vowels, on the other hand, play a crucial role in syllabification, as they often serve to repair illegal syllable structures (Hall, 2011). For instance, in loanword Kurdish phonology, a very short high vowel is inserted through epenthesis to repair illicit consonant clusters in the codas of Arabic loanwords like /dʒæ'bɨɾ/ 'algebra' and /qæ'bɨɾ/ 'grave'. These clusters violate the SSP due to their rising sonority. The epenthetic vowels inserted in these codas not only form the syllable nucleus but also bear the primary stress in the respective word examples. It needs to be mentioned that epenthetic vowels do not always serve to repair illegal structures nor are they always stress-taking. A relevant example is found in colloquial Levantine Arabic dialects spoken across Lebanon, Syria, Israel, Palestine, and Jordan (Hall, 2013). In Lebanese dialects, for example, the coda sequence /-nt/ which adheres to the SSP in the word /bint/ 'girl' may be spoken either with an epenthetic vowel, as in /'binit/, or without it, as in /'bint/.

Characteristics	**Intrusive Vowels**	**Epenthetic Vowels**
Vowel types	Schwa, a copy of an adjacent vowel, or influenced by the place features of the nearby consonants.	Vowels may be fixed or may be copied from an adjacent vowel. Does not have to be schwa.
Vowel copies	If the vowel quality of another vowel is copied over a consonant, then that consonant must be a sonorant or a guttural.	The vowel quality may be copied over any type of intervening consonant.
Cluster types	Occurs in heterorganic clusters.	
Speech rate	May have a variable duration. May disappear at fast rates.	Not impacted by speech rate.
Vowel function	Does not repair illicit structures. Clusters where it appears may be less marked in terms of sonority than clusters in the same language which are not impacted by vowel insertion.	Serves to repair structures that are marked in terms of being cross-linguistically rare. The structure may be avoided by other processes in the same language.

Table 1.7 Characteristics of intrusive and epenthetic vowels (Hall, 2006).

1.4.2. Differences between Epenthetic and True (Lexical) Vowels

In a study using acoustic analysis, Davidson (2006) investigated the production of onset clusters by 20 adult native English speakers. The focus was on the production of initial consonant clusters that either contained an epenthetic schwa (Cᵊ C) or were split by a syllabic or lexical schwa (CəC). The goal was to determine the acoustic similarities between these two types of schwas. The participants were asked to pronounce pseudo-Czech words with initial clusters consisting of /s/, /f/, /z/, and /v/ followed by an obstruent or nasal (e.g., /zvaba/, /zbano/, and /fnada/), forming what was referred to as the CC condition. The primary objective was to examine the nature of the epenthetic schwa, which would occur if the participants struggled to produce the non-native given CCs. The duration, F1, and F2 characteristics of these inserted schwas with those of lexical schwas in the CəC condition (e.g., /zəvaba/, /zəbana/, and /fənada/), produced by the same participants was compared.

The results of this study indicated that there were qualitative differences between the schwa produced in the (C^{ə}C) and the (CəC) conditions. The durations of the epenthetic schwa were significantly shorter than the lexical schwa as well and the F1 and F2 midpoint values were significantly lower. These findings imply that when producing the epenthetic schwas, the tongue was positioned higher and farther back in the mouth than it was for the schwas naturally occurring in words. Davidson proposed that this difference might be attributed to what she termed as 'gestural mistiming' in the production of the consonant cluster elements. More specifically, he assumes that speakers may fail to overlap/coordinate consonants altogether when the consonants in a given sequence are not a legal cluster in their native language, and assumes that they are not epenthesising a vowel, but rather are ''mistiming'' articulatory gestures associated with the consonants in a cluster.

Davidson's gestural mistiming interpretation comes from the central principle of Articulatory Phonology (Browman & Goldstein, 1986), which postulates that a segment is made up of several articulatory gestures and that gestures have a duration in time termed 'temporal landmarks' (Gafos, 2002). The temporal landmarks of a gesture, shown in Figure 1.4, are indicated as follows: an 'onset', marking the point when the articulators first come under active control; a ‘target’, representing the desired constriction to be reached; a ‘centre’, positioned at the midpoint of the constriction; a ‘release’, marking the start of the movement away from the target; and an ‘offset’, indicating when the articulator is no longer under active control.

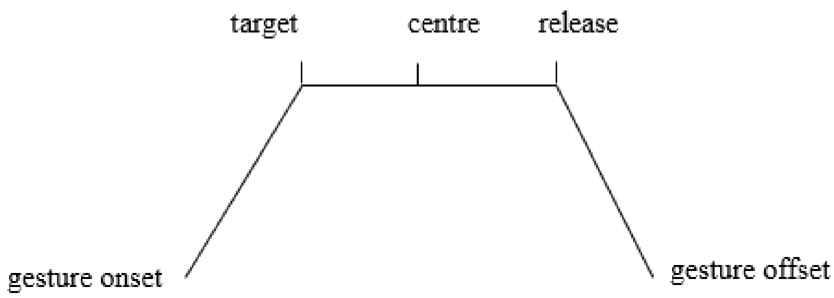

Figure 1.4 The temporal landmarks of a gesture in articulatory phonology (Gafos, 2002).

Articulatory gestures in a consonant cluster are also suggested to overlap with one another as shown schematically in Figure 1.5 where the release of the first consonant C1 is coordinated with the target of the second consonant C2.

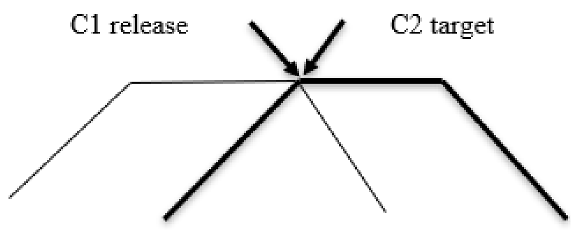

Figure 1.5 The articulatory gestures in a consonant cluster, as described in Davidson (2003).

When faced with phonotactically illegal clusters, speakers are assumed to insert a gesture corresponding to the schwa vowel into a gestural score. Steriade (1990) and Browman & Goldstein (1986) add that such a gesture may be perceived by the listener as a vowel if it has a very short duration. A schematic representation of Davidson's gestural mistiming is presented in Figure 1.6. in which the inserted /ə/ is argued to be produced as a result of mistiming or lack of sufficient overlap between the consonantal gestures in the pronunciation of the sequence /fp/. It is also obvious that /ə/ does not have a gesture corresponding to it and is therefore not considered a segment (Davidson, 2006).

In an attempt to further investigate epenthesis resulting from gestural mistiming, particularly focusing on whether the proposed gestural mistiming nature of schwas, as suggested in Davidson (2004, 2006), applies universally to languages that do not permit initial clusters of obstruent-obstruent and obstruent-nasal combinations, Davidson (2010) conducted a study that involved 23 English-speaking and 14 Catalan-speaking adults as participants. In this research, participants were presented with target words containing initial consonant clusters (CC) (e.g., /pka'di/) or sequences with schwa-insertion (CəC) (e.g., /pəka'di/). Participants were required to produce the target word after receiving auditory cues or both auditory and visual stimuli. The participants' responses were recorded, and acoustic analysis was performed to assess the duration, F1, and F2 values of intentionally produced schwa vowels and any inserted vowels in cases where participants failed to produce the target clusters. The results for schwa duration, and F1 were consistent with the findings of Davidson (2006) in that both English and Catalan speakers produced inserted schwas that were significantly shorter and had lower F1 values than their lexical schwas.

Hall (2013) conducted an acoustic analysis to compare the formant values and durations of lexical and epenthetic vowels in Lebanese Arabic. The focus was on the production of word pairs that consisted of a /CiCiC/ verb and /CiCC/ nouns, the latter was hypothesised to be realised with vowel epenthesis as /CiCiC/, where the underlined vowel represents an epenthetic vowel. A total of 22 native Lebanese speakers participated in this study. The participants were presented with the written form of the target words and also listened to an audio recording of the same words. The target words were written without vowels (as is normal in Arabic orthography). After hearing the sentence and reading the target word, speakers were asked to say the word in four frame sentences. Epenthesis rates were generally high, both across speakers and items, yet no significant difference in duration was found between lexical and epenthetic vowels; 60 ms and 61 ms, respectively. The author attributed this to potentially high speech rates at which the words were produced. Hall (2013) also observed considerable variation among speakers in the production of epenthetic vowels. Some speakers produced an epenthetic vowel that closely resembled the lexical /i/ in Lebanese Arabic in terms of formant frequency and duration. Others produced an epenthetic /ə/, while some speakers produced an intermediate vowel that heavily overlapped with the lexical /i/ in terms of formant frequency and duration.

The studies by Davidson (2006, 2010) and Hall (2013) collectively provide insights into the nature of lexical vowels and epenthetic vowels. Davidson's research highlights qualitative differences in the acoustic characteristics of epenthetic schwas compared to lexical schwas in English, suggesting a phenomenon termed 'gestural mistiming', where the production of illegal consonant clusters is thought to lead to the insertion of an epenthetic vowel. This pattern of shorter duration and lower F1 and F2 values in epenthetic schwas implies a distinct articulatory pattern. Davidson's subsequent study verifies these findings across English and Catalan speakers. Hall's study on Lebanese Arabic shows variation in the production of epenthetic vowels, with some speakers producing vowels closely resembling lexical vowels while others produce different epenthetic vowels. However, no significant duration differences were found between lexical and epenthetic vowels, possibly due to high speech rates. Together, these studies suggest that while there are acoustic differences between lexical and epenthetic vowels, the precise realisation of epenthetic vowels may vary across languages and speakers.

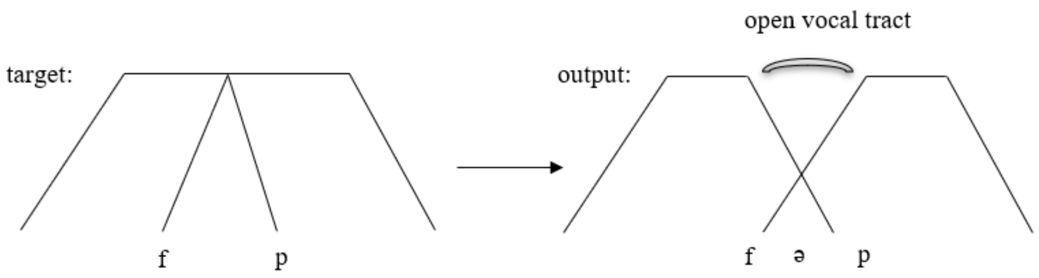

Figure 1.6 Gestural mistiming in the pronunciation of /fp/ cluster, from Davidson (2010). The inserted gesture corresponds to a schwa vowel.

1.4.3. The Epenthetic Vowel in Kurdish

The epenthetic vowel in NK and CK dialects has been described as a very short central high vowel /ɨ/. The phonemic status of the vowel has been controversial with Kurdish scholars assigning it phonemic and non-phonemic status alike. While some linguists consider it a separate (lexical) phoneme in the Kurdish inventory (e.g. Ahmed, 1986 for CK, and Hasan, 2017; Shokri, 2002 for NK), others (e.g., Hamid, 2016) argue against its ability to act phonemically as much as other lexical vowels do.

In NK, I argue that the vowel /ɨ/ in monosyllabic words in (4) is less likely to be epenthetic even though it is not represented in orthography when the Arabic script is adapted. This vowel exhibits characteristics typical of genuine lexical vowels: it can function as a syllable nucleus and forms minimal pairs with other lexical vowels, as exemplified in (4). Additionally, the /ɨ/ vowel does not disappear under morphological processes such as affixation. When the singular suffix /-æk/ is added to the words in (5), the /ɨ/ vowel remains intact and the primary stress is maintained on /ɨ/, as evidenced in the examples provided in (5).

(4) The /ɨ/ vowel vs. lexical vowels in NK and CK (from Hamid, 2016)

	Example	Gloss	Example	Gloss
a.	/'ʒɨn/	woman	/'ʒi:n/	life
b.	/'mɨl/	shoulder	/'mi:l/	mile
c.	/'tɨɾ/	other	/'ti:ɾ/	arrow

(5)

	Plural form	Singular/indefinite form	Gloss
a.	/'ʒɨn/	/'ʒɨnæk/	a woman
b.	/'mɨl/	/'mɨlæk/	a shoulder
c.	/'kɨʧ/	/'kɨʧæk/	a girl
d.	/'dɨl/	/'dɨlæk/	a heart

Hamid argues that the absence of an orthographic representation for the /ɨ/ vowel in Kurdish leads to the conclusion that it cannot be considered a lexical vowel, even in monosyllabic words. However, this assertion does not hold true for NK, particularly in regions like Turkey and Syria, where NK is written using the Roman alphabet. In this writing system, the vowel /ɨ/ is represented by the letter ‘i’. Therefore, the absence of an orthographic symbol does not diminish the status of /ɨ/ as a lexical vowel in monosyllabic words in NK.

In bisyllabic words, the vowel /ɨ/ does not consistently exhibit the features of lexical vowels: it tends to variably attract the primary stress and often disappears in morphological processes. In the examples in (6), /ɨ/ has attracted the primary stress in the presence of a lexical vowel. Yet, when the singular suffix /-æk/ is added to these words, /ɨ/ disappears, and the main stress shifts to the /æ/ vowel in the suffix, as illustrated in the example in (7).

(6) Stressed /ɨ/ in bisyllabic words in NK and CK (from Hamid, 2016)

	Example	Gloss
a.	/gæˈnɨm/	wheat
b.	/bɑˈqɨl/	beans
c.	/tʃɑˈdɨɾ/	tent

(7) Loss of /ɨ/ after the addition of the suffix /-æk /

	Example	Singular/indefinite form
d.	/gæˈnɨm/	/gænˈmæk /
e.	/bɑˈqɨl/	/bɑqˈlæk /
f.	/tʃɑˈdɨɾ/	/tʃɑdˈɾæk /

In other bisyllabic words, Hamid (2016) notices that /ɨ/ in the examples in (8) does not attract the primary stress. For these reasons, it can be argued that the /ɨ/ vowel in bisyllabic words in NK is more likely epenthetic even though it can variably take the primary stress. It is worth noting that Kurdish is not the only language that may be argued to have stressed epenthetic vowels. These vowels are also observed in the Papuan language Yimas (Alderete, 1999) which assigns the primary stress to the initial epenthetic syllable as in the examples given in (9).

(8) Unstressed /ɨ/ in bisyllabic words in NK and CK (from Hamid, 2016)

	Example	Gloss
a.	/ˈʤæʒɨn/	Eid
b.	/ˈbæfɨɾ/	snow
c.	/ˈkæpɨɾ/	pergola
d.	/ˈtʰæqɨn/	mud

(9) Stressed epenthetic vowel in Yimas (from Alderete, 1999)

	Example	Gloss
a.	/ˈtɨkɨt/	chair
b.	/ˈkɨlɨwa/	flower
c.	/ˈkrɨmkɨnawt/	wasp

In conclusion, the status of the vowel /ɨ/ as an epenthetic or lexical vowel in NK and CK dialects is still unsettled among Kurdish scholars. While some argue for its recognition as a distinct phoneme, particularly in monosyllabic words, others question its phonemic status. In NK, the vowel demonstrates characteristics of a lexical vowel in monosyllabic words, yet its behaviour in bisyllabic words is more variable, suggesting a possible epenthetic role. However, the transcription of NK using the Roman alphabet supports the argument for its lexical status at least in monosyllabic words. Further research is needed to fully understand the phonemic role of /ɨ/ in Kurdish dialects and its implications for phonological analyses.

1.4.4. Vowel Epenthesis by Kurdish Learners

Research concerning adult Kurdish learners of foreign or second languages has predominantly concentrated on their acquisition of English in the context of English as an EFL. Within the specific domain of English cluster acquisition, a limited body of literature exists. To the best of my knowledge, only three studies have attempted to examine how speakers of NK and CK dialects navigate the challenges posed by the acquisition of English clusters that are absent in their L1. These studies, conducted by Nasr (2011), Omer & Hamad (2016), and Keshavarz (2017), represent the existing research in this domain.

In Nasr's (2011) study, one hundred NK speakers, who were pursuing a major in English as an EFL at the University of Duhok, College of Arts, English Department, in the Kurdistan Region of Iraq were investigated regarding their perception and production of English onset and coda clusters. The participants were chosen from four different study levels, representing various proficiency levels in English. The hypothesis tested in the study posited that students in more advanced levels would exhibit reduced frequency in the use of cluster simplification processes such as epenthesis, deletion, and metathesis, compared to speakers at lower study levels.

The perception task aimed to examine if the participants were able to judge the presence of an epenthetic vowel within a given cluster or not because it was hypothesised that the participants may hear a monosyllabic word of English with a complex cluster (e.g., 'plight' /plaɪt/) as two syllables (e.g., 'polite'/pəˈlaɪt/). Pairs of such words were presented to the participants in written form on paper, with one word having a vowel that broke the cluster either at the beginning (e.g., ‘plight’ /plaɪt/ and ‘polite’/pəˈlaɪt/) or at the end (e.g., ‘packed’ /pækt/ and ‘packet’ /ˈpækɪt/). A recording of a native speaker pronouncing only one of the words was played to the participants. The participants were then immediately asked to identify which word had been played to them. The results of the perception task revealed that some participants perceived the wrong word which was not read by the native speaker. That is, they perceived ‘polite’/pəˈlaɪt/ when ‘plight’ /plaɪt/ was played to them, and vice versa. The frequency of errors in cluster misperception was slightly reduced as proficiency levels advanced. Nasr attributed this error to the influence of negative transfer from their native language (Kurdish).

In the production task, participants were asked to read words containing clusters from a provided word list. Additionally, they had to read cluster words integrated into sentences. The results revealed that cluster simplification processes, including epenthesis, deletion, and metathesis, were commonly employed by participants. However, these error types showed a gradual decline across proficiency levels. Deletion was the more frequent process when analysing both onset and coda clusters together. In contrast, epenthesis emerged as the dominant strategy, particularly in the case of onset clusters, especially triple onset clusters, when considered in isolation. It was also observed that the epenthetic schwa /ə/ was the preferred inserted vowel with onset clusters, whereas other inserted vowels including /ɪ/, and /e/ alongside /ə/ were inserted to repair coda clusters. Marked clusters, in terms of syllable margin length, were found to be more simplified and accordingly more challenging for the participants. The order in which onset and coda clusters were simplified was the following: CCCC (for coda clusters only) > CCC > CC (where > means more simplified or acquired later). Nasr, however, did not look into the role of markedness in terms of sonority, i.e., whether /s/- clusters and non-/s/-clusters were acquired differently. Ultimately, Nasr attributed learners' difficulties in pronouncing complex English clusters to two main factors: negative transfer from their native language and the universal principle of markedness.

In their study investigating cluster simplification strategies among adult CK learners of English, Omer & Hamad (2016) focused on the production of English initial triple clusters, including /skr-/, /spr-/, /spl-/, /str-/, /stj-/, /skw-/, /skl-/, /skj-/, and /spj-/. Fourteen Kurdish EFL learners participated, reading a word list, which was then compared to a native English speaker's pronunciation of the same words. The research revealed that most participants tended to insert an epenthetic /i/ between the first two elements of the given clusters (e.g., saying /sikri:m/ instead of /skri:m/). Due to this vowel insertion, Omer and Hamad observed that the learners' pronunciation of English clusters had a longer duration acoustically when compared to the native speaker's pronunciation of the same clusters. One potential shortcoming of this study is that it only investigated initial triple clusters and excluded other types of clusters. This narrow focus may limit the generalisability of the findings to a broader range of pronunciation challenges faced by Kurdish EFL learners. Also, the study's sample size was relatively small, with only 14 Kurdish EFL learners participating. A larger and more diverse sample could provide more robust insights into the pronunciation patterns and challenges experienced by this population. Furthermore, the study only compares the pronunciation of the learners to that of a single native English speaker. Including multiple native English speakers could offer a more comprehensive understanding of the differences in pronunciation between learners and native speakers. Lastly, while the study identifies a specific error pattern (epenthetic vowel insertion) among the participants, it does not delve deeply into the underlying reasons or mechanisms behind this phenomenon.

In the study conducted by Keshavarz (2017), an investigation was undertaken to identify the most problematic English coda clusters for 18 CK adult learners of English pursuing a university degree at a private university in Northern Cyprus. It was hypothesised that these clusters are more challenging for the participants due to negative interference from the native language. The objective was to determine the cluster simplification strategies employed by these learners when they are faced with these clusters. Participants were required to read a short paragraph, a series of sentences, and a wordlist containing the target double coda clusters (stop + /s/, stop + /t/ or /d/, affricate +/t/, dental fricative + /s/) as well as a selection of triple onset clusters (/skr/, /stj/, /str/). These clusters had been identified as particularly challenging through the researcher's classroom observation. The study's findings indicated that coda clusters posed greater difficulties for the participants compared to initial clusters. Keshavarz attributed the ease with which onset clusters were produced to positive transfer from Kurdish, which he assumes allows initial consonant clusters. The predominant simplification strategy observed among all participants was vowel anaptyxis, involving the insertion of an epenthetic /ɪ/. For example, the words 'books' and 'looked' were pronounced as /bʊkɪz/ and /lʊkɪd/, respectively. Keshavarz attributed the challenges with coda clusters to negative transfer from the participants' native language phonotactics and insufficient exposure to the target language. Additionally, he suggested that these errors might have become fossilised in the pronunciation of the participants. One potential limitation of this study is its reliance on a rather small and specific participant group, which may limit the generalisability of the findings to a broader population of English language learners because individual differences in proficiency level, for example, could impact the strategies employed to simplify coda clusters. Additionally, the absence of a comparison group comprising native English speakers means that the study focuses primarily on non-native learners' challenges without directly contrasting them with native speaker patterns.

Overall, the studies discussed above provide support for speech production difficulties among Kurdish learners in their learning of English complex syllable structures. What unifies these studies is that native language phonotactic constraints are reported as the main cause behind cluster production difficulties. Only Nasr's study seems to have looked into the role of proficiency and markedness based on syllable margins. Yet, in none of the previously discussed research has the impact of markedness based on sonority been examined. More specifically, it has not been tested whether onset clusters violating the SSP and adhering to it are produced differently. This question is particularly interesting when viewed in relation to markedness constraints, which have been linked to the ease with which an L2 cluster is acquired (Selkirk, 1984; Clements,1990; Steriade, 1990; Carlise, 2001; Yavas, 2013). Several studies in IL phonology provide support for this role of sonority difference in the acquisition of L2 onset clusters (see 1.2.3. for a review of such studies). The second study of this thesis expands on such findings by examining the difficulties of Kurdish adult speakers in their acquisition of English onset clusters that violate the SSP and abide by it. Furthermore, the study also aims to validate the findings of Nasr (2011) by examining the role of markedness in terms of syllable margin length by testing whether Kurdish learners modify longer L2 sequences more frequently than shorter sequences. Results from some studies on IL consistently tend to confirm this general hypothesis, demonstrating that longer L2 sequences are acquired later or undergo modifications more frequently than shorter sequences (see 1.2.4 for several example studies). Also, the study aims to examine whether improved L2 proficiency as measured through an Elicited Imitation Task and a vocabulary task would help to improve the accurate production of L2 clusters. L2 proficiency in Nasr's study has been measured rather vaguely using the number of English major study years, which is more likely to overlook important individual proficiency differences.

Additionally, the studies conducted thus far have primarily employed controlled tasks, such as reading word lists or paragraphs, to elicit the target clusters. However, research suggests that such tasks may not fully capture real-world language knowledge (de Leeuw et al., 2021). The reliance on controlled tasks may prompt participants to focus excessively on their pronunciation, rather than generating responses that accurately reflect their linguistic abilities in natural conversation. Hence, in the L2 study presented in this thesis (see Chapter 4), a less controlled task known as phonemic verbal fluency is incorporated, in addition to a reading task. This approach is adopted with the aim of eliciting responses that better reflect the participants' actual pronunciation of L2 clusters in natural settings. Finally, while anaptyxis stands out as the main simplification strategy in the studies discussed above, especially concerning the production of English onset clusters, there remains a gap in understanding the acoustic properties of the inserted vowel. Specifically, it has not been determined whether these inserted vowels retain their spectral characteristics or simply replicate those of a neighbouring lexical vowel. The second study of this thesis aims to address this gap by investigating the acoustic properties of the inserted vowel, particularly whether it maintains its own spectral characteristics or mimics those of a nearby lexical vowel.

1.5. Summary

In this chapter, key concepts and theories concerning Interlanguage phonology overall, with a specific focus on the acquisition of English consonant clusters, have been explored. The influence of universals in the context of markedness, specifically in relation to sonority and syllable margin length, as well as the impact of L1 language transfer, appear to be significant factors in the process of acquiring the target syllable structure. Sonority and syllable margin length play crucial roles in determining syllable structure complexity. Sonority governs the arrangement of sounds within syllables, with languages typically favouring patterns of rising sonority from the onset to the nucleus and falling sonority from the nucleus to the coda. Syllable margin length refers to the number of consonants permitted at the beginning or end of a syllable. Languages vary in their allowance of consonant clusters at syllable margins, impacting L2 syllable structure acquisition. Moreover, the influence of L1 language transfer cannot be neglected. Learners often apply patterns and structures from their native language to the target language, which can either facilitate or impede the acquisition of the target syllable structure. If the syllable structures in the L1 differ significantly from those of the target language, learners may encounter challenges in adjusting their syllable patterns accordingly.

furthermore, this chapter has presented the relevant characteristics of the L1 and the L2 in this study, i.e., Kurdish and English, illustrating some differences concerning phonemic and syllable structure inventories. It was observed that English possesses a more complex syllable structure, allowing for combinations like (CCC)V(CCCC), while Kurdish permits a maximum of two consonants to cluster together. Based on this difference, Kurdish learners of English are expected to draw from their native language consonant cluster inventory in their acquisition of English consonant clusters. See Chapter 3 for specific predictions. Although on the one hand NK has a maximum of two consonants in a cluster, so lesser complexity than English, on the other hand, NK has a greater variety of cluster combinations, including many that potentially disobey the SSP, if they are confirmed as true clusters in the L1 study (see Chapter 3). The literature on

NK phonology reveals inconsistencies in describing certain consonant sequences as true clusters. Specifically, there is ambiguity regarding whether these sequences form true clusters or are interrupted by a vocalic element. Therefore, this thesis aims to clarify the status of these combinations as clusters in L1 NK.

Lastly, the chapter has ended with a brief discussion of the notion of vowel epenthesis and its major types: anaptyxis and prothesis, with the former being reported as a more common simplification strategy employed by L2 learners when confronted with marked L2 structures. A discussion regarding the distinction between epenthetic and intrusive vowels has also been provided based on Hall's diagnostics for these two vowel types. It has been noticed that vowels employed by L2 learners when confronted with marked L2 structures are mainly epenthetic as they attempt to repair the marked clusters, whereas intrusive vowels may not accessorily function as a repair strategy. A distinction between epenthetic vowels and true lexical vowels has also been given. The literature available on these two vowel types has found acoustic differences in terms of duration and formant frequencies. The issue of what constitutes an epenthetic vowel in NK, the Kurdish dialect understudy, has also been addressed. The status of the mentioned vowel seemed to be unsettled in Kurdish phonology. Finally, the chapter has concluded with three studies investigating how Kurdish speakers confront challenges posed by acquiring English clusters absent and/or present in their L1, with vowel epenthesis being found as their main and preferred simplification strategy. The following chapter will state the goal and contribution of the current thesis and will present the research questions addressed, as well as its hypothesis.

Chapter Two

2. Goals, Research Questions and Hypotheses

2.1. Goals

This thesis comprises two main studies. The first study (L1 Kurdish study) aims to settle the cluster status of several consonant sequences in NK by providing the first acoustic and impressionistic analysis of these sequences, along with examining how they are perceived by native Kurdish speakers. The second study (L2 English study) aims to investigate, in light of predictions of the Sonority Sequencing Principle, markedness theory, and the results of the Kurdish study, the specific challenges and difficulties faced by Kurdish learners of English as a foreign language when producing English onset clusters. This study also aims to determine the extent to which English proficiency is associated with enhanced production of English consonant clusters among Kurdish learners.

2.2. Research Questions

This thesis aims to answer the following research questions, organised in terms of whether they address the status of consonant clusters in L1 NK or in L2 English.

Regarding the perception and production of NK L1 consonant sequences:

- RQ.1. Do NK speakers perceive as more Kurdish-like or natural native onset and coda consonant combinations with or without a vocalic element/epenthetic vowel?
- RQ.2. Do NK speakers produce native onset and coda consonant combinations with or without a vocalic element/epenthetic vowel?

- RQ.3. Is the perception and production of a vocalic element/epenthetic vowel determined by factors such as the Sonority Sequencing Principle, consonant sequence combination, and consonant sequence position (onset vs coda)?
- RQ.4. What is the relationship between the perception and production of NK consonant sequences?

Regarding the production of English L2 onset clusters:

- RQ.5. How do Kurdish EFL learners produce English onset consonant clusters?
    - SUB-RQ.5.1. How do Kurdish EFL learners produce English 2-consonant onset clusters?
    - SUB-RQ.5.2. How do Kurdish EFL learners produce English 3-consonant onset clusters?
    - SUB-RQ.5.3. Is the production of English onset clusters determined by factors such as L1 transfer, the Sonority Sequencing Principle, and markedness?
- RQ.6. To what extent can English proficiency (L2 proficiency) be associated with enhanced production of English onset clusters among Kurdish EFL learners?

2.3. Hypotheses

RQ.1 addresses the issue of whether native NK speakers perceive certain onset and coda consonant combinations as more Kurdish-like/natural with or without the addition of an epenthetic vowel. The available literature (e.g., Kahn, 1976; Hasan, 2009; Shokri, 2002) concerning the cluster status of these onset and coda sequences is often inconsistent. More specifically, there is ambiguity regarding whether these sequences constitute actual clusters or if they are broken by a vocalic element. In all of these works, no attempt has been made as to whether these sequences are perceived as actual clusters by native Kurdish speakers, that is, whether NK speakers perceive these sequences as more Kurdish-like or natural with or without the presence of a vocalic element.

Examining native speakers' perception of consonant combinations as actual clusters is crucial for two main reasons. Firstly, it helps reveal the phonological reality of these combinations as experienced and used by the community which will, in turn, support theoretical analyses of what constitutes an actual cluster in NK. Secondly, it would provide valuable information on phonotactic constraints within the language. Concerning the latter point, most of the consonant sequences reported in Hasan (2009) as actual clusters in NK are sequences that violate the sonority principle (Clements, 1990) and are, therefore, less likely to constitute actual clusters. Consonant sequences violating the sonority principle are universally considered rare permissible combinations, that is, they do not often exist in the world's languages (Carlisle, 2001), and are often broken up by a vocalic element. Thus, it can be hypothesised in this study that consonant sequences described in Kahn (976) and Hasan (2009) as actual clusters will be perceived as more Kurdish-like or natural with the addition of an epenthetic vowel.

All previous descriptions of consonant clusters in NK are primarily descriptive (Kahn, 1976; Hasan, 2009; Shokri, 2002). These descriptions may have originated from the orthographic representation of Kurdish words, which typically omits epenthetic vowel representations, or have relied on the subjective native intuition of the respective authors. Notably, native Kurdish speakers often disregard the epenthetic vowel /ɨ/ when asked to list the sounds that make up a word (Hamid, 2016). Importantly, none of these works has undertaken a production study to investigate how these consonant combinations are produced by native NK speakers and to acoustically determine whether these combinations indeed constitute true clusters – specifically, whether a vocalic element is acoustically identified as absent in these combinations.

The absence of such acoustic investigations may have contributed to discrepancies concerning the cluster status of certain consonant combinations in NK. Therefore, the acoustic analysis to be conducted in this thesis on the production of consonant sequences that will also be perceptually tested will represent the first experimental examination of these combinations. A high frequency of vocalic elements within these sequences is expected to be found. It is hypothesised that the participants of the Kurdish study will produce their native onset and coda consonant combinations more frequently with the addition of a vocalic element/an epenthetic vowel (RQ.2).

Factors like consonant sequence combination – whether in terms of the frequency of combination use or the homogeneity of place of articulation among its constituents – and consonant sequence position (onset vs coda) are not expected to greatly influence the perception of a sequence as more Kurdish-like or natural if the sequence violates the sonority principle (RQ.3). That is, all sequence combinations that violate the SSP are expected to be perceived as more Kurdish-like or natural with vowel epenthesis, regardless of whether their consonants are homorganic or whether they occur at the beginning or end of the syllable. Just as in the case of perception, sequence combination, and position (onset vs coda) are not expected to play a vital role in the production of a vocalic element/epenthetic if a given sequence violates the sonority principle. That is, sequence combinations that violate the sonority principle are expected to be consistently produced with a vocalic element regardless of their consonant structure or their location within a syllable (onset vs coda). As a result, a clear link regarding the perception and production of vowel epenthesis is expected to be found in these sequences (RQ.4). That is, sequences characterised by a high degree of vowel epenthesis in production would also be perceptually preferred with vowel epenthesis. Eventually, this outcome is expected to help determine the cluster status of the sequences tested. Regarding the nature of the inserted vocalic element, it is predicted to mainly exhibit the characteristics of epenthetic vowels outlined in Hall (2003, 2006) and therefore inserted to repair illicit consonant combinations, i.e., those violating the sonority principle.

The outcomes of the Kurdish study are anticipated to have important implications for the study of the acquisition of English consonant clusters by Kurdish adult learners of English (RQ.5). It is expected that English 2-consonant onset clusters may pose challenges for Kurdish learners, leading to frequent epenthesis, when these combinations are determined as non-clusters in the L1 Kurdish study (L1 transfer in SUB-RQ.5.3). This phenomenon is particularly likely to be more prominent among learners in the early stages of language acquisition, in accordance with the predictions of the Ontogeny Phylogeny Model (Major, 2001), which posits that transfer effects are at their peak at the beginning of L2 learning and that those features that are unmarked in the L2 are more affected by transfer than those features that are marked. Conversely, L1 positive transfer from Kurdish is expected in the acquisition of English consonant combinations that exist as true clusters in both languages.

Regarding the effect of the Sonority Sequencing Principle (SUB-RQ.5.3), and based on the Minimal Sonority Distance Principle (Broselow & Finer, 1991), English onsets consisting of greater sonority differences between their members – i.e., less marked structures – are expected to be less challenging and accordingly produced more accurately than those with a smaller sonority difference between their members – i.e., more marked structures – as several studies in interlanguage phonology provide support for this role of sonority difference in the acquisition of L2 onset clusters (Broselow & Finer, 1991; Hancin-Bhatt & Bhatt, 1997; Carlisle, 1988, 1991, 1992, 1994, 2006; Abrahamson, 1999; Rauber & Baptista, 2004; Cardoso, 2008; Almalki, 2014). Moreover, it is anticipated that attaining native-like patterns of English sonority reversals in fricative /s/ + stop onset clusters, as discussed by Carlise (2001), will pose greater challenges. This is because such clusters represent a universally marked structure in the onset position. They disobey the sonority principle by transitioning from a higher sonority voiceless fricative to a lower sonority voiceless stop (Clements, 1990). However, if the fricative /s/ + stop onset combination is established perceptually and acoustically as a true cluster in the L1 Kurdish study, the production of its English equivalent is expected to pose less difficulty for Kurdish learners if positive transfer from their L1 is found to influence their English pronunciation more significantly than the sonority principle.

Concerning the production of English 3-consonant onset clusters, the Markedness Differential Hypothesis (Eckman, 1977) and the Interlanguage Structural Conformity Hypothesis (Eckman, 1991) predict that L2 structures that are different and more marked than L1 structures would be more difficult to acquire. However, L2 forms that differ from the LI forms, but are not more marked, are less likely to present difficulties in learning. Since 3-consonant clusters do not exist in NK (Shorkri, 2002; Hasan, 2009; 2012), and are widely acknowledged as universally marked structures (Greenberg, 1965; Kaye & Lowenstamm, 1981), it is expected that Kurdish learners will acquire these sequences later or modify them more frequently than shorter sequences. Results from many studies on interlanguage phonology (Eckman, 1991; Carlisle, 1997, 1998, 2002; Hancin-Bhatt, 2000; Rauber & Baptista, 2004; Alosaimi, 2023) consistently confirm this general hypothesis, finding that English learners produced less marked onset clusters – 2-consonant onsets – more accurately than more marked onset clusters – 3-consonant onsets. Thus, the length-based complexity of syllable margins is expected to greatly influence the mastery of L2 onset clusters by Kurdish learners.

The existing research on the acquisition of English consonant clusters by Kurdish learners, as investigated by Nasr (2011), Omer & Hamad (2016), and Keshavarz (2017), has identified anaptyxis – the insertion of an epenthetic vowel between the first two consonants of a given L2 cluster – as the primary and preferred simplification strategy used by Kurdish learners when confronted with challenging L2 structures, particularly in the production of English onset clusters. However, there remains a gap in understanding the acoustic properties of these inserted vowels. Specifically, it has yet to be determined whether these inserted vowels maintain their spectral characteristics, replicate those of neighbouring lexical vowels, or correspond to the epenthetic vowels used to repair illicit consonant sequences in the learners' L1. It is anticipated that these inserted vowels will exhibit spectral characteristics similar to those found in L1 Kurdish, suggesting that participants are more apt to transfer their L1 epenthetic vowels to simplify complex L2 clusters.

Little attention has been directed to assessing how English proficiency influences the acquisition of English consonant clusters among Kurdish learners (RQ.6), as to my knowledge, only Nasr (2011) has investigated this issue and found that Kurdish senior undergraduate learners outperformed junior learners in their production of English clusters. It should be noted that L2 proficiency in Nasr's study has been measured rather vaguely using the number of English major study years, which is more likely to overlook important individual proficiency differences. Therefore, it is anticipated that the proficiency levels of individual learners, as assessed in this thesis through the use of an Elicited Imitation task (EIT) and a vocabulary task, will more accurately reflect the impact of L2 proficiency on the production of L2 clusters. Specifically, drawing from the Ontogeny Phylogeny Model (Major, 2001), as learners' proficiency in their L2 increases, the tendency for transfer from their first language is expected to diminish, accompanied by a reduced influence from language universal/markedness. Consequently, we anticipate that Kurdish learners with higher L2 proficiency levels will exhibit more native-like patterns in the production of both marked and less marked English clusters.

This section has stated the goals of the current thesis and presented its main research questions. Moreover, the hypotheses have been discussed according to frequently cited L2 acquisition models relevant to this study and the results of previous research. The following chapters (Chapters 3 for the L1 Kurdish study and 4 for the L2 English study) will provide a detailed description of the methodology employed to investigate the research questions posed in this thesis, followed by the presentation of the results, analyses, and discussions of the results obtained from both studies.

Chapter Three

3. Perception and Production of Consonant Sequences in L1 Kurdish

An examination of the syllable structure in NK has revealed discrepancies in the existing literature (e.g., Kahn, 1976; Hasan, 2009; Shokri, 2002) concerning the cluster status of certain onset and coda consonant sequences (see Chapter 1). Specifically, there is ambiguity regarding whether these sequences constitute actual clusters or if they are broken by a vocalic element. In all of these works, no attempt has been made as to whether these sequences are perceived as actual clusters by native Kurdish speakers, that is, whether they perceive them as more Kurdish-like or natural with or without the presence of a vocalic element. Examining how native speakers perceive consonant combinations as clusters is crucial for understanding their phonological reality and supporting theoretical analyses in NK. Many of these sequences, identified as clusters in previous works, violate the SSP and are less likely to be true clusters. Such violations are rare across languages (Carlise, 2001) and often necessitate the insertion of a vocalic element. The first research question of this study involves whether NK speakers perceive as more Kurdish-like or natural these onset and coda consonant combinations with or without a vocalic element/epenthetic vowel. To achieve this goal, a perception experiment was conducted using a forced-choice goodness task.

The existing discrepancies in the literature regarding the cluster status of these sequences may have also originated from the lack of an acoustic investigation. None of the previous works has undertaken a production study to investigate how native NK speakers produce these consonant combinations and to acoustically determine whether these combinations indeed constitute true clusters – specifically, whether a vocalic element is acoustically identified as absent in these combinations. Therefore, the second research question of this study addresses these gaps and aims to explore how native NK speakers articulate these consonant combinations. It seeks to ascertain acoustically whether these combinations truly qualify as clusters, with particular attention to identifying the presence of a vocalic element in these combinations. To this aim, a production experiment is carried out consisting of two production tasks: a carrier sentence reading task and a picture-naming task. An impressionistic analysis, along with an acoustic analysis, is conducted on the sequences produced. This study also attempts to examine the relationship between the perception and production of the investigated sequences. Specifically, the study aims to determine whether sequences perceived as true clusters are also produced as true clusters and sequences preferred with a vocalic element are also produced with a vocalic element. The results of both perception and production tasks are then discussed in light of the SSP predictions, as well as the frequency and positional distribution (onset vs coda) of the combinations.

3.1. Methodology

The perception and production of several NK consonant sequences were assessed using a perceptual forced-choice goodness task, a carrier sentence reading task, and a picture-naming task. This section describes the participants in this study, the stimuli used in the different tasks, and the actual tasks and data collection procedure.

3.1.1. Participants

A group of 15 NK speakers participated in this study. These included 8 females and 7 males with a mean age of 32.6 years. (SD = 7.8). All participants were native speakers of the NK dialect spoken in Duhok Governorate in the Kurdistan region of Iraq. They were academics and administrative staff at Zakho University. All participants reported normal vision and hearing abilities and voluntarily participated in this study. Participant's daily use of L1 and their knowledge of foreign and/or second language(s) were assessed on the basis of their responses to a questionnaire established at the start of the perception experiment. Thirteen people reported speaking two or more foreign languages in addition to Kurdish, namely Arabic and English, English and German, or Arabic, English, and German. The remaining two participants reported knowledge of a single foreign language: either Arabic or German. NK, however, was reported to be the only mother tongue of all participants, with the majority (n = 11) reporting 76-100% daily use of NK. The remaining participants, (n = 3), reported a mean use of 51-75% while one participant seemed to speak NK very little (0-25%). Although, ideally, only Kurdish monolinguals should have been tested in this study, this was not easily possible given the linguistic reality of the Kurdistan region where English and Arabic – the latter is the second official language in the region – are mandatory materials in the school curriculum of Kurdistan Region. Moreover, 50% of the participants belonged to the older generation who had received their entire school education in Arabic. In this way, it could be argued that these participants should not have been included in the first place, but the reality was that even participants belonging to the younger generation – the remaining 50% – consume a lot of audio-visual content in Arabic and/or have strong family ties with Arabic-speaking relatives. Additionally, Kurds – as a Muslim community – use Arabic as a religious language to conduct their religious deeds, prayers, and behaviours and to read the Holy Qur'an, a significant religious text written in Classical Arabic (Al Shlowiy, 2022). Finding NK monolingual speakers was not easily possible because of the factors mentioned above.

However, knowledge of Arabic is not expected to highly impact the participants' pronunciation of initial L1 consonant sequences because Modern Standard Arabic (MSA), the standard form of Arabic in the contemporary era (Al Soswah, 2002) and the variety that most participants were exposed to through media and school materials, does not allow more than one consonant in the onset. Conversely, coda sequences of up to two consonants (VCC) are allowed in MSA. Such sequences, however, are found to be often challenging to produce as clusters by native Arab speakers themselves. Obeidat (2010) in his treatment of VCC clusters in MSA considers its complex codas "difficult to pronounce" in some cases, including /ħidʒl/ 'anklet' and /qabr/ 'grave', /ħidʒl/ 'anklet' and /nuqr/ 'sound'. Such sequences, he adds, are often variably epenthesised by a vowel, i.e., /qabir/, /ħidʒil/ and /nuqir/. Despite this observed variability in the pronunciation of Arabic coda clusters, it is less likely that the participants of this study will transfer this knowledge directly to their mother tongue, Kurdish because Arabic, while present in media and educational materials, is not commonly spoken in everyday life by Kurds due to political tensions between Kurdish communities and Arabic-speaking governments. For Kurds, speaking Kurdish is a matter of national identity.

3.1.2. Test Words

Words containing consonant sequences described in Kahn (1976), Shokri (2002), and Hasan (2009) as constituting actual clusters were selected for the perception and production experiments to test if these authors' descriptions were accurate. A total of 29 words (see Appendix B for all words used in the Kurdish study) formed the basis of perception and production test items, with many words shared between the two tasks to test if NK speakers perceive and produce as more Kurdish-like or natural native consonant sequences with or without an epenthetic vowel. It needs to be mentioned that fewer words were included in the perception task than in the production tasks to limit the task's complexity and duration. In addition to the test items, several filler words were included in each task but these were neither meant to target any particular phonological variable, nor did they contain an onset and/or a coda cluster. The following subsections describe how perception stimuli were created (see section 3.1.2.1) and how production test items were selected for the reading task and the picture-naming task (see section 3.1.2.2).

3.1.2.1. Perception Stimuli

The stimuli for the perception task were derived from a total of 15 words, consisting of 11 types of consonant sequence combinations. These sequences comprised 10 onset-cluster words and 5 coda-cluster words. All words were morphologically simple nouns except /p^{h}tɨɾ/ and /lvin/, which are a determiner and an infinitive verb, respectively.

Regarding the number of syllables constituting these words, there were two possibilities: the words might be monosyllabic or disyllabic. If the consonant sequences to be tested in these words constituted actual clusters – i.e., contained no epenthetic vowel following the descriptions given in Kahn (1976), Shokri (2002), and Hasan (2009) – then these words would be considered monosyllabic; having only a single main lexical (root) vowel. But if – as hypothesised – an epenthetic vowel was present breaking the combinations and forming a syllable nucleus, these words would be disyllabic. Regarding the stressed vowels in these words, lexical vowels /ɑ/, /i/, /e/, /æ/, and /u/ were stressed in all words, with the exception of /ɨ/ in /p^{h}tɨɾ/. The status of /ɨ/ as a lexical or epenthetic vowel is still under debate, as discussed in Hamid (2016), Hasan (2016), and Shokri (2002). Despite the debatable status of /ɨ/, it is assumed to carry the primary stress in /p^{h}tɨɾ/ (see Chapter 1 for a discussion of epenthetic vowels in Kurdish). Finally – and to examine the predictions of the SSP – selected words contained 7 sequences (6 onsets and 1 coda) obeying the SSP, 7 sequences (3 onsets and 4 codas) violating the SSP, and 1 word (/p^{h}tɨɾ/) with a sonority plateau initial sequence. Given that sonority plateau sequences are one kind of SSP violation (see Chapter 1), they were considered as violating the SSP throughout this study. Thus, the perception experiment examined 7 sequences obeying the SSP, and 8 sequences violating it. Table 3.1 below gives a detailed description of words used in the perception task alongside specifications relevant to the target sequences: positions (onset vs coda), combinations, and SSP violation.

Test word	Grammatical category	Gloss	Onset sequence combination	SSP violation
/nveʒ/	Noun	prayer	nasal + fricative	Yes
/pʰtɨɾ/	Determiner	more	stop + stop	Yes
/lvin/	Infinitive verb	to move	approximant + fricative	Yes
/steɾ/	Noun	star	fricative + stop	Yes
/bnɑɣ/	Noun	basis	stop + nasal	No
/mɾiʃk/	Noun	chicken	nasal + approximant	No
/tʰfæɳg/	Noun	rifle	stop+ fricative	No
/sɾuʃt/	Noun	nature	fricative + approximant	No
/bɾin/	Noun	wound	stop + approximant	No
/snel/	Noun	teenage	fricative + nasal	No
			Coda sequence combination	
/ʤæʒn/	Noun	Eid	fricative + nasal	Yes
/kæpɾ/	Noun	pergola	stop + approximant	Yes
/bæfɾ/	Noun	snow	fricative + approximant	Yes
/tʰæqn/	Noun	mud	stop + nasal	Yes
/ʃæɾm/	Noun	shyness	approximant + nasal	No

Table 3.1 Words used in the perception task with their grammatical categories and glosses. Specifications of the target sequences (positions, combinations, and SSP violation) are also given.

A female NK native speaker, who was the author of this thesis, produced several repetitions of each test word, and the best tokens were chosen by two trained phoneticians. The speaker produced all the stimulus words with epenthetic vowels (henceforth CvC stimuli), as shown in the right-hand column of Table 3.2 below. The recording took place in a quiet room in Joan Maragall's public library in Barcelona. The software used for the recording was Audacity installed on a Microsoft laptop Model 1943. The mean duration of the epenthetic vowels for all CvC stimuli was 53.6 ms (SD = 9.7, Range = 40 – 65). The recordings were digitised at a 44 kHz sampling rate, and the stimuli were normalised for intensity (70 dB). Afterwards, the epenthetic vowel was deleted from the stimuli, such that new stimuli without epenthetic vowels (henceforth CC stimuli) were created, listed in the second column in Table 3.2. Deleting the epenthetic vowel from a cluster was based on the analysis of the spectrogram and waveform using Praat (Boersma & Weenink, 2021). Specifically, the sequence of the two consonants in the cluster was inspected and any vocalic element, as shown by periodicity in the acoustic signal, relative higher intensity, and visible vowel-like formant structure, was delimited at zero-intensity crossings and deleted. Thus, 30 stimuli were created from 15 test words: two stimuli for each test word, a CvC stimulus, and a CC stimulus. See the examples in Figures 3.1 and 3.2, which provide a visual display (waveform and spectrogram) of the CC and CvC stimuli created for the word /steɾ/. In addition to the test stimuli, a total of 12 stimuli were created for 6 filler words that were only meant to distract the participants' attention from the purpose of the perception task.

Edited stimulus with no epenthetic vowel	**Original stimulus with an epenthetic vowel**
/ʃæɾm/	/ʃæɾɨm/
/ʤæʒn/	/ʤæʒɨn/
/bæfɾ/	/bæfɨɾ/
/tʰæqn/	/tʰæqɨn/
/kæpɾ/	/kæpɨɾ/
/pʰtɨɾ/	/pʰɨtɨɾ/
/bnɑɣ/	/bɨnɑɣ/
/sɾuʃt/	/sɨɾuʃt/
/mɾiʃk/	/mɨɾiʃk/
/nveʒ/	/nɨveʒ/
/lvin/	/lɨvin/
/tʰfæŋg/	/tʰɨfæŋg/
/bɾin/	/bɨɾin/
/snel/	/sɨnel/
/steɾ/	/sɨteɾ/

Table 3.2 Tokens used in the forced-choice goodness task.

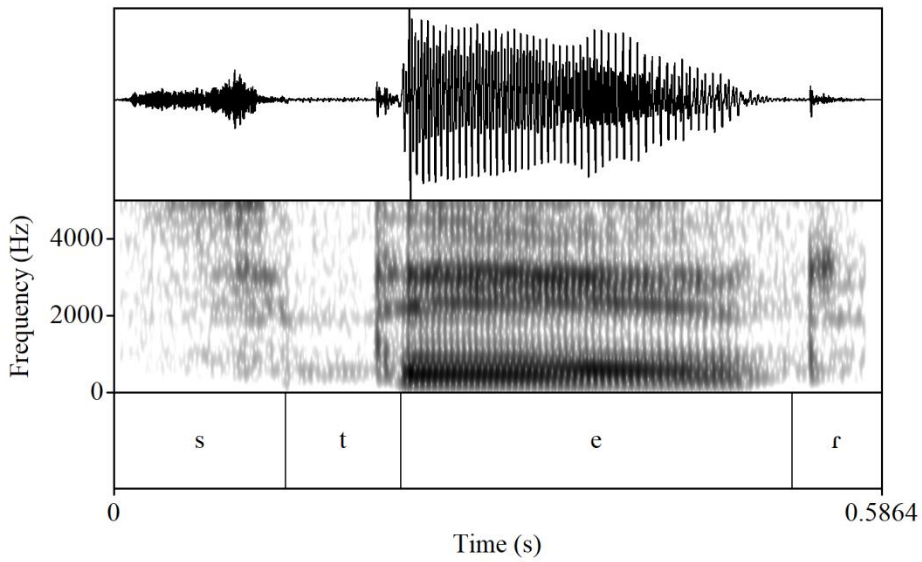

Figure 3.1 Spectrogram of an example of word stimulus used in the perception task, without an epenthetic vowel (/steɾ/).

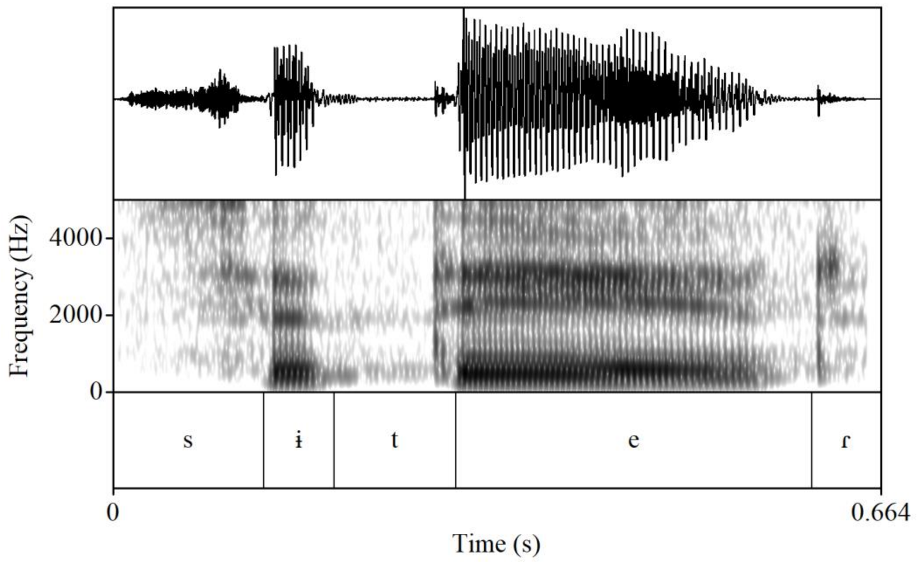

Figure 3.2 Spectrogram of an example of word stimulus used in the perception task, with an epenthetic vowel (/siteɾ/).

3.1.2.2. Production Stimuli

A total of 21 words were included in the reading task (see Table 3.3 below) – 11 onset-cluster words and 10 coda-cluster words. All words were morphologically simple nouns except /lvin/, /pʰtɨɾ/ and /spi/. Similar to the test words in the perception task (see 3.1.2.1), words in this task could be considered monosyllabic or disyllabic depending on whether or not they contained an actual cluster. Lexical vowels /ɑ/, /i/, /e/, /æ/, and /u/ were stressed in these words, and the /ɨ/ vowel in /pʰtɨɾ/ is assumed to be stressed based on the perspectives of two NK phonologists affiliated with the University of Zakho. In view of examining the role of the SSP, a selection of 13 words contained sequences obeying the SSP (7 onsets and 6 codas), and 8 words contained clusters violating the SSP (4 onsets and 4 codas). It should be mentioned that 11 words included in the reading task were also included in the perception task. Thus, in the reading task, a total of 15 sequence combination types were tested, with 13 sequences obeying the SSP, and 8 sequences violating it. It is worth noting that a few sequences, e.g., the fricative + stop combination, violate the SSP when occurring at the beginning of a word, but adhere to it when positioned at the end of a word.

Test word	Grammatical category	Gloss	Onset sequence combination	SSP violation
/pʰtɨɾ/	Determiner	more	stop + stop	Yes
/nveʒ/	Noun	prayer	nasal + fricative	Yes
/lvin/	Infinitive verb	to move	approximant + fricative	Yes
/spi/	Adjective	white	fricative + stop	Yes
/pʰʃik/	Noun	cat	stop + fricative	No
/bnɑɣ/	Noun	basis	stop + nasal	No
/znɑɾ/	Noun	personal name	fricative + nasal	No
/sɾuʃt/	Noun	nature	fricative + approximant	No
/mɾiʃk/	Noun	chicken	nasal + approximant	No
/ʧnɑɾ/	Noun	name of a tree	affricate + nasal	No
/kʰɾɑs/	Noun	dress	stop + approximant	No
			Coda sequence combination	
/ʤæʒn/	Noun	Eid	fricative + nasal	Yes
/bæfɾ/	Noun	snow	fricative + approximant	Yes
/tʰæqn/	Noun	mud	stop + nasal	Yes
/kæpɾ/	Noun	pergola	stop + approximant	Yes
/dæst/	Noun	hand	fricative + stop	No
/kʊʧk/	Noun	palace	affricate + stop	No
/ʃæɾm/	Noun	shyness	approximant + nasal	No
/gʊnd/	Noun	village	nasal + stop	No
/mæɾʤ/	Noun	condition	approximant + affricate	No
/biɾs/	Noun	hunger	approximant + fricative	No

Table 3.3 Words used in the reading task with their grammatical categories and glosses. Specifications of the target sequences (positions, combinations, and SSP violation) are also given.

A total of 12 words were used in the picture-naming task, 8 of which were already included in the previous tasks (perception task and reading task). Among the four remaining words, /pʰdi/, /tɾi/, and /bælg/, were morphologically simple nouns like the rest of the test words whereas /ɾʒɑndɨn/ was an infinitive verb. If the consonant sequences to be tested in /pʰdi/, /tɾi/, /bælg/ and /ɾʒɑndɨn/ constituted actual clusters – following the descriptions given in Kahn (1976), Shokri (2002) and Hasan (2009) – then these words would be considered monosyllabic except /ɾʒɑndɨn/ which would be disyllabic. Regarding stress placement in these words, the main stress in /ɾʒɑndɨn/ falls on the final syllable. However, in the case of /pʰdi/ and /tɾi/, the main stress does not fall on the lexical vowel /i/ in these words. It is thought to fall on syllables that were previously described by Hasan (2009) as containing actual onset clusters. Consequently, should an epenthetic vowel be confirmed within these words or sequences, it is probable that it would assume stress, i.e., /ˈpʰɨdi/ and /ˈtɨɾi/. Finally, all the words used in the picture-naming task were meant to elicit 12 consonant combinations, with 5 sequences obeying the SSP and 7 violating it.

Test word	Grammatical category	Gloss	Onset sequence combination	SSP violation
/nveʒ/	Noun	prayer	nasal + fricative	Yes
/spi/	Adjective	white	fricative + stop	Yes
/pʰdi/	Noun	gum	stop + stop	Yes
/ɾʒɑndɨn/	Infinitive verb	to spill	approximant + fricative	Yes
/tri/	Noun	grape	stop + approximant	No
/tʰfæŋg/	Noun	rifle	stop+ fricative	No
/mɾiʃk/	Noun	chicken	nasal + approximant	No
			Coda sequence combination	
/ʤæʒn/	Noun	Eid	fricative + nasal	Yes
/tʰæqn/	Noun	mud	stop + nasal	Yes
/kæpɾ/	Noun	pergola	stop + approximant	Yes
/dæst/	Noun	hand	fricative + stop	No
/bælg/	Noun	leaf	approximant + stop	No

Table 3.4 Words elicited using the picture-naming task with their grammatical categories and glosses. Specifications of the target sequences (positions, combinations, and SSP violation) are also given.

3.1.3. Task Design

3.1.3.1. Perception Task

Cluster perception was assessed using a forced-choice goodness task with confidence ratings. Using the Labguistic online platform (Ménétrey & Schwab, 2014), the participants were presented with two productions of the same word, one with an epenthetic vowel (e.g., /sɨteɾ/) and one without it (e.g., /steɾ/). They were instructed to select the option that sounded more Kurdish-like or natural to them, and then provide a confidence rating using a 6-point scale, where 6 meant ‘confident’ about the option selected, and 1 meant ‘not confident’, with the remaining points indicating intermediate levels of confidence. The purpose of the task was to determine the extent to which native NK speakers considered a stimulus with an epenthetic vowel as more Kurdish-like or natural than a stimulus without it. There were two trials for every two stimuli belonging to a test item. The order of stimuli in the trials was counterbalanced (e.g., /sɨteɾ/- /steɾ/ and /steɾ/- /sɨteɾ/). In total, there were 54 trials, 30 trials involving test words plus 24 trials for filler words. All trials appeared randomly in the course of the perception task.

Participants had the chance to listen to every trial only once, and then they had to respond by clicking on one of the response options appearing on the computer screen. Every trial presented to the participants was also provided with a written form of the word it belonged to. Screenshots illustrating the way the response options appeared on the Labguisitc screen and the rating scale following every trial are provided in Figures 3.3 and 3.4, respectively. The experimental task was preceded by a short practice session so as to familiarise the participants with the task requirements. The practice session was made up of four trials. There was no time limit for the responses.

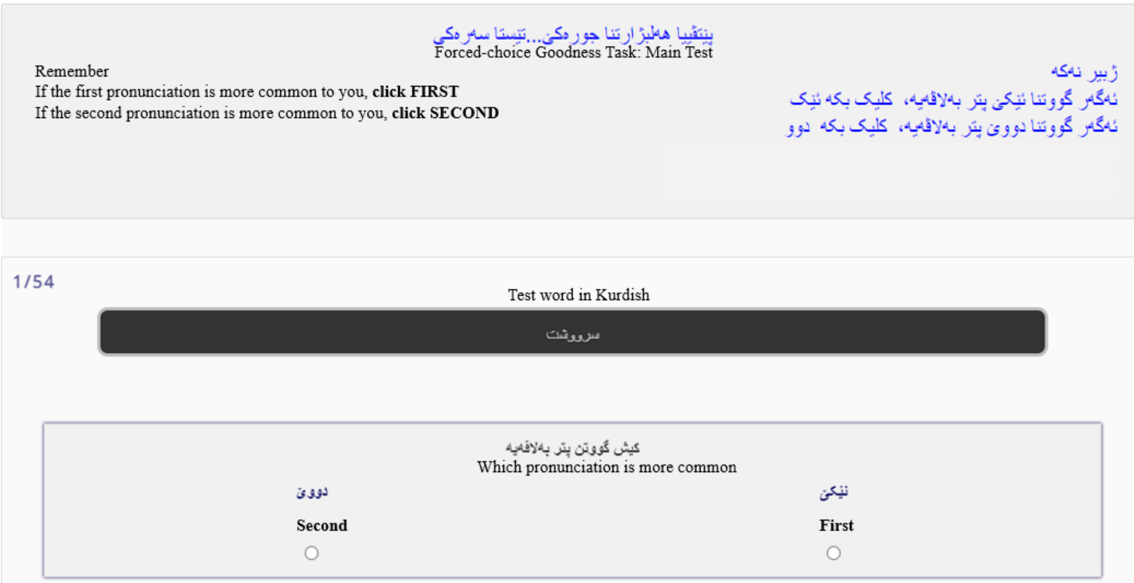

Figure 3.3 A screenshot of the forced-choice perception task. Only the Kurdish text, highlighted in blue was visible on the test screen. The English translation is added to the screenshot to clarify the nature of the instructions.

Figure 3.4 A screenshot of the rating scale used in the perception task. Only the Kurdish text, highlighted in blue was visible on the test screen. The English translation is added to the screenshot to clarify the nature of the instructions.

3.1.3.2. Production Tasks

The production of onset and coda consonant sequences was examined by means of two tasks: a carrier sentence reading task and a picture-naming task. In the reading task, test words were embedded in the Kurdish carrier sentence '*ئەز دبێژم ... نوکە*' /æz dɨ beʒɨm…. nukæ/ which means 'I am saying .... now'. Thus, the target words were placed in the middle of the carrier sentence following and preceding a consonant. The same carrier sentence was used for all test items. The sentences were presented to the participants on a laptop screen. A total of 29 sentences were used, which included 21 target words and 8 filler words. In the picture-naming task – which was used with a view of controlling for orthographic interference – participants were shown pictures presented on a laptop screen. To facilitate the elicitation of the intended target words, the first letter of each test word appeared together with the image, just above the picture. Figure 3.5 gives an example of an image with the first letter of the intended word above the image. A total of 20 pictures were used, which included 12 pictures to elicit the target words and 8 filler pictures. All pictures are provided in Appendix C.

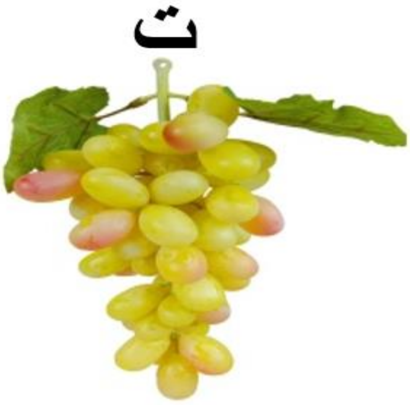

Figure 3.5 An example of an image used in the picture-naming task. The first letter of the intended target word is provided above the image.

3.1.3.3. Procedure and Task Order

The participants in this study took part in the perception task and the production tasks. They were tested in a soundproof room at the Humanities Lab of the University of Zakho by a staff member from the English Department. Participants were first provided with instructions in NK, as a way to control for the activation of the native language mode given that several participants were academic staff from the English Department of the University of Zakho and could have possibly been in an English language mode before they were presented with the tasks. A consent form in NK was signed by all participants just before the beginning of the tasks.

The production tasks were completed first in order to ensure that the contrast between stimuli with epenthetic vowels versus stimuli without an epenthetic vowel was not made salient to the participants during the perception task. Participants completed the reading task first. All sentences were embedded in a PowerPoint presentation and were presented to the participants on a laptop screen. Participants were instructed to read each sentence twice. Afterwards, they completed the picture-naming task. In the instructions for this task, it was stated they would see pictures and should name them and that the words should begin with the Arabic letters that appeared just above the images. Again, they had to name each picture twice. A CAROL Dynamic Vocal Microphone GS-67 was used. Recordings were made with the software Audacity and the files were saved in WAV format. The reading task took on average 4 minutes and the picture-naming task took around 3 minutes. After a short break, participants completed the perception task. For this task, they used Sennheiser headphones [Sennheiser (Wedemark, Germany) HD-25]. The total duration of the perception task including the questionnaire was around 10 minutes. In total, it took the participants around 20 minutes to complete the three experiments.

3.2. Perception Results

This section will present as well as analyse and discuss the results obtained from the perception task. But first, an explanation of the analysis methodology used for the perception data will be provided. Then, the results from the forced-choice goodness task, along with the rating scale results, will be presented and discussed in light of the predictions of the SSP, sequence combination, and sequence position at the end of the section.

3.2.1. Analysis of Perception Results

All participants – 15 people – were included in the analysis of the results for the perception task. Recall that participants in this task were presented with two stimuli of the same word, one with an epenthetic vowel (e.g., /sɨteɾ/) and one without it (e.g., /steɾ/), and then they had to choose the stimulus that sounded more common or Kurdish-like or natural to them. After providing a response, participants had to indicate their confidence in their choice using a 6-point rating scale. Their responses were extracted from the Labguistic platform and analysed in an Excel sheet. The percentage of times participants chose the option with an epenthetic vowel – i.e., a CvC stimulus – as the preferred pronunciation – i.e., more common or more Kurdish-like or natural – and the mean confidence rating for each test stimulus (sequence) was calculated.

3.2.2. Forced-Choice Goodness Task: Results and Discussion

The results presented in Table 3.5 and are graphically illustrated in Figures 3.6 and 3.7 display the percentage preference across participants for CvC stimuli per test item (per sequence in a given position), along with the corresponding average confidence rating. Complete preferences for CvC stimuli (100%) are highlighted in bold in Table 3.5. The mean percentage preference for CvC stimuli across test items and participants was generally high, reaching 84.2% (SD = 10), with an average rating of 5.7 (SD = 0.9) out of 6.

Interestingly, there was one exception to the general preference for stimuli with epenthetic vowels. The stimulus /sɨteɾ/ belonging to the fricative /s/ + stop onset sequence was never preferred (0% preference with an epenthetic vowel) in contrast to the stimuli /bɨnɑɣ/ (stop + nasal), /mɨɾiʃk/ (nasal + approximant) and /tʰɨfæɳg/ (stop+ fricative) (100% preference) and the coda sequences in the stimuli /ʤæʒɨn/ (fricative + nasal), /kæpɨɾ/ (stop + approximant), /sɨɾuʃt/ (fricative + approximant), /nɨveʒ/ (nasal + fricative), /bæfɨɾ/ (fricative + approximant), /pʰɨtɨɾ/ (stop + stop), /bɨɾin/ (stop + approximant) and /lɨvin/ (approximant + fricative) (90% – 93% preference). The remaining stimuli, namely /sɨnel/ (fricative + nasal) and /ʃæɾɨm/ (approximant + nasal), were also rather highly preferred with an epenthetic vowel (76% – 86% preference) followed by /tʰæqɨn/ (stop + nasal), which was less preferred (67% preference). It is worth noting that only three participants consistently avoided selecting coda CvC stimuli from the sequences /ʃæɾɨm/ (approximant + nasal) and /tʰæqɨn/ (stop + nasal). Therefore, the overall preference for CvC sequences in these cases appeared lower compared to other sequences analysed. Specifically, participants 4 and 12 consistently opted for CC stimuli over CvC stimuli from the sequence in /tʰæqɨn/, while participant 3 consistently avoided selecting CvC stimuli from the sequence /ʃæɾɨm/ (approximant + nasal).

The stimulus /steɾ/ (without an epenthetic vowel) also received the highest confidence rating (6 out of 6) although, in general, the rest of the stimuli received high confidence ratings (average of rating = 5.7, SD = 0.9). Thus – and except for the results obtained for /sɨteɾ/– there seemed to be an overwhelming preference among all participants for stimuli with epenthetic vowels.

CvC stimulus	**Onset sequence combination**	**SSP violation**	**% preference for CvC stimulus**	**Average rating (out of 6)**
/nɨveʒ/	nasal + fricative	Yes	93 (9)	5.9 (0.2)
/pʰɨtɨɾ/	stop + stop	Yes	90 (14)	5.7 (0.9)
/lɨvin/	approximant + fricative	Yes	90 (5)	5.6 (0.9)
/sɨteɾ/	fricative + stop	Yes	0 (0)	6 (0.0)
/bɨnɑɣ/	stop + nasal	No	**100 (0)**	5.9 (0.3)
/mɨɾiʃk/	nasal + approximant	No	**100 (0)**	5.9 (0.3)
/tʰɨfæɳg/	stop+ fricative	No	**100 (0)**	5.6 (0.9)
/sɨɾuʃt/	fricative + approximant	No	93 (9)	5.3 (1.4)
/bɨɾin/	stop + approximant	No	90 (14)	5.7 (0.6)
/sɨnel/	fricative + nasal	No	86 (9)	5.5 (0.9)
	Coda sequence Combination			
/ʤæʒɨn/	fricative + nasal	Yes	93 (9)	5.7 (0.9)
/kæpɨɾ/	stop + approximant	Yes	93 (9)	5.7 (0.7)
/bæfɨɾ/	fricative + approximant	Yes	90 (14)	5.7 (0.6)
/tʰæqɨn/	stop + nasal	Yes	67 (28)	5.4 (1.2)
/ʃæɾɨm/	approximant + nasal	No	76 (24)	5.3 (1.4)

Table 3.5 Percentage preference for stimuli with epenthetic vowels (CvC stimuli) and average confidence rating scores, per sequence across participants. Results are ordered according to sequence position (onset vs coda) and SSP violation specification (Yes vs No). The standard deviation is given in parentheses.

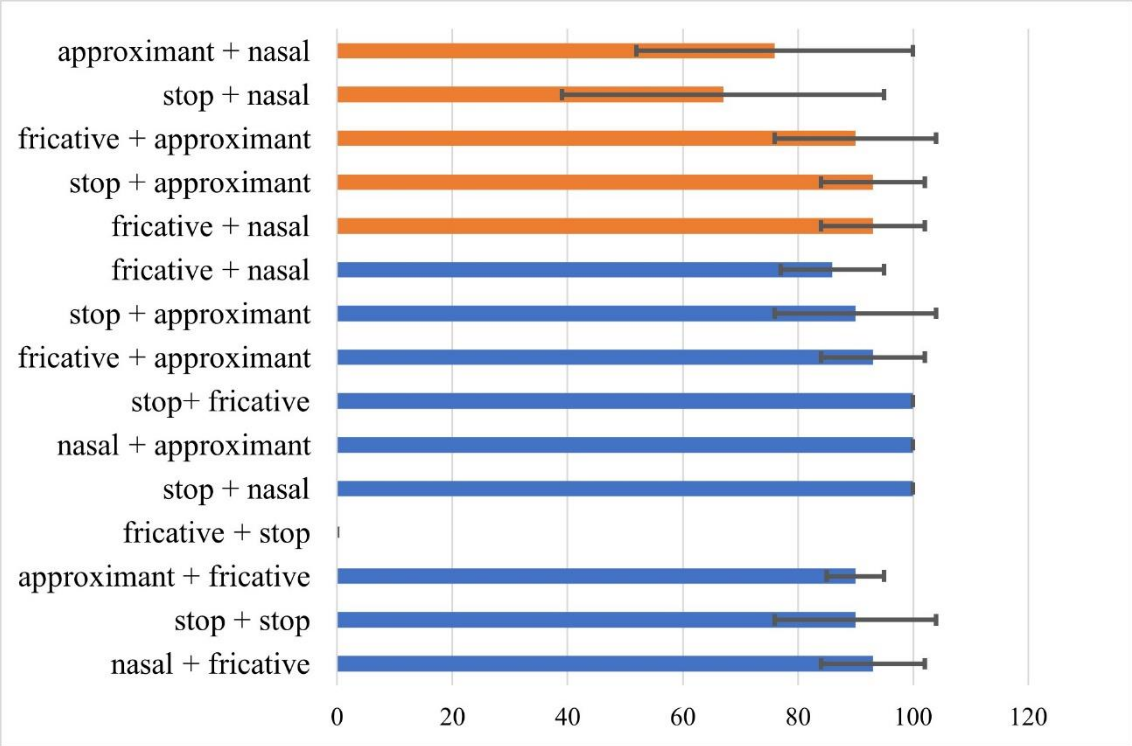

Figure 3.6 Mean and standard deviation representing percentage preference for CvC stimulus per sequence combination for onset ( ) and coda ( ) sequences.

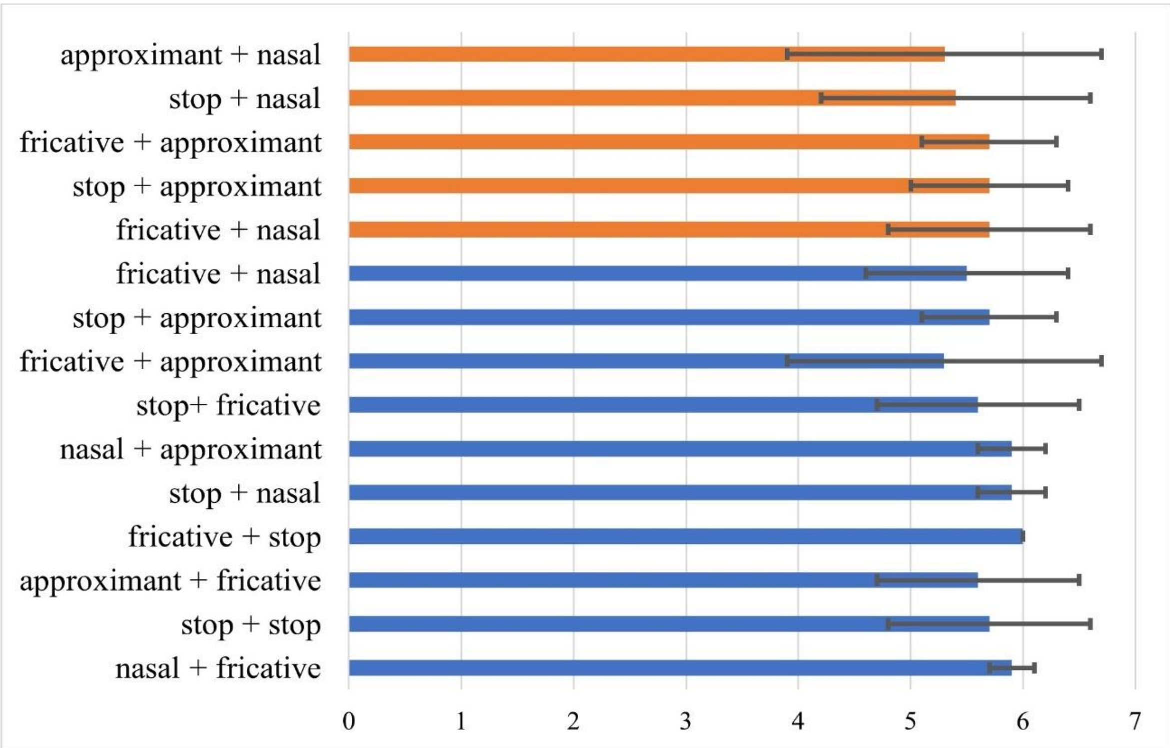

Figure 3.7 Mean and standard deviation ratings per sequence combination for onset ( ) and coda ( ) sequences.

Despite the relatively high and consistent preference for stimuli with vowel epenthesis across the sequences tested, the impact of factors such as violations of the SSP, sequence combinations, and sequence position on this preference is worth looking at. Regarding the impact of the SSP violation, the results presented in Table 3.5 reveal an unexpected finding regarding the influence of the SSP on the perception of onset CvC stimuli. Sequences that violate the SSP were found to be less highly preferred when an epenthetic vowel was present (N = 4, M = 68.3, Md = 90, SD = 7) compared to sequences that do not violate the SSP (N = 6, M = 94.8, Md = 96.5, SD = 5). This finding could be attributed to two potential factors. Firstly, the presence of the fricative /s/ + stop onset sequence in /steɾ/ might have greatly influenced the results. This sequence, despite violating the SSP, was always perceived without vowel epenthesis by all participants. Resistance to vowel insertion in this specific combination could be explained in light of the adjunct approach to /s/-C clusters (Giegerich, 1992; Kenstowicz, 1994). According to this approach, /s/-clusters are treated differently from non-/s/-clusters (also termed true clusters in Yavas, 2003) and are considered a direct dependent of the syllable (see Chapter 1). Secondly, it is important to recognise that the entire perception test relied on a limited number of words per sequence combination. If more words had been tested, the results regarding the current reversed influence of the SSP could have been different. In other words, the preference for CvC stimuli violating the SSP in the onset position might have been higher because according to the predictions of the SSP (Clements, 1990), sequences violating the principle and constituting actual clusters are marked structures and universally rare.

It is notable that when we exclude the results for the fricative /s/ + stop onset combination, the mean percentage preference for CvC onset stimuli, whether violating the SSP or not, is very similar. Specifically, the mean percentage preference for stimuli violating the SSP is 91, while for stimuli not violating it, it is 94.8. This similarity is further confirmed by the statistically insignificant results of an unpaired-samples t-test ($t(7) = -1.038$, $p = .166$), which compared the mean preference for the CvC option with onsets violating the SSP – but excluding the results for the fricative /s/ + stop combination – with onsets that do not violate the SSP, and indicated no substantial effect of the SSP on the perception of CvC onset stimuli.

Concerning the influence of the SSP violation on the perception of coda CvC stimuli, in the four sequences tested which violate the SSP, preference for CvC stimuli was relatively high and consistent across the sequences (M = 85.8, Md = 91.5, SD = 15). This finding follows the predictions of the SSP because sequences violating the SSP are expected to be more naturally perceived when a vocalic element is present. In other words, they are less likely to constitute actual clusters cross-linguistically. Yet, even the single coda sequence that adheres to the SSP, i.e., approximant + nasal, was relatively frequently preferred with vowel epenthesis (76%). With only one coda sequence adhering to the SSP tested it is difficult to determine how adherence to the SSP influences the perception of CvC stimuli in the coda position. Acoustic and impressionistic analyses could potentially offer a more comprehensive understanding of the impact of the SSP on coda combinations, as will be examined in the production tasks.

Furthermore, despite the generally high and consistent preference for stimuli with epenthetic vowels across all sequence combination types (except for the fricative + stop onset combination), certain combinations stood out. For example, the combinations stop + nasal, nasal + approximant, and stop + fricative (in the onset position) were perceived with vowel epenthesis 100% of the time. Once these high percentages are confirmed impressionistically and acoustically, it can be confirmed that the given sequences described in Hasan (2009) to be actual clusters are not in fact consonant clusters. On the other hand, the stop + nasal combination in the coda position, despite violating the SSP, was preferred the least frequently with vowel epenthesis, occurring only 67% of the time. The outcome of the stop + nasal combination in the word /tʰæqɨn/ 'mud' might be affected by how often this specific word appears in NK, i.e., /tʰæqɨn/ could be a high-frequency word in NK. Yet, conducting impressionistic and acoustic identification of vowel epenthesis in this sequence could either support or challenge these results.

Lastly, it appears that sequence position influenced vowel epenthesis perception. In onset sequences, but excluding the exceptional results obtained for the fricative /s/ + stop sequence in /steɾ/, preference for CvC stimuli appears to be higher (M = 94, Md = 93, SD = 7) compared to coda sequences (M = 84, Md = 90, SD = 17). This observation was confirmed by the significant results of an unpaired-samples t-test (t (13) = 2.181, p = .024), which compared the mean preference for CvC sequences in onset and coda positions. A possible explanation for this finding could be that listeners were more susceptible to perceiving a vocalic element in the onset positions than in the codas. Onset positions often have a more prominent and perceptually salient role in syllable structure, and this prominence might have increased the listeners' perceptions of CvC stimuli in the onset position. In order to assess more finely the status of vowel epenthesis in NK consonant sequences, the production of the consonant sequences tested perceptually along additional sequences was also investigated in a production experiment aimed to test the effect of the SSP, sequence combination, and sequence position on the production of such sequences. This is presented in the next section.

3.3. Production Results

This section will present, analyse and discuss the results obtained from the production tasks. Firstly, an explanation of the analysis methodology used for the production data will be provided, followed by the presentation of the impressionistic analysis followed by the acoustic analysis of the results. After that, both sets of results will be discussed in light of the predictions of the SSP, the type of sequence combination, and the sequence position in the word. At the end of the section, the correlation between the results of perception and production tasks is explored.

3.3.1. Analysis of Production Results

The production of all participants (15 people) from the reading task and the picture-naming task were analysed together. Recall that participants had to read a total of 29 carrier sentences with 21 target words that contained the target consonant sequences and they had to name a total of 20 pictures, which included 13 pictures to elicit the target words (sequences). A total of 510 tokens were produced – 315 tokens from the reading task (15 x 21) and 195 tokens from the picture-naming task (15 x 13). Each token contained a single target consonant sequence, thus 510 sequences were produced by 15 people. These data were analysed in two ways, impressionistically and acoustically. Thus, the presence or absence of an epenthetic vowel was examined by auditory judgments made by up to three judges (raters), and through a spectrographic analysis in order to determine the presence or absence of an epenthetic vowel and to examine the acoustic characteristics of vocalic elements, when present.

Three tokens from the picture naming task were excluded from the impressionistic analysis because target words were not elicited. As a result, a total of 507 tokens were impressionistically analysed – 315 tokens from the reading task and 192 tokens from the picture-naming task. Two proficient native speakers of NK with expertise in NK Kurdish and English phonology, and fluency in Arabic, listened to all tokens and provided their impressionistic judgments regarding whether or not they perceived an epenthetic vowel in the given tokens (sequences). At first, the first speaker (henceforth Judge 1, who was also the author of this thesis) provided her responses. Then the second speaker (henceforth Judge 2) – who was not informed of the purpose of the study – gave her responses. Both judges recorded their responses in an Excel sheet. Perception of CvC production was indicated by 2 and its absence by 1. The responses were analysed by calculating two sets of percentages: (1) the percentage of cases showing the overall agreement between Judge 1 and Judge 2, including CvC and CC judgments, and (2) the percentage of cases showing agreement specifically regarding CvC judgments. Discrepancies between the two judges regarding the perception of CvC or CC sequence in a given token/sequence were settled by the help of a third judge (Judge 3), also a native NK speaker with expertise in NK Kurdish and English phonology and fluency in Arabic, who listened to these tokens and provided her perception of CvC/CC sequences.

The acoustic analysis aimed to visually assess the potential presence of an epenthetic vowel in a given sequence by examining both its duration and formant frequencies. This step was crucial for validating the impressionistic and perceptual findings, as well as for understanding the nature of vocalic elements when identified. Out of a total of 510 produced tokens, 506 were included in the acoustic analysis. One additional token was excluded, along with the three tokens omitted from the impressionistic analysis, due to difficulty in determining the presence or absence of an inserted vowel in that specific token. In the acoustic analysis of the 506 examined tokens, a vocalic element was acoustically identified as present in 350 tokens. However, in 21 tokens, particularly those containing sequences with approximant consonants, it was inconclusive whether a vowel was present, so these were also eliminated. Ultimately, an epenthetic vowel was considered produced in 329 tokens and not produced in 156 tokens, with 25 tokens excluded from the analysis.

3.3.2. Impressionistic Analysis Results

Each production was coded in terms of whether an epenthetic vowel was perceptually detected (henceforth, CvC judgments) or no epenthetic vowel was perceived (henceforth, CC judgment) in the production of th target consonant sequences. Table 3.6 presents the percentage of cases showing: (1) the overall agreement between Judge 1 and Judge 2, including CvC and CC judgments, (2) the percentage of cases showing agreement specifically regarding CvC judgments, and (3) the percentage of cases showing agreement regarding CC judgments. The overall agreement (CvC and CC judgments) between Judge 1 and Judge 2 responses for all production data was very high, reaching 90.5%. The remaining cases (9.5%) included tokens that were judged to have an epenthetic vowel by only one of the two judges. The overall agreement (CvC and CC judgments) between Judge 1 and Judge 2 was higher for tokens produced in the picture naming task (96.9%) than for those resulting from the reading task (86.7%). If we consider CvC and CC judgements separately, agreement between Judge 1 and Judge 2 involving CvC judgements amounted to 68.5% out of the 90.5% of overall agreement (64.4% in the reading task, and 75% in the picture-naming task), and the rest (22%) were CC agreement judgments.

In Table 3.7, the total of tokens together perceived by Judge 1 and Judge 2 to contain an epenthetic vowel (CvC judgments) for each type of cluster is presented. The total of tokens receiving CC judgments is also given. There were, for example, 15 onset sequences (one per person) produced for the affricate + nasal in /ʧnɑɾ/, the two judges agreed that 11 of these contained an epenthetic vowel (CvC judgement) and for the remaining 4 the two judges did not agree; one perceived CvC and the other CC. In total, 347 tokens (347 sequences) received CvC judgments while 112 tokens (112 sequences) received CC judgments. The remaining tokens, totalling 48, exhibited discrepancies between the two judges. That is, one judge perceived CvC and the other CC. Specifically, Judge 1 overwhelmingly perceived a CvC in 45 tokens, accounting for 93.8% of the ones there was disagreement about, while Judge 2 reported perceiving a CvC in 4 tokens, accounting for only 8.3% of the ones there was disagreement about. To settle these discrepancies, Judge 3 listened to these tokens and provided her perception of CvC and/or CC sequences. She displayed a higher agreement with Judge 2 (58.8%) than with Judge 1 (11.8%) regarding not perceiving CvC in all 48 tokens. Among the 48 tokens judged, Judge 1 perceived CvC in 45 tokens, Judge 2 in only 4 tokens, and Judge 3 in 3 tokens. Table 3.8 gives the total of tokens that received discrepant judgments by Judge 1, judge 2, and Judge 3.

Task	% of overall agreement (CvC and CC judgments)	% of agreement regarding CvC judgments	% of agreement regarding CC judgments
Reading task	86.7	64.4	22.3
Picture-naming task	96.9	75	21.9
Both tasks	90.5	68.5	22

Table 3.6 Degree of agreement (in percentages) between Judge 1 and Judge 2 regarding the presence of an epenthetic vowel (CvC judgments) for all production data. Overall agreement (CvC and CC judgments) and agreement regarding the absence of an epenthetic vowel (CC judgments) between Judge 1 and Judge 2 are also given.

Test word	Onset sequence combination	Total tokens judged	Tokens receiving CvC judgment	Tokens receiving CC judgment	Tokens receiving a discordant judgment
/ʧnɑɾ/	affricate + nasal	15	11	0	4
/ɾʒɑndɨn/, /lvin/	approximant + fricative	29	27	0	2
/sɾuʃt/	fricative + approximant	15	10	1	4
/znɑɾ/	fricative + nasal	15	15	0	0
/spi/	fricative + stop	30	0	30	0
/mɾiʃk/	nasal + approximant	30	26	0	4
/nveʒ/	nasal + fricative	30	29	0	1
/tri/, /kʰɾɑs/	stop + approximant	30	22	0	8
/pʰʃik/, /tʰfæɳg/	stop + fricative	30	16	0	14
/bnɑɣ/	stop + nasal	15	15	0	0
/pʰdi/, /pʰtɨɾ/	stop + stop	29	26	0	3
	Coda sequence combination				0
/kʊʧk/	affricate + stop	15	9	5	1
/mæɾʤ/	approximant + affricate	15	2	11	2
/biɾs/	approximant + fricative	15	5	8	2
/ʃæɾm/	approximant + nasal	15	14	0	1
/bælg/	approximant + stop	14	2	12	0
/bæfɾ/	fricative + approximant	30	29	0	1
/ʤæʒn/	fricative + nasal	30	29	0	1
/dæst/	fricative + stop	30	0	30	0
/gʊnd/	nasal + stop	15	0	15	0
/kæpɾ/	stop + approximant	30	30	0	0
/tʰæqn/	stop + nasal	30	30	0	0

Table 3.7 Total of tokens receiving a CvC judgment, a CC judgment, or a disagreement judgment by Judge 1 and Judge 2.

Test word	No. of discrepant original judgments	Received CvC judgment by Judge 1	Received CvC judgment by Judge 2	Received CvC judgment by Judge 3
/bæfɾ/	1	1	0	1
/ʤæʒn/	1	1	0	0
/kʊʧk/	1	1	0	0
/nveʒ/	1	1	0	0
/ɾʒɑndɨn/	1	1	0	0
/ʃæɾm/	1	1	0	0
/biɾs/	2	1	1	0
/lvin/	2	2	0	0
/mæɾʤ/	2	0	2	0
/tri/	2	2	0	0
/pʰtɨɾ/	3	3	0	0
/tʰfæɳg/	3	3	0	0
/mɾiʃk/	4	4	0	0
/sɾuʃt/	4	4	0	0
/ʧnɑɾ/	4	3	1	0
/kʰɾɑs/	6	6	0	1
/pʰʃik/	10	10	0	1

Table 3.8 Tokens receiving disagreement judgments by Judge 1, Judge 2, and Judge 3.

For all 48 tokens judged, agreement between any two judges over CvC or CC judgments was the criterion followed to classify each token/sequence as containing either a CvC or CC. For example, if a particular token received a CvC judgment by any two judges – either Judge 1 and Judge 2, or Judge 2 and Judge 3 or Judge 1 and Judge 3 – it was perceptually classified as containing a CvC sequence. As a result of this approach, only 5 tokens were classified as containing a CvC, while 43 tokens were considered to contain a CC. When combined with the tokens listed in Table 3.7, final impressionistic judgments were obtained for all 507 tokens, as shown in Table 3.9. This table gives the total count of tokens, belonging to a given sequence combination across 15 participants, collectively perceived by Judges 1, 2, and 3 to contain CvC or CC. In Table 3.9, if there are more than 15 tokens per sequence, it indicates that either a specific test word was included in both production tasks (e.g., /spi/) or that two test words belonging to the same sequence were examined (e.g., /ɾʒɑndɨn/, /lvin/).

Of relevance to the current analysis is the percentage of CvC judgments given to a specific sequence combination. This was obtained by calculating the percentage of times an epenthetic vowel was impressionistically perceived in all tokens belonging to a specific sequence across participants. In Table 3.9, for example, 15 tokens were produced (one token per participant) for /ʧnɑɾ/ with the affricate + nasal sequence. Among these, 12 tokens received CvC judgments from the three judges, while only 3 tokens received CC judgments. Thus, the percentage of /ʧnɑɾ/ tokens, and accordingly the affricate + nasal sequence, receiving CvC judgments was 80%. These percentages are given in Table 3.10

Test word	**Onset sequence combination**	**Total tokens judged**	**Received CvC judgment**	**Received CC judgment**
/bnɑɣ/	stop + nasal	15	15	0
/znɑɾ/	fricative + nasal	15	15	0
/nveʒ/	nasal + fricative	30	29	1
/ɾʒɑndɨn/, /lvin/	approximant + fricative	29	28	1
/pʰdi/, /pʰtɨɾ/	stop + stop	29	26	3
/mɾiʃk/	nasal + approximant	30	26	4
/ʧnɑɾ/	affricate + nasal	15	12	3
/tri/, /kʰɾɑs/	stop + approximant	30	22	8
/sɾuʃt/	fricative + approximant	15	10	5
/pʰʃik/, /tʰfæŋg/	stop + fricative	30	17	13
/spi/	fricative + stop	30	0	30
	Coda sequence combination			
/kæpɾ/	stop + approximant	30	30	0
/tʰæqn/	stop + nasal	30	30	0
/bæfɾ/	fricative + approximant	30	30	0
/ʤæʒn/	fricative + nasal	30	29	1
/ʃæɾm/	approximant + nasal	15	14	1
/kʊʧk/	affricate + stop	15	9	6
/biɾs/	approximant + fricative	15	6	9
/bælg/	approximant + stop	14	2	12
/mæɾʤ/	approximant + affricate	15	2	13
/dæst/	fricative + stop	30	0	30
/gʊnd/	nasal + stop	15	0	15

Table 3.9 Total count of tokens per sequence combination across participants which either received a CvC or CC judgment by Judge 1, Judge 2, and Judge 3 together.

Onset Sequence				**Coda Sequence**			
Test word	**Sequence combination**	**SSP violation**	**% of CvC judgment**	**Test word**	**Sequence combination**	**SSP violation**	**% of CvC judgment**
/nveʒ/	nasal + fricative	Yes	96.7	/kæpɾ/	stop + approximant	Yes	100
/ɾʒɑndɨn/ /lvin/	approximant + fricative	Yes	96.6	/tʰæqn/	stop + nasal	Yes	100
/pʰdi/ /pʰtɨɾ/	stop + stop	Yes	89.7	/bæfɾ/	fricative + approximant	Yes	100
/spi/	fricative + stop	Yes	0	/ʤæʒn/	fricative + nasal	Yes	96.7
/bnɑɣ/	stop + nasal	No	100	/ʃæɾm/	approximant + nasal	No	93.3
/znɑɾ/	fricative + nasal	No	100	/kʊʧk/	affricate + stop	No	60
/mɾiʃk/	nasal + approximant	No	86.7	/biɾs/	approximant + fricative	No	40
/ʧnɑɾ/	affricate + nasal	No	80	/bælg/	approximant + stop	No	14.3
/tri/ /kʰɾɑs/	stop + approximant	No	73.3	/mæɾʤ/	approximant + affricate	No	13.3
/sɾuʃt/	fricative + approximant	No	66.7	/dæst/	fricative + stop	No	0
/pʰʃik/ /tʰfæŋg/	stop + fricative	No	56.7	/gʊnd/	nasal + stop	No	0
Total % of CvC judgments per sequence position			76.9				56.2
Total % of CvC judgments across sequences							66.5

Table 3.10 Percentage of CvC judgments per sequence combination. Total percentages per sequence position and across sequences are also given. Results are given in descending order and according to the SSP violation specification (Yes vs No).

3.3.2.1. Impressionistic Results: Statistical Analysis and Discussion

The findings presented in Table 3.10 in section 3.3.2 display a moderately high level of impressionistic perception of vowel epenthesis by the three judges across all sequences (onsets and codas) and participants, with an average percentage of 66.5% (Md = 83.4, SD = 36.9). When the fricative /s/ + stop onset combination is excluded, the level of impressionistically identified CvC tokens across all other sequences and participants was slightly higher with a mean rate of 69.7% (Md = 86.7, SD = 34.7).

Regarding the effect of the SSP on the impressionistic perception of vowel epenthesis in onset sequences violating the SSP (N = 3, M = 94.3, Md = 96.6, SD = 3.3) – but excluding the fricative /s/ + stop combination – compared to sequences not violating it (N = 7, M = 80.5, Md = 80, SD = 15.2), no significant effect of the SSP was found, as indicated by the results of an unpaired-samples ttest: (t (8) = 1.401, p = 0.198). These results are in line with the perception results regarding the impact of the SSP on the perception of CvC onset stimuli. In contrast to onset combinations, the impressionistic perception of vowel epenthesis in codas violating the SSP (N = 4, M = 99.2, Md = 100, SD = 1.4) was higher than in codas not violating it (N = 7, M = 31.6, Md = 14.3, SD = 32.3), as indicated by the significant results of a Mann-Whitney U test, U = 28, Z = 2.580, p = 0.009, with a large effect size r = 0.778. These findings concerning the impact of the SSP on the impressionistic perception of vowel epenthesis in coda combinations are consistent with the SSP predictions (Clements, 1990).

Considering the influence of sequence combinations, certain combinations stood out. For example, the fricative + stop sequence, whether in onset or coda position, was never perceived with vowel epenthesis (0% CvC judgment), indicating a consistent absence of epenthesis in this particular sequence. This result aligns with the outcomes observed in the perception task for the fricative + stop onset (0% preference for the CvC stimulus), reinforcing the robustness of the impressionistic finding. Similarly, the nasal + stop coda sequence was never perceived with vowel epenthesis (0% CvC judgment). Although this specific sequence was not included in the perception task, one can argue that it is highly likely to constitute an actual cluster. This finding is in line with Shokri's (2002) characterisation of this sequence as an actual cluster in NK (see Kurdish consonant cluster inventory in Chapter 1). The presence of homorganic consonants in /dæst/ or /gʊnd/ does not necessarily make them more likely to form actual coda clusters, as other coda sequences with non-homorganic consonants, such as the fricative + stop combination /-ft/ in /ħæʃt/ (seven), are also expected to form clusters. It is more likely that /-st/ and /-nd/ form actual clusters because they conform to the SSP in their respective positions. Additionally, the frequency of these combinations in the language likely plays an important role. That is, nasal + stop and fricative + stop combinations in the coda position may be frequent sequences in NK.

In contrast to the fricative + stop sequence, the stop + nasal sequence, regardless of its syllable-initial or syllable-final position, always received a CvC judgment (100% CvC judgment). This observation further strengthens the results obtained from the perception task, especially regarding the finding obtained for the CvC stimulus in the onset position (100% preference). Based on these results, it is very likely that the stop + nasal sequence is not an actual onset cluster, contradicting Hasan's (2009) characterisation of this combination as an actual cluster in NK. Regarding the coda position, while impressionistic results yielded a 100% CvC judgment, and perception results showed a 67% preference for the onset CvC stimulus, further validation through acoustic analysis is needed to determine whether or not the stop + nasal sequence can constitute an actual cluster in the coda position. Similarly, the fricative + nasal (onset position), stop + approximant (coda position), and fricative + approximant (coda position) sequences were 100% of the time impressionistically perceived with vowel epenthesis, i.e., received 100% CvC judgment. These sequences were also overwhelmingly perceived with vowel epenthesis in the perception task, with percentage preferences for CvC stimuli ranging from 86% to 93%. Given these results, one can claim that the perceived presence of vowel epenthesis in these sequences makes them less likely to constitute actual clusters.

The results for a few other sequences in onset positions, including approximant + fricative and nasal + fricative, as well as those in coda positions, such as approximant + nasal and fricative + nasal, were similarly very high, ranging from 93.3% to 96.7% of CvC judgment. These sequences were also widely perceived with vowel epenthesis in the perception task (90% - 93% preference for

CvC stimuli), except the approximant + nasal sequence, which showed a moderate percentage preference for its CvC stimulus counterpart in the perception task (76%). Likewise, the results for affricate + nasal, nasal + approximant and stop + stop onset sequences were rather high (80% to 89.7% of CvC judgment). Excluding the affricate + nasal sequence, which was not tested in the perception task, the rest of the sequences were also highly perceived with vowel epenthesis in the perception task (90% -100% CvC stimuli preference). In light of these results, but excluding the affricate + nasal sequence, it remains very unlikely for these sequences to constitute actual clusters, again contradicting the descriptions given in Hasan (2009).

For a few sequences in the onset position, i.e., stop + fricative, fricative + approximant, and stop + approximant, as well as two sequences in coda positions, i.e., approximant + fricative and affricate + stop, the results indicated a moderate range of CvC judgment, ranging from 40% to 73%. For the three onset sequences, the percentage preference for CvC stimuli was consistently high in the perception (90% - 100%) whereas the two coda sequences were not tested in the given task. Finally, the approximant + stop and approximant + affricate coda sequences received the lowest CvC judgments ranging from 13.3% - 14.3%. These two sequences were not tested in the perception task. For sequences with moderate to low CvC judgments, determining their potential as actual clusters is not reasonable until an acoustic examination of the rate of vowel epenthesis occurrence in these sequences is conducted. This holds true for sequences not tested in the perceptual task, such as the affricate + nasal onset sequence and the coda sequences approximant + fricative, affricate + stop, approximant + stop, and approximant + affricate. The results of the acoustic analysis of the production data are presented in the next section.

Lastly, and even though the impressionistic perception of vowel epenthesis was higher in onset sequences – excluding the results for the fricative /s/ + stop combination – (N = 10, M = 84.6, Md = 88.2, SD = 15.1) than in coda sequences (N =11, M = 56.2, Md = 60, SD = 41.5), no significant effect of sequence position (onset vs coda) was found regarding the impressionistic perception of vowel epenthesis, as confirmed by the insignificant results of a Mann-Whitney U test, $U = 68.5$, $Z = 0.922$, $p = 0.356$, with a small effect size $r = 0.2$. Despite the lack of a significant result, which may be the consequence of the smallness of the sample, the difference in the mean percentage of CvC sequences in both word positions points to a greater presence of an epenthetic vowel in onsets than in codas. It is possible that with a larger sample of tokens, the difference would yield significance. The presence of an epenthetic vowel in onsets might be influenced by universal phonological tendencies. In many languages, simpler and more open syllable structures (CV) are preferred, particularly at the start of words (Carlise, 2001). This could lead to a higher likelihood of vowel insertion in onsets to conform to these preferred syllable structures.

3.3.3. Acoustic Analysis

This section presents the results of the acoustic analysis of consonant sequences, aimed at determining the presence or absence of a vocalic element, as well as the characteristics of the vowel, if present. Evidence of a vocalic element was assessed by visual inspection of consonant sequences on the waveform and spectrogram. The existence of a vocalic element was associated with the presence of vertical striations in the spectrogram, greater amplitude than neighbouring sounds, and vowel-like formant structure. This section provides first an analysis of vowel duration, followed by an analysis of the formant structure.

3.3.3.1. Vowel Duration

The first acoustic parameter measured was vowel length. The epenthetic vowel identified, as well as the main vowel in each word (i.e., the lexical/root vowel), were delimited and annotated using textgrids in Praat (Boersma & Weenink, 2021). A Praat script was used to calculate the duration of all labelled vowels. To exemplify the difference between tokens produced with and without an epenthetic vowel, Figures 3.8 and 3.9 show the waveform, spectrogram, and annotated textgrids for the words /lɨvin/ (with an epenthetic vowel) and /spi/ (without an epenthetic vowel) produced by participant 2.

In Table 3.11, the average duration of epenthetic vowels across all CvC tokens within a sequence, alongside the average duration of their corresponding main vowels is given. Note that the results for epenthetic and main vowel duration combine data from words sharing the same consonant combination, that is, /pʰdi/ and /pʰtɨɾ/ (stop + stop), as well as /tri/ and /kʰɾɑs/ (stop + approximant), are collectively reported. Duration values for male and female speakers were combined. The average duration for all epenthetic vowels identified across all CvC tokens and participants was 46.6 ms (SD = 27.3), and the average duration of the corresponding main vowels was 136.4 ms (SD = 44.8).

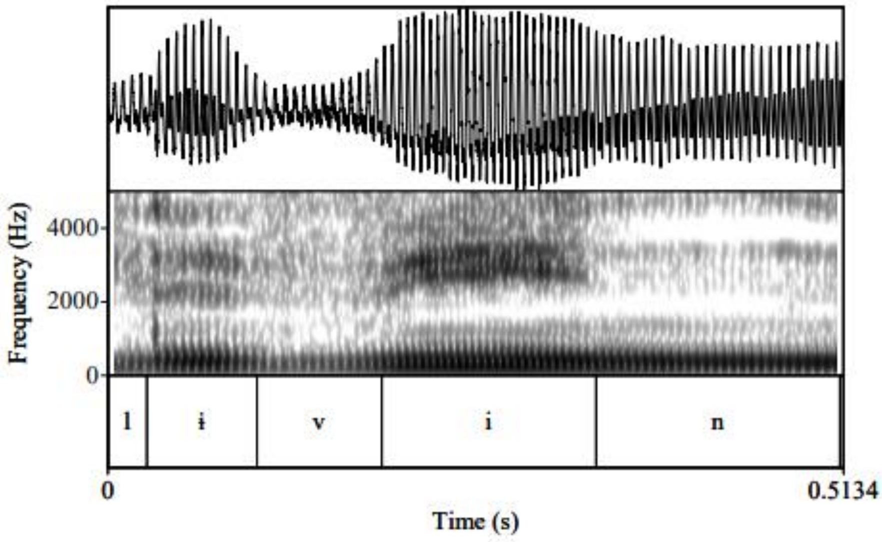

Figure 3.8 Waveform and spectrogram of the word /livin/ produced by Participant 2 with vowel epenthesis.

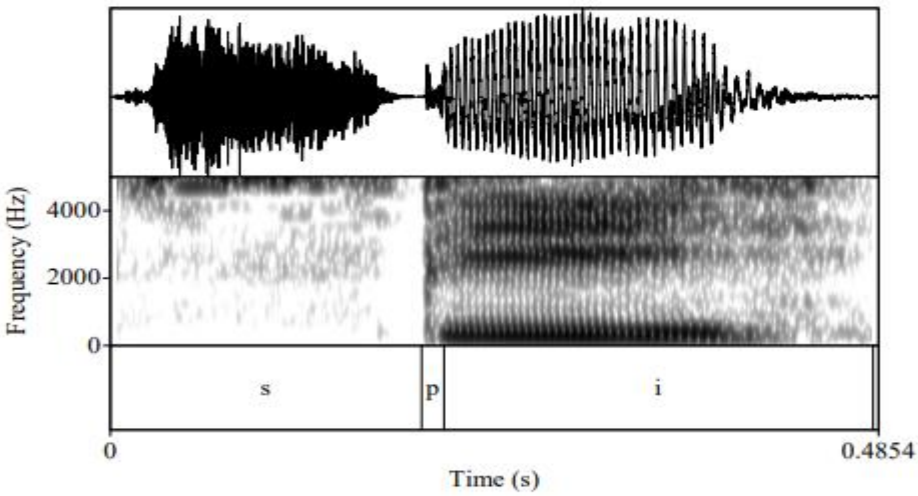

Figure 3.9 Waveform and spectrogram of the word /spi/ produced by Participant 2 without vowel epenthesis.

In all tokens produced with vowel epenthesis in Table 3.11, the duration of the epenthetic vowel was consistently shorter than the duration of the main vowel in the same test word(s), constituting approximately one-third of the main vowel duration (34.2%). Notably, even cases like /tɾi/ and /pʰdi/ produced with epenthetic vowels that appeared to carry the primary stress (i.e., /ˈtɨɾi/ and /ˈpɨʰdi/) exhibited noticeably shorter durations (75 ms and 57 ms, respectively) compared to their corresponding main vowels (185 ms and 163 ms, respectively), behaving just like the unstressed epenthetic vowels identified in the rest of the test words. This finding contradicts Hasan's (2017) claim, which suggests that duration serves as a phonetic cue for stress assignment in NK. Still, the current data is based on only two words that contain epenthetic vowels, and therefore a study including a greater number of examples would be necessary to fully evaluate this issue. Although epenthetic vowels tended to be slightly longer in onset sequences (excluding the results for the fricative /s/ + stop combination) with a mean duration of 55.8 ms (Md = 58.9, SD = 12.2) compared to coda sequences with a mean duration of 42.4 ms (Md = 32.9, SD = 32.9), a subsequent unpaired-samples t-test did not reveal a statistically significant difference ($t(19) = -1.164$, $p = .129$). It is noteworthy, however, that coda sequences exhibited greater variability in epenthetic vowel duration. For instance, epenthetic vowels in coda stop + approximant and fricative + approximant combinations have the longest durations (83.5 – 89.2 ms, respectively), whereas those in approximant + stop and approximant + affricate coda sequences have the shortest durations (9.2 - 14.1 ms). This variability may be attributed to the nature of the sequence combination or the violation of the SSP. Coda sequences containing an approximant consonant as the second element, such as stop + approximant and fricative + approximant, and thus constituting a clear violation of the SSP, exhibit the longest epenthetic vowel duration, in contrast to coda sequences with an approximant consonant as the first element, such as approximant + stop and approximant + affricate, which do not violate the SSP and contain epenthetic vowels with the shortest duration (see Table 3.11). The difference in duration between coda sequences violating the SSP (N = 4, M = 80.2, Md = 80.6, SD = 8.1) and coda sequences that obeyed the SSP (N = 7, M = 20.8, Md = 14.1, SD = 21.3) reached significance in an unpaired-samples t-test (t (9) = 5.273, p =.005). Hence, in the case of coda combinations, the violation of the SSP not only affected the impressionistic perception of vowel epenthesis discussed above but also influenced the acoustic duration of the identified epenthetic vowels.

In onset sequences, and excluding the results for the fricative /s/ + stop sequence, the impact of SSP violation on the duration of the inserted vowel was found to be less noticeable, as confirmed by the insignificant results of an unpaired-sample t-test (t (8) = -0.825, p = .216), which compared the means of the duration of the identified epenthetic vowels in onset sequences that violated the SSP (N = 3, M = 60.8, Md = 65.2, SD = 14.2) to those which adhered to it (N = 7, M = 53.7, Md = 58.4, SD = 11.8). While two onset sequences violating the SSP, namely approximant + fricative and nasal + fricative, still exhibited the longest epenthetic vowel durations among all onset sequences (65.2 – 72.3 ms), one sequence, i.e., stop + stop, had a comparatively shorter epenthetic vowel duration than many onset sequences adhering to the SSP.

Having seen the comparatively shorter duration of the identified epenthetic vowels compared to the duration of the main vowels within the same word(s), it was necessary to investigate whether these epenthetic vowels also exhibit distinct formant frequencies. To address this question, the formant frequencies of the identified epenthetic vowels were measured and compared to those of the corresponding main vowels (see section 3.3.3.2). If differences between main and epenthetic vowels exist, it can be claimed that the identified epenthetic vowels possess their distinct spectral characteristics, and are not merely copy vowels.

Test word	Onset sequence combination	SSP violation	Total tokens examined	Identified CvC tokens	Average epenthetic vowel duration	Average main vowel duration
/ɾʒandɨn/ /lvin/	approximant + fricative	Yes	29	29	72.3	140.3
/nveʒ/	nasal + fricative	Yes	30	29	65.2	184.4
/pʰdi/ /pʰtɨɾ/	stop + stop	Yes	29	25	44.9	135.3
/spi/	fricative + stop	Yes	30	0	0	220.1
/znɑɾ/	fricative + nasal	No	15	15	63.8	173.2
/mɾiʃk/	nasal + approximant	No	30	29	62.7	134.4
/tri/ /kʰɾɑs/	stop + approximant	No	30	27	59.3	179.6
/bnɑɣ/	stop + nasal	No	15	15	58.4	192.7
/sɾuʃt/	fricative + approximant	No	15	10	54.2	134.7
/ʧnɑɾ/	affricate + nasal	No	15	12	47.5	179.8
/pʰʃik/ /tʰfæɲɡ/	stop + fricative	No	30	18	30.1	150.6
Average vowel duration across onset sequences					50.8	165.9
	Coda sequence combination					
/bæfɾ/	fricative + approximant	Yes	30	27	89.2	114.8
/kæpɾ/	stop + approximant	Yes	29	28	83.5	97.3
/ʤæʒn/	fricative + nasal	Yes	30	27	77.6	142.4
/tʰæqn/	stop + nasal	Yes	30	30	70.5	82.6
/ʃæɾm/	approximant + nasal	No	15	11	58.3	13.2
/kʊʧk/	affricate + stop	No	15	9	32.9	83.9
/biɾs/	approximant + fricative	No	15	5	31.4	86.7
/mæɾʤ/	approximant + affricate	No	15	2	14.1	129.2
/bælɡ/	approximant + stop	No	14	2	9.2	155.2
/dæst/	fricative + stop	No	30	0	0	153.3
/ɡʊnd/	nasal + stop	No	15	0	0	117.9
Average vowel duration across coda sequences					42.4	107
Average vowel duration across onset and coda sequences					46.6	136.4

Table 3.11 Average duration (in ms) of epenthetic and main vowels in CvC tokens per sequence combination. Average epenthetic and main vowel duration per sequence position (combined onsets vs combined codas) and across sequences (combined onsets and codas) are also given.

3.3.3.2. Vowel Quality

First and second formant frequencies (F1 and F2) were measured at the midpoint of 329 identified epenthetic vowels and their corresponding main vowels – totalling 658 vowels – using a

Praat script. The resulting measurements in Hertz were normalised and scaled back to Hertz-like values for clarity of interpretation of the normalised values, using Lobanov's (1971) normalisation method and applying the NORM web-based interface for normalising formant data (Thomas & Kendall, 2007).

Given the inherent variations in vocal tract dimensions between male and female speakers, distinct formant frequencies are often observed. To account for this, the mean F1 and F2 frequencies for identified epenthetic vowels and their corresponding main vowels are presented separately across 7 male speakers and 8 female speakers in Table 3.12 for unnormalised values, and Table 3.13 for normalised scaled back to Hertz-like values. See Appendix D for mean F1 and F2 values (unnormalised and normalised scaled back to Hertz-like values) for each identified epenthetic vowel and its corresponding main vowel per speaker.

Speaker	**Epenthetic vowel**	**No. of vowel**	**F1 (Hz)**	**F2 (Hz)**	**Main Vowel**	**F1 (Hz)**	**F2 (Hz)**
Male	epV_ɑ	67	379	1631	ɑ	535	1199
	epV_æ	146	456	1668	æ	611	1628
	epV_e	28	361	1730	e	417	1943
	epV_ɨ	16	552	1816	ɨ	420	1642
	epV_i	77	386	1927	i	289	2253
	epV_ʊ	9	518	1857	ʊ	340	1320
	epV_u	11	344	1674	u	333	1238
	Epenthetic vowel	**No. of vowel**	**F1 (Hz)**	**F2 (Hz)**	**Main Vowel**	**F1 (Hz)**	**F2 (Hz)**
Female	epV_ɑ	67	493	1869	ɑ	619	1392
	epV_æ	146	557	1898	æ	716	1892
	epV_e	28	455	2139	e	475	2368
	epV_ɨ	16	472	1813	ɨ	538	1883
	epV_i	77	445	2261	i	364	2444
	epV_ʊ	9	403	2511	ʊ	417	1685
	epV_u	11	431	1936	u	399	1305

Table 3.12 Mean F1 and F2 (unnormalised Hz values) for epenthetic vowels and their corresponding main vowels across 7 male and 8 female speakers. 'epV_x' refers to epenthetic vowels, with 'x' representing the main/lexical vowel within the word.

Speaker	Epenthetic vowel	No. of vowel	Scaled to Hz-like F1	Scaled to Hz-like F2	Main Vowel	Scaled to Hz-like F1	Scaled to Hz-like F2
Male	epV_ɑ	67	339	1333	ɑ	409	1042
	epV_æ	146	363	1350	æ	422	1326
	epV_e	28	326	1407	e	344	1556
	epV_ɨ	16	364	1437	ɨ	350	1334
	epV_i	77	337	1535	i	298	1753
	epV_ʊ	9	355	1476	ʊ	319	1108
	epV_u	11	322	1361	u	314	1066
	Epenthetic vowel	**No. of vowel**	**Scaled to Hz-like F1**	**Scaled to Hz-like F2**	**Main Vowel**	**Scaled to Hz-like F1**	**Scaled to Hz-like F2**
Female	epV_ɑ	67	534	1173	ɑ	534	1173
	epV_æ	146	599	1454	æ	599	1454
	epV_e	28	427	1744	e	427	1744
	epV_ɨ	16	480	1449	ɨ	480	1449
	epV_i	77	353	1807	i	353	1807
	epV_ʊ	9	395	1367	ʊ	395	1367
	epV_u	11	360	1063	u	360	1063

Table 3.13 Mean F1 and F2 (normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels across 7 male and 8 female speakers. 'epV_x' refers to epenthetic vowels, with 'x' representing the main/lexical vowel within the word.

The average positions of the epenthetic vowels and their corresponding main vowels were plotted on an acoustic F1-F2 space to visually inspect the distribution of the epenthetic vowels. See Figures 3.10 and 3.11 for male and female speakers, respectively. As can be observed, the epenthetic vowels tended to cluster around the mid-central position within the vowel space, particularly for male speakers. To determine the differences in the F1 and F2 values between epenthetic and their corresponding main vowels, and accordingly examine the nature of the inserted vowels, statistical analyses (analysis of variance ANOVA) were conducted separately for the F1 and F2 normalised scaled back to Hertz-like values of the identified epenthetic vowels and their corresponding main vowels with the type of vowel (epenthetic vs. main) as a factor, and F1 and F2 values as dependent variables. These analyses were conducted on all the data for male and female speakers together. Although the one-way ANOVA of F1 values yielded a significant effect of vowel ($F(13,174)$ =

10.692, $p < .01$), the results of Tukey HSD post-hoc tests showed that the identified epenthetic vowels did not differ from one another in their F1, indicating a similar nature. They were, however, influenced by the quality of their corresponding main/lexical vowels as they did not differ from them either. Only several comparisons between epenthetic and other (non-corresponding) main vowels in F1 values were significant, at the $p < .01$ level, as shown in Table 3.14. The analysis of the F2 values also yielded a main effect of vowel ($F(13,174) = 25.467$, $p < .01$). The post-hoc test, in this case, revealed two epenthetic vowels differing from one another; epV_ɑ and epV_i. The results also showed that three epenthetic vowels (epV_ɑ, epV_ʊ, and epV_u) differed from their corresponding main vowels. Together these results suggest that the identified epenthetic vowel is a kind of common epenthetic vowel but is also influenced by the quality of their main corresponding vowels.

In brief, the visual inspection of the acoustic vowel space together with the results of the statistical analysis indicate that the inserted vowels tend to exhibit a more centralised and relaxed articulation but there appears to be an influence of their corresponding main vowels too. It is possible that including a larger set of data in the analyses would help to assess which of the two factors, the tendency towards a common articulation or the effect of the main vowel, is a more determining factor. In any event, the clustering behaviour of the epenthetic vowels, particularly around the mid-central position within the vowel space, seems to lend support to Hamid's (2016) characterisation of Kurdish epenthetic vowels as a mid-central high vowel.

Formant frequency	Epenthetic vowel	No. of vowel	Significant differences ($p < .01$) from:		
			other epenthetic vowel(s)	the corresponding main vowel	other main vowel(s)
F1	epV_æ	15			i, u
	epV_ɑ	15			æ
	epV_e	15			ɑ, æ
	epV_i	15			ɑ, æ
	epV_ʊ	9			ɑ, æ
	epV_u	11			ɑ, æ
	epV_ɨ	14			æ
F2	epV_æ	15			ɑ, e, i, u
	epV_ɑ	15	epV_i	ɑ	e, i, u
	epV_e	15			ɑ, i, ʊ, u
	epV_i	15	epV_ɑ		ɑ, æ, ɨ, ʊ, u
	epV_ʊ	9		ʊ	ɑ, u
	epV_u	11		u	ɑ, e, i
	epV_ɨ	14			ɑ, i, u

Table 3.14 Tukey HSD post-hoc significant test results in F1 and F2 scaled back to Hertz-like values among epenthetic vowels, between epenthetic vowels and their corresponding main vowels, and between epenthetic vowels and other main vowels. 'epV' refers to epenthetic vowels in the environments of the adjacent corresponding main vowels; for example, epV_æ refers to the epenthetic vowels in words that have /æ/ as the main vowel.

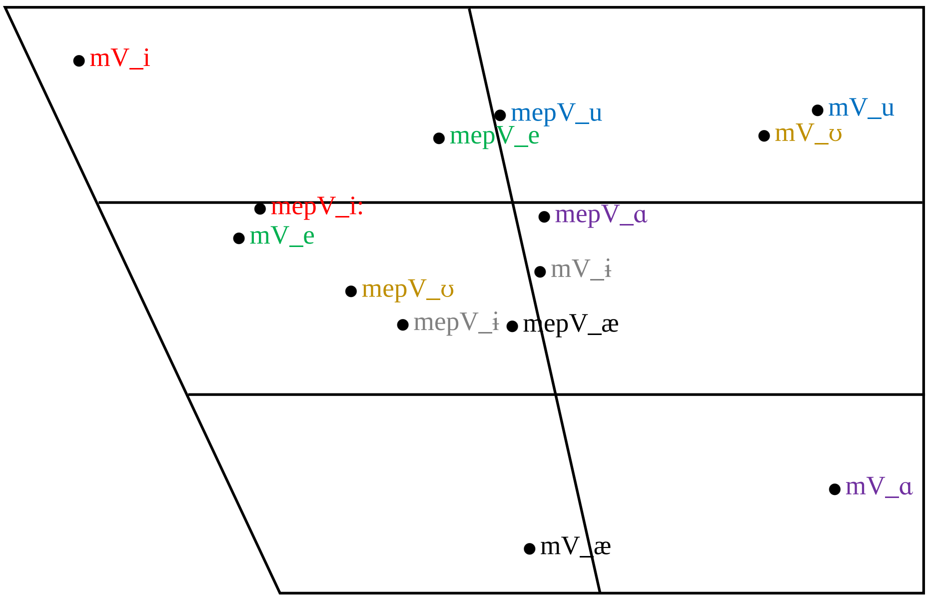

Figure 3.10 Vowel plot of the average F1 and F2 (using scaled back to Hertz-like values) for 7 male speakers. 'mV' refers to a main corresponding vowel 'V' for a male speaker 'm' and 'mepV' is its epenthetic vowel (epV) for the same male speaker. Each main vowel is color-coded along with its corresponding epenthetic vowel for clarity.

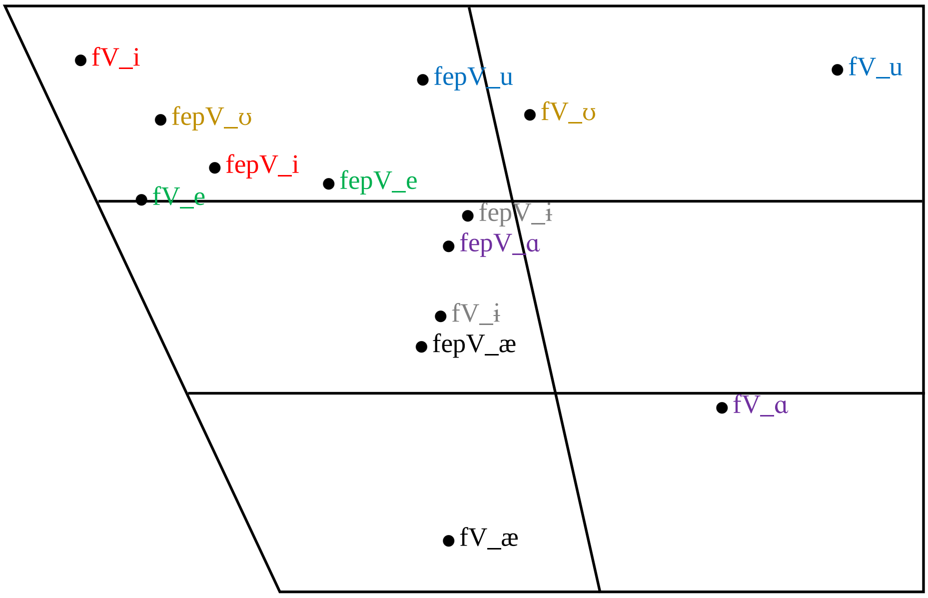

Figure 3.11 Vowel plot of the average F1 and F2 (using scaled back to Hertz-like values) for 8 female speakers. 'fV' refers to a main corresponding vowel for a female speaker 'f' and 'fepV' is its epenthetic vowel (epV) for the same female speaker. Each main vowel is color-coded along with its corresponding epenthetic vowel for clarity.

Finally, since the main purpose of conducting the acoustic analysis was to determine the potential presence of an epenthetic vowel in the sequences under study and to contrast that information with the results of the impressionistic analysis, the percentage of times an epenthetic vowel was acoustically identified for each specific sequence across participants was calculated. For example, as shown in Table 3.11 in section 3.3.3.1, out of 15 tokens produced for /ʧnɑɾ/ (with the affricate + nasal onset sequence), an epenthetic vowel was acoustically identified in 12 tokens, and in 3 tokens, no epenthetic vowel was identified. Thus, an epenthetic vowel was acoustically identified in 80% of the total /ʧnɑɾ/ tokens, and accordingly in the onset affricate + nasal sequence. The results for all the sequences are given in Table 3.15, which shows a moderately high level of acoustically identified CvC tokens across all sequences (including the onset combination of fricative /s/ + stop) and participants, with a mean rate of 65.8% (Md = 83.1, SD = 36.6). When the fricative /s/ + stop onset combination is excluded, the level of acoustically identified CvC tokens across all other sequences and participants was slightly higher with a mean rate of 68.9% (Md = 86.2, SD = 33.3).

The results for the acoustic identification of vowel epenthesis do not differ much from those obtained from the impressionistic perception of vowel epenthesis shown in Table 3.10 in 3.3.2. A statistical analysis was conducted to determine the strength of the association between the percentages of CvC tokens identified acoustically and impressionistically for each sequence combination across participants. The results of a Pearson correlation revealed a highly strong association between the two sets of data ($r = .983$, $N = 22$, $p < .01$), indicating a consistent alignment between subjective impressionistic judgments and objective acoustic measurements.

Onset sequence				Coda sequence			
Test word	**Sequence combination**	**SSP violation**	**% of acoustic CvC**	**Test word**	**Sequence combination**	**SSP violation**	**% of acoustic CvC**
/ɾʒɑndɨn/ /lvin/	approximant + fricative	Yes	100	/tʰæqn/	stop + nasal	Yes	100
/nveʒ/	nasal + fricative	Yes	96.7	/kæpɾ/	stop + approximant	Yes	96.6
/pʰdi/ /pʰtɨɾ/	stop + stop	Yes	86.2	/bæfɾ/	fricative + approximant	Yes	90
/spi/	fricative + stop	Yes	0	/ʤæʒn/	fricative + nasal	Yes	90
/bnɑɣ/	stop + nasal	No	100	/ʃæɾm/	approximant + nasal	No	73.3
/znɑɾ/	fricative + nasal	No	100	/kʊʧk/	affricate + stop	No	60
/mɾiʃk/	nasal + approximant	No	96.7	/biɾs/	approximant + fricative	No	33.3
/tri/ /kʰɾɑs/	stop + approximant	No	90	/bælg/	approximant + stop	No	14.3
/ʧnɑɾ/	affricate + nasal	No	80	/mæɾʤ/	approximant + affricate	No	13.3
/sɾuʃt/	fricative + approximant	No	66.7	/dæst/	fricative + stop	No	0
/pʰʃik/ /tʰfæɳg/	stop + fricative	No	60	/gʊnd/	nasal + stop	No	0
Total % of acoustic CvC per sequence position			79.7				51.9
Total % of acoustic CvC across sequences							65.8

Table 3.15 Percentages of acoustically identified CvC tokens per sequence combination. Total percentages per sequence position and across sequences are also given. Results are given in descending order and according to the SSP violation specification (Yes vs No).

3.3.3.3. Factors Affecting Vowel Epenthesis in Production

This section evaluates the effects of production task, SSP status, sequence combination, and word position (onset vs coda) on the presence of epenthetic vowels. First, it was examined whether the prevalence of vowel epenthesis differed depending on the production task used. Given the strong association revealed by the strong correlation between acoustic and impressionistic measures, the effect of production task differences on the production of vowel epenthesis was examined using the results obtained from the acoustic identification of CvC tokens. The percentage of times an epenthetic vowel was inserted for each type of consonant combination was calculated for each task. The insertion of an epenthetic vowel was notably less frequent in the sentence reading task (M = 77.1, Md = 86.7, SD = 20.1) than in the picture-naming task (M = 95.4, Md = 95, SD = 4.7) for a total of 8 sequence combinations included in both tasks. This observed difference in epenthetic vowel insertion frequency was further supported by the results of a paired-samples t-test (t (7) = 2.671, p = .031), indicating statistical significance. The participants may have been influenced by the orthographic representation of the test words, where an epenthetic vowel is not written. The results suggest that the performance in the picture-naming task possibly better reflects the natural production of words/sequences in normal conversation.

In relation to the influence of the SSP on the acoustic identification of a vocalic element, onset combinations did not demonstrate a significant effect. Excluding the results obtained for the fricative /s/ + stop onset sequence, the acoustic identification of vowel epenthesis in onset sequences violating the SSP (N = 3, M = 94.3, Md = 96.7, SD = 7.2) and those not violating it (N = 7, M = 84.8, Md = 90, SD = 16.3) did not significantly differ, as revealed by the results of an unpaired-samples t-test (t (8) = -0.947, p = .185). In contrast to onset combinations, the acoustic identification of vowel epenthesis in codas violating the SSP (N = 4, M = 94.1, Md = 93.3, SD = 4.3) was more consistent and higher than in codas not violating it (N = 7, M = 32.4, Md = 23.8, SD = 26.4), aligning with the results of the impressionistic perception of vowel epenthesis, and again supporting the predictions of the SSP (Clements, 1990). This observed difference was further supported by the results of a Mann-Whitney U test, $U = 28$, Z = 2.562, $p = 0.010$, with a large effect size $r = 0.770$, indicating a significant difference between the two groups being compared.

The effect of sequence combination appears to be more obvious in non-SSP-violating coda sequences than in onset sequences. Among non-SSP onset combinations, only fricative + approximant and stop + fricative combinations show relatively low rates of vowel epenthesis compared to other onset combinations. This lower rate may be attributed to the frequency of these combinations rather than the similarity in the consonants' places of articulation. In other words, these combinations may occur more frequently than other onset sequences.

In non-SSP-violating coda combinations, there is greater variability in the production of CvC combinations. For fricative + stop and nasal + stop combinations, homogeneity of the place of articulation does not seem to explain the observed patterns, as non-homorganic equivalent combinations are also produced as true clusters in other contexts, such as the /-sp/ sequence in /hæsp/ (horse). It is more likely that the frequency of these combinations in the language plays an important role. The frequency of combination use, rather than homogeneity of place of articulation, may also account for the relatively lower rates of epenthesis in approximant + affricate, approximant + stop, and approximant + fricative combinations (13.3% – 33.3% of CvC). However, these results are based on a limited set of words. Testing a broader array of words could provide clearer evidence of the impact of combination frequency and the likelihood of these sequences forming actual clusters.

In the case of affricate + stop and approximant + nasal combinations, one might argue, based on the Minimal Sonority Distance principle, that these sequences are more likely to be epenthesised and less likely to form true clusters due to the small sonority difference between their members (2 for approximant + nasal and 1 for affricate + stop). However, this is unlikely to be the primary factor, as the fricative + stop coda combination in /dæst/, which also has a low sonority difference (2), was never epenthesised. It is more likely that the frequency of these combinations in the language is a stronger influence, as affricate + stop and approximant + nasal combinations are, to my knowledge, less common than other non-SSP-violating combinations tested. Overall, the impact of sequence frequency may be more accurately assessed by testing more words per combination in future studies.

Finally and in relation to whether onset or coda combinations triggered more vowel insertions, the acoustic identification of vowel epenthesis appeared to be higher in onset combinations – excluding the results for the fricative /s/ + stop combination – (N = 10, M = 87.6, Md = 93.4, SD = 14.5) than in codas (N = 11, M = 51.9, Md = 60, SD = 38.6). This was also confirmed by the significant results of a Mann-Whitney U test, $U = 85$, Z = 2.088, $p = 0.036$, with a medium effect size $r = 0.46$, indicating a significant effect of sequence position on the acoustic identification of vowel epenthesis. This observed effect, however, was found insignificant ($U = 68.5$, $Z = 0.922$, $p = 0.356$, with a small effect size $r = 0.2$) in terms of the impressionistic perception of vowel epenthesis in onset and coda combinations.

3.3.4. Discussion of Production Results

The production of 22 sequences (11 onset sequences and 11 coda sequences) was examined both acoustically and impressionistically to assess whether these sequences were produced with or without a vocalic element and if factors such as violation of the SSP, sequence combination, and sequence position have any influence on the presence of a vocalic element in these sequences.

The first finding was the strong agreement observed between impressionistic analysis and acoustic analysis results, as evidenced by a strong correlation coefficient reported above (i.e., r =

.983, $N = 22$, $p < .01$). This agreement related to sequences both with and without epenthetic vowels, indicating a consistent alignment between subjective impressionistic judgments and objective acoustic measurements. For example, an absolute agreement was found regarding the absence of a vocalic element in the fricative /s/ + stop combination whether in the onset or coda position. This finding is consistent with Shokri's (2002) description of this sequence as an actual cluster in NK, both in onset and coda positions. Resistance to vowel insertion in this specific combination in the onset position could be explained in light of the adjunct approach to /s/-C clusters (Giegerich, 1992; Kenstowicz, 1994). Additionally, in the nasal + stop coda sequence, no epenthetic vowel was impressionistically perceived or acoustically identified, again consistent with Shokri's (2002) and Hasan's (2009) descriptions of this sequence as an actual coda cluster. This finding was expected given that the nasal + stop sequence adheres to the SSP (Clements, 1990) in the coda position. Consistency between impressionistic analysis and acoustic analysis results regarding the rest of the sequences, which contained epenthetic vowels to varying degrees, was also very high, indicating the robustness of the findings.

The second main finding relates to the impact of the SSP, which was more obvious in coda combinations compared to onsets. This was evident in both impressionistic and acoustic analyses. An epenthetic vowel was consistently perceived impressionistically and identified acoustically in all onset sequences, regardless of whether they violated or adhered to the SSP. The exception was the fricative /s/ + stop combination. It is worth noting that all these sequences, except for the fricative /s/ + stop combination, were previously described as actual clusters in Hasan's 2009 work. For coda sequences, the impact of the SSP was more obvious. In the four violating SSP-sequences, stop + nasal, stop + approximant, fricative + approximant, and fricative + nasal, the rate of vowel epenthesis was very high, again contradicting Hasan's (2009) descriptions of these sequences as actual coda clusters. For coda sequences adhering to the SSP, the rate of vowel epenthesis was comparatively low. Yet, unexpected results were observed in specific combinations. The approximant + nasal and affricate + stop combinations exhibited relatively high rates of vowel epenthesis. This finding is surprising, especially considering that no epenthetic vowel was identified in other coda sequences, such as fricative + stop and nasal + stop combinations, or the rate of vowel epenthesis was comparatively low in approximant + fricative, approximant + stop, and approximant + affricate combinations. A possible explanation may lie in the greater influence of sequence frequency over SSP violation in approximant + nasal and affricate + stop combinations. In other words, these combinations may be less frequent than other non-SSP coda combinations.

Concerning the acoustic characteristics of the identified epenthetic vowels, the results of the acoustic analysis in terms of duration and formant frequencies detected reliable differences between the identified epenthetic vowels and the corresponding main vowels in the same word. The identified epenthetic vowels were found to be consistently shorter than their main vowels, constituting only one-third of the corresponding main vowel duration. In terms of vowel quality, the epenthetic vowels tended to have generally common spectral characteristics even if the F1 and F2 values were partially affected by those of the corresponding main vowels. Possibly, an analysis of a larger amount of data per consonant sequence would shed light on the issue of the acoustic nature of the NK epenthetic vowel, which may point to a common epenthetic vowel across contexts.

Based on Hall's 2006 diagnostics for epenthetic and intrusive vowels (see Chapter 1 for a discussion on intrusive and epenthetic vowel diagnostics), it may be argued that the inserted vowels in onset and coda sequences adhering to the SSP are more likely to have been intrusive than epenthetic because the inserted vowels do not fulfill the primary function of epenthetic vowel insertion, which is to repair illicit sequence combinations. However, examples of epenthetic vowel insertion in sequences that do not violate the SSP have also been documented in other languages. One such example is the colloquial Levantine Arabic dialects spoken in Lebanon, Syria, Israel, Palestine, and Jordan (Hall, 2012). The coda sequence /-nt/ adhering to the SSP in /bint/ 'girl' may be pronounced either with an epenthetic vowel as /binit/ or without it as /'bint/ in Lebanese. Additionally, and particularly for onset combinations, the frequency of vowel insertion – excluding the results obtained for fricative /s/ + stop combinations – was relatively high and consistent across sequences (N = 10, M = 79.7, Md = 90, SD = 29) indicating that the inserted vowel was not optionally present and is more likely to be epenthetic. If the inserted vowel was intrusive in these sequences, its frequency of occurrence would have been lower, following Hall's 2006 diagnostics for intrusive vowels. These vowels are optionally present in speech and thus occur less frequently than epenthetic vowels. The inserted vowel in codas adhering to the SSP, especially in sequences involving approximant + fricative, approximant + stop, and approximant + affricate, could be classified as intrusive, given their notably low frequency of occurrence in these sequences. Yet, a more comprehensive examination, involving a broader set of words and a greater number of repetitions per speaker, and involving both slow and casual speech rates, would be necessary to fully assess whether the inserted vowels in coda sequences adhering to the SSP are indeed intrusive. In the following section, the relationship between perception task and production task results is looked at. This analysis is crucial for assessing which sequences may or may not be considered actual clusters in NK.

3.3.5. Relationship between Perception and Production Task Results

This section examines whether the perception task and production task results were closely related in terms of perception and production of vowel epenthesis, i.e., CvC tokens perceived and produced per sequence combination. Given the high similarity between impressionistic and acoustic analysis results obtained from the production tasks (see 3.3.3.3) and for the sake of simplicity, only the acoustic analysis results will be considered for comparison with perception task results. The acoustically identified percentage of CvC tokens for each sequence combination across participants was compared with the percentage preference for CvC stimuli in each sequence combination across the same group of participants. It was expected that the two measures would be positively correlated, that is, sequences characterised by a high degree of vowel epenthesis in production would also be perceptually preferred with vowel epenthesis. Table 3.16 presents the results of the comparison between the percentages of CvC tokens for each sequence combination produced by participants and the corresponding percentages representing perceptual preference. Sequences that were not tested in either the production or perception task were labelled as 'not tested' in Table 3.16. For certain sequence combinations where the same word was not assessed in either the production or perception task, the alternative word is given in the table.

The expected results were found, as an inspection of the individual data suggested a strong link between the perception and production values for the majority of sequences tested. Accordingly, a Spearman correlation test conducted on the percentages of CvC tokens perceived and produced per sequence combination revealed a strong positive relation between the two sets of data (r =.797, N =15, $p < .01$). This association helped assess which sequences could eventually be (dis)regarded as actual clusters in NK. For example, the results obtained for all onset combinations in Table 3.16, excluding the fricative + stop and affricate + nasal combinations, suggest that these sequences are very unlikely to form actual onset clusters in NK. This is primarily due to the consistent triggering of vowel epenthesis observed in these sequences, as indicated by the particularly high percentages of CvC tokens identified acoustically in these sequences (ranging between 60-100%), as well as the strong preference observed for the CvC stimuli belonging to these sequences (86-100%). Regarding the affricate + nasal sequence which was not tested in the perception task, the substantial occurrence of vowel epenthesis in this sequence (80%) can be interpreted as a good indicator that this sequence is also less likely to form an actual onset cluster. Therefore, among onset combinations, the only sequence forming an actual cluster in the onset position is the fricative /s/ + stop combination. This combination was never perceptually preferred or produced with vowel epenthesis. The results obtained for onset combinations support the claim made by Hamid (2016) that NK imposes stricter restrictions on onset combinations than on codas. It is possible that NK, despite being genetically unrelated to Arabic, has developed similar restrictions on onset cluster formation due to the Sprachbund effect (Andersson, Sayeed, & Vaux, 2017). The coexistence of these languages in the same geographical area has likely led to a convergence in their phonological patterns, resulting in comparable constraints on forming onset clusters.

Regarding the results for coda combinations in Table 3.16, the sequences stop + nasal, stop + approximant, fricative + approximant, fricative + nasal, and approximant + nasal are very unlikely to form actual coda clusters in NK. This is because they have consistently been produced with vowel epenthesis (73.3-100%) and strongly preferred perceptually with vowel epenthesis (67-93%). The fact that the first four sequences violate the SSP may explain why these combinations are less likely to form clusters, while the results for the non-SSP-violating approximant + nasal combination may be better explained by the frequency of its usage in NK. Regarding the affricate + stop combination, and because it is not tested in the perception task and produced moderately with vowel epenthesis (60%) in the production tasks, it is not definitive to suggest its inability to form an actual cluster in the coda position, especially that it does not violate the SSP in the given position. Further investigation, possibly involving a wider array of words, may be necessary to ascertain its cluster status in NK.

The results for other sequences, namely approximant + fricative, approximant + stop, and approximant + affricate, seem to indicate a variable cluster status for these particular combinations. This suggests that these sequences can potentially form actual clusters in NK, given their low rates of vowel epenthesis (13.3-33.3%) and adherence to the SSP. However, it is also observed that they may occasionally be broken up by a vocalic element be it epenthetic or intrusive. It is possible that the presence of an epenthetic vowel may be determined by other factors such as speech rate, an issue that is left for future research. Finally, although not assessed in the perception task, the results of the current study suggest that, among all coda combinations, fricative + stop and nasal + stop are the most robust examples of true cluster combinations, as they were never produced with vowel epenthesis. The frequency of these two combinations in NK, along with the fact that they do not violate the SSP in their respective positions, likely explains why these combinations functioned as actual clusters.

In conclusion, the straightforward relationship between perception and production tasks results in this study proved instrumental in determining the likelihood of certain sequences forming actual clusters in NK. Notably, among onset combinations, the fricative /s/ + stop combination emerged as the only sequence forming an actual cluster, while other sequences were deemed unlikely due to the consistent triggering of vowel epenthesis. This is probably linked to the extrasyllabic or ‘adjunct’ nature of /s/-C clusters (Giegerich, 1992; Kenstowicz, 1994). In coda combinations, the stop + nasal, stop + approximant, fricative + approximant, fricative + nasal, and approximant + nasal sequences were considered unlikely as actual clusters, given their consistent production with vowel epenthesis and perceptual preference for such forms. The affricate + stop combination, not tested in perception tasks, requires further investigation for its coda cluster status. Sequences involving approximants showed a variable cluster status, indicating potential cluster formation but with occasional vocalic interruptions. Finally, the results of this study suggest that fricative + stop and nasal + stop combinations are the only coda sequences forming actual clusters, as they were consistently produced without vowel epenthesis.

Onset sequence					Coda sequence				
Test word	**Sequence combination**	**SSP violation**	**Production: % of acoustic CvC**	**Perception: % preference for CvC stimuli**	**Test word**	**Sequence combination**	**SSP violation**	**Production: % of acoustic CvC**	**Perception: % preference for CvC stimuli**
/ɾʒɑndɨn/ /lvin/	approximant + fricative	Yes	100	90 for /lvin/	/tʰæqn/	stop + nasal	Yes	100	67
/nveʒ/	nasal + fricative	Yes	96.7	93	/kæpɾ/	stop + approximant	Yes	96.6	93
/pʰdi/ /pʰtɨɾ/	stop + stop	Yes	86.2	90 for /pʰtɨɾ/	/bæfɾ/	fricative + approximant	Yes	90	90
/spi/	fricative + stop	Yes	0	0	/ʤæʒn/	fricative + nasal	Yes	90	93
/bnɑɣ/	stop + nasal	No	100	100	/ʃæɾm/	approximant + nasal	No	73.3	76
/znɑɾ/	fricative + nasal	No	100	86 for /snel/	/kʊʧk/	affricate + stop	No	60	not tested
/mɾiʃk/	nasal + approximant	No	96.7	100	/biɾs/	approximant + fricative	No	33.3	not tested
/tri/ /kʰɾɑs/	stop + approximant	No	90	90 for /bɾin/	/bælg/	approximant + stop	No	14.3	not tested
/ʧnɑɾ/	affricate + nasal	No	80	not tested	/mæɾʤ/	approximant + affricate	No	13.3	not tested
/sɾuʃt/	fricative + approximant	No	66.7	93	/dæst/	fricative + stop	No	0	not tested
/pʰʃik/ /tʰfæɳg/	stop + fricative	No	60	100 for /tʰfæɳg/	/gʊnd/	nasal + stop	No	0	not tested

Table 3.16 A comparison between the percentages of CvC tokens for each sequence combination produced across participants and the corresponding percentages representing perceptual preferences for CvC stimuli.

3.4. General Discussion

This section offers a general discussion of the main findings regarding the perception and production of several consonant sequences in NK and the factors that may affect the cluster status of these sequences. A group of 15 NK native speakers participated in a perception experiment aimed at eliciting the participants' preference for CvC vs. CC productions and also completed a production experiment in which they produced a number of crucial consonant sequences. The first finding of this study concerns whether the perception and production of the consonant sequences tested revealed any instances of true clusters (i.e., complete absence of an epenthetic vowel). Out of a total of sixteen sequences tested, only three sequences, namely fricative + stop in the onset and coda positions and nasal + stop in the coda position acted consistently as actual clusters, as they never triggered vowel epenthesis in any of the tokens produced by all participants, nor were they perceptually perceived with vowel epenthesis, as was evident in the case of the fricative /s/ + stop onset sequence which was included in the perception task. Possible reasons for the lack of epenthetic vowels in these sequences are discussed below. The findings regarding these three combinations are consistent with the findings in previous studies (Shokri, 2002; Omer & Hamad, 2016) and suggest that the NK dialect spoken in the Kurdistan region of Iraq allows for a strictly limited number of consonant clusters (unlike English, as will be discussed in Chapter 4 [L2 study]).

The findings pertaining to the remaining 13 sequences tested run counter to the earlier descriptions of consonant clusters given by Hasan (2009) and Kahn (1976). In those works, these combinations were described as actual clusters in NK. It is plausible that the descriptions of consonant clusters, particularly those outlined by Hasan (2009), primarily originate from the orthographic representation of Kurdish words, which typically omits epenthetic vowel representations. As a result, it is possible that any two adjacent consonant letters in the orthography were considered a true consonant cluster. Alternatively, these descriptions may have been based on the author's native intuitive phonetic segmentation of words as the majority of native Kurdish speakers do not often include the vowel /ɨ/ when they break apart a word into its sounds (Hamid, 2016). Additionally, the descriptions of consonant clusters in these works lack experimental validation, either acoustically and/or perceptually.

The results of the perception task did not reveal an important effect of SSP violation, sequence combination, or sequence position. The mean percentage preference for CvC stimuli across all sequences (onsets and codas) and participants was consistently high (M = 84.2, SD = 10), indicating a general preference for these stimuli. High confidence ratings (M = 5.7 out of 6, SD = 0.9) further suggested participants' confidence in their choices. Recall that all sequences perceptually preferred as more Kurdish-like or natural with vowel epenthesis were described as actual clusters in Hasan (2009). For onset sequences, only the fricative /s/ + stop combination, despite violating the SSP, was perceived as Kurdish-like or natural without vowel epenthesis (0% preference for CvC stimuli). This combination was the only one considered an actual onset cluster in Shokri (2002). It is possible that /s/ behaved as a direct dependent of the syllable, as proposed by the 'adjunct' approach to /s/-C clusters (Giegerich, 1992; Kenstowicz, 1994). The remaining onset sequences showed a consistent preference for CvC stimuli (86-100%), regardless of whether they violated the SSP or not, suggesting no clear influence of SSP violation or sequence combination. For coda sequences, four combinations, including those violating and not violating the SSP, were highly perceived as more Kurdish-like or natural with vowel epenthesis (76-93%). An exception was the stop + nasal sequences, which, despite violating the SSP, was preferred with vowel epenthesis to a lesser extent (67% preference for CvC stimuli). Nonetheless, the results of the production analysis for this sequence revealed a substantial rate of vowel insertion, reaching 100%.

In regards to the production of consonant sequences examined – including the onset combination of fricative /s/ + stop combination – the findings showed that, on the whole, all participants produced most of the tested sequences (both onsets and codas) with a vocalic element as was hypothesised. This was confirmed both impressionistically (M = 66.5, Md = 83.4, SD = 36.9) and acoustically (M= 65.8, Md = 83.1, SD = 36.6). An effect of SSP violation – especially in the case of coda combinations – sequence combination, and sequence position was found.

For onset sequences, only the fricative + stop combination, despite violating the SSP, acted consistently as an actual cluster (0% of CvC production). Conversely, this was not observed for other onset sequences, both violating the SSP (N = 3, M = 94.3, Md = 96.7, SD = 7.2) – i.e., approximant + fricative, nasal + fricative, stop + stop – and those adhering to the SSP (N = 7, M = 84.8, Md = 90, SD = 16.3) – i.e., stop + nasal, fricative + nasal, nasal + approximant, stop + approximant, affricate + nasal, fricative + approximant, and stop + fricative. These findings indicated no important effect of sequence combination for onsets. Additionally, they supported the perception task results and contradicted the descriptions by Hasan (2009) and Kahn (1976) regarding these combinations as true clusters.

For coda sequences, only the fricative + stop and nasal + stop combinations acted consistently as constituting actual coda clusters (0% of CvC production). These results were not surprising given that the two sequences do not violate the SSP, and they were also described as actual clusters in previous studies. It cannot be asserted that the presence of homorganic consonants in the selected example words for these sequences, i.e., /-st/ in /dæst/ and /-nd/ in /gʊnd/, makes them more likely to form actual clusters. Equivalent sequences involving non-homorganic consonants, like /-sp/ in /hæsp/ ‘horse’ for fricative + stop, and /-mt/ in /sʊmt/ ‘drilled’ for nasal + stop, are also expected to form clusters. It is plausible that, in accordance with the claims made in (Shokri, 2002), the phonotactic constraints within NK exhibit more flexibility towards the formation of coda clusters compared to onset clusters. It is possible that NK, despite being genetically unrelated to Arabic, has developed similar restrictions on onset cluster formation due to the Sprachbund effect (Andersson, Sayeed, & Vaux, 2017).

Additionally, the impact of the SSP violation was obvious for coda sequences. Sequences that violated the SSP – i.e., stop + nasal, stop + approximant, fricative + approximant, and fricative + nasal – were highly and consistently produced with a vocalic element (N = 4, M = 99.2, Md = 100, SD = 1.4), following the predictions of the SSP (Clements, 1990). Sequences that did not violate the SSP, including the fricative + stop and nasal + stop combinations, were, overall, less frequently produced with vowel insertion (N = 7, M = 32.4, Md = 23.8, SD = 26.4). Among these, sequences involving approximants, and displaying relatively low rates of vowel insertion (13.3% - 33.3%), i.e., approximant + fricative, approximant + stop, and approximant + affricate, may suggest potential cluster formation in these sequences with occasional vocalic insertions. It could be claimed that the inserted vowel in these sequences is more likely intrusive than epenthetic, based on Hall's 2006 diagnostics for epenthetic and intrusive vowels. Conversely, in the case of coda sequences adhering to the SSP but characterised by relatively high rates of vowel insertion (60% - 73.3%), i.e., approximant + nasal and affricate + stop combinations, one could argue that sequence combination in terms of frequency of combination use has a greater impact than SSP violation in these cases. Given the relatively high rates of vowel insertions in these sequences, it remains unlikely for them to constitute an actual cluster even though they do not violate the SSP. Further investigation, possibly involving more words, and including more examples of each cluster combination per speaker, may be necessary to determine whether or not these sequences can form actual clusters in NK.

In relation to the acoustic characteristics of the identified inserted vowels, the inserted vowel showed many of the properties given for epenthetic vowels in Hall (2006). Firstly, the important differences in duration and F1 and F2 frequencies between the inserted vowels and their corresponding main vowels indicated that the former vowels were not copies of a nearby vowel. Rather, they often showed, as described in Hamid (2016), a more centralised and relaxed articulation and were partly independent of their corresponding main vowels. In general, the inserted vowels did not differ from one another revealing a common vowel quality regardless of the main/lexical vowel in the word, but at the same time, in most of the cases, the epenthetic vowels also did not differ so much from the corresponding main vowels either. This may indicate that there is a range of possible realisations of the epenthetic vowel, mostly underspecified, but partly influenced by the quality of their main corresponding vowel.

Although the inserted vowels did not consistently appear to serve the purpose of repairing illicit structures (marked structures) – meaning, they were also present in onset and coda sequences that did not violate the SSP (unmarked structures) – it would not be appropriate to categorise them as intrusive in such contexts. In all onset combinations, with the exception of the fricative /s/ + stop combination (which had a 0% CvC production rate), the consistent presence of vowel insertion in these sequences (M= 84.8, Md = 90, SD = 15.1) suggested a higher likelihood of epenthesis. If the vowel had been considered intrusive in these sequences, its rates of insertion would likely have been lower, as intrusive vowels are typically more optional in speech (Hall, 2006).

Regarding coda sequences adhering to the SSP, particularly in approximant + fricative, approximant + stop, and approximant + affricate sequences, the inserted vowels could be classified as intrusive due to their low frequency of occurrence in these sequences, and given that they do not repair the given sequences. Yet, the inserted vowels in these sequences need to be tested if they are speech-rate dependent to fully assess whether they are indeed intrusive. The vowels inserted in coda sequences violating the SSP – i.e., stop + nasal, stop + approximant, fricative + approximant, and fricative + nasal – are more likely epenthetic as they function to repair the given marked structures (Clements, 1990). In the remaining two coda sequences – i.e., approximant + nasal and affricate + stop, I would argue that the inserted vowels are also epenthetic, despite not repairing the given sequences because they are relatively highly inserted in these two sequences, ranging from 60% to 73.3% of CvC production.

In summary, this chapter has aimed to present a comprehensive study of the perception and production of a variety of consonant combinations in NK. In general, the results support the presence of an epenthetic vowel in most cases, particularly in the onset position. The possible implications that this may have for the learning of L2 clusters (the second main goal of this thesis) are discussed below.

3.5. Implications of the Study for L2 English Learning

The findings of this study on the perception and production of onset and coda consonant combinations by native NK speakers carry certain important implications for the acquisition of foreign onset and coda clusters by adult Kurdish learners. In the context of English as a foreign/second language, it is expected that English initial and final two-consonant clusters, particularly those involving fricative + stop combination, will likely be easily acquired by Kurdish learners of English, given the positive transfer from their L1, as indicated by the current study's results. Even though the fricative /s/ + stop combination is a marked structure in the onset position, i.e., it is a sonority reversal, it is expected to be easier to produce because the effect of L1 positive transfer is expected to override the effect of universal markedness: sequences violating the SSP are challenging in foreign language learning. The same combination but with the addition of another consonant (CCC onset cluster), however, is expected to pose more challenges for Kurdish learners because of two main reasons. Firstly, this sequence does not exist in L1 Kurdish, and secondly, it is a universally marked structure

(Eckman, 1991). Often, L2 learners tend to struggle more with syllables containing longer onsets or codas (Carsile, 2001). As a result, it is predicted that Kurdish EFLs would break up English triple-onset sequences. However, learners with better English proficiency levels are expected to exhibit reduced frequency in the use of cluster simplification processes such as epenthesis, deletion, and metathesis, compared to speakers at lower levels. If this happens, the results of the second study of this thesis (Chapter 4) will replicate those obtained in Nasir (2011), i.e., learners with more advanced levels would exhibit reduced frequency in the use of cluster simplification processes. In other words, a more English-like production of these sequences is expected by more proficient learners. In the case of the fricative + stop and nasal + stop combinations in the coda position, and based on the prediction of the Markedness Differential Hypothesis (Eckman, 1977), it is predicted that Kurdish learners will find these combinations less challenging to produce because they are neither absent in L1 Kurdish (L1 positive transfer) nor typologically more marked (they adhere to SSP).

The relatively high rates of vowel insertion in onset sequences adhering to the SSP, i.e., stop + nasal, fricative + nasal, nasal + approximant, stop + approximant, affricate + nasal, fricative + approximant, and stop + fricative, suggests that achieving native-like patterns in these clusters may present challenges for Kurdish learners of languages permitting these combinations. In the context of English as a foreign language, it is predicted that Kurdish learners may encounter difficulties with stop + approximant and fricative + approximant onset clusters due to negative transfer from their native language. This phenomenon is particularly likely to happen among learners in the early stages of language acquisition, in accordance with the Ontogeny Phylogeny Model (Major, 2001), which posits that transfer effects are at their peak at the beginning of L2 learning and that those features that are unmarked in the L2 are more affected by transfer than those features that are marked. The stop + approximant and fricative + approximant onset clusters are unmarked structures in English since do not violate the SSP.

Similar challenges may arise in the production of foreign coda sequences despite adherence to the SSP. Among the coda sequences examined in this study, only three have counterparts in rhotic English varieties: approximant + stop (‘hard’ /hɑːrd/), approximant + nasal (‘farm’ /fɑːrm/), and approximant + fricative (‘harsh’ /hɑːrʃ/). Negative transfer from L1 Kurdish in the form of vowel insertion is expected to influence the production of these clusters by Kurdish learners. Once again, these challenges are likely to be more obvious among early learners, given the heightened role of language transfer during the initial stages of language acquisition (Major, 2001). For further discussion on English coda clusters, see Roach (2009) and Giegerich (1992).

Lastly, and given that the majority of the tested sequences exhibited an insertion of an epenthetic vowel, it is expected that Kurdish learners will likely use a vowel with similar spectral characteristics to simplify the pronunciation of challenging English onset sequences. Moreover, it is more probable for vowel epenthesis (anaptyxis) to occur rather than vowel prothesis because it has just been seen that Kurdish allows for sibilants followed by obstruents clusters (i.e., fricative + stop). Often, vowel prosthesis has been used by learners of English whose L1 does not allow these combinations in the onset position such as in Spanish. For these learners, English words like ‘stop’ and ‘skip’ are pronounced as /estɒp/ and /eskɪp/ (Carlisle, 1991).

3.6. Summary

This chapter examined the perception and production of various onset and coda consonant sequences in NK by investigating whether native speakers perceive and produce these combinations as more Kurdish-like/ natural with or without the addition of a vocalic element. Results from both perception and production experiments showed a consistent pattern of general preference for an epenthetic vowel, contrary to what previous analysis of NK clusters suggested (Kahn, 1976; Shokri, 2002; Hasan, 2009). Those previous studies were not based on perceptual or acoustic data, hence the current study may present a more accurate description of the cluster status of the sequences tested.

Among the sixteen sequences tested, only fricative /s/ + stop in the onset and coda positions, as well as nasal + stop in the coda position, consistently functioned as actual clusters, remaining unaffected by vowel epenthesis in all participant tokens. This may be explained by the fact that the fricative /s/ + stop in the onset position is a direct dependent of the syllable, exhibiting behaviour distinct from other clusters whereas the same sequence in the coda position, along with the nasal + stop combination, do not violate the SSP in their respective positions.

The perception task revealed no important effects of the SSP violation, sequence combination, or sequence position, as most sequences were perceived as Kurdish-like or natural with vowel epenthesis. However, the production task demonstrated varying effects, with onset sequences allowing for more vowel insertion and a reduced role of SSP violation, while coda sequences exhibited a stronger influence of SSP violation, resulting in fewer instances of vowel insertion. The inserted vowel tended to exhibit distinct spectral characteristics, resembling features of an epenthetic vowel. Finally, the findings of the current study carried important implications for adult Kurdish learners of foreign languages. In light of these implications, the following chapter will explore how adult Kurdish learners of English produce English onset clusters that are either absent in their native language or are universally considered more marked.

Chapter Four

4. Production of Consonant Clusters in L2 English

This chapter aims to investigate the acquisition of English 2-consonant onsets and 3-consonant onsets by Kurdish EFL learners in light of the outcomes of the L1 study and the consequent roles of positive and negative L1 transfer, markedness, and sonority. The findings of the L1 Kurdish study (see Chapter 3) on the perception and production of onset and coda consonant combinations by native NK speakers carried certain important implications for the acquisition of foreign onset and coda clusters by adult Kurdish learners. In the context of English as a foreign/second language, it is expected that English 2-consonant onset clusters, particularly those involving fricative /s/ + stop combination, will likely be easily acquired by Kurdish learners of English, given the positive transfer from their L1, as indicated by the L1 study's results. Even though the fricative /s/ + stop combination is a marked structure in the onset position, i.e., it is a sonority reversal, it is expected to be easier to produce because the effect of L1 positive transfer is anticipated to override the effect of universal markedness: sequences violating the SSP are challenging in foreign/second language learning. The same combination but with the addition of another consonant (3-consonant onset clusters starting with /s/), however, is expected to pose challenges for Kurdish learners because of two main reasons. Firstly, this sequence does not exist in L1 Kurdish (L1 negative transfer), and secondly, it is a universally more marked structure (Eckman, 1991). Often, L2 learners tend to struggle more with syllables containing longer onsets or codas (Carsile, 2001). As a result, it is predicted that Kurdish EFLs would break up English 3-consonant onsets more often than 2-consonant onsets.

Regarding the production of English two-consonant onset clusters that were determined as non-clusters in the L1 study, it is expected – based on the Minimal Sonority Distance

Principle (Broselow & Finer, 1991) – for onset combinations consisting of greater sonority differences between their members – i.e., less marked structures – to be less challenging and accordingly produced more accurately than those with a smaller sonority difference between their members – i.e., more marked structures. Also, the effect of L1 negative transfer for the production of these combinations is expected to be more prominent among learners in the early stages of language acquisition, in accordance with the Ontogeny Phylogeny Model (Major, 2001), which posits that transfer effects are at their peak at the beginning of L2 learning and that those features that are unmarked in the L2 are more affected by transfer than those features that are marked. To achieve the goals of this study and test these hypotheses, the production of L2 onset clusters by a group of 32 Kurdish learners of English as a foreign language was elicited by means of two production tasks: a carrier sentence reading task and a verbal fluency task. An acoustic analysis was conducted on the sequences produced, with a particular focus on productions that deviate from the target productions. Also, the acoustic characteristics of the inserted vowels were examined in terms of duration and formant frequencies.

This study also aims to explore the influence of L2 proficiency on the acquisition of English consonant clusters. Proficiency was measured using two tasks: an Elicited Imitation task devised by Wu et al. (2022) and a vocabulary size test by Meara & Miralpeix (2016). The L2 study has also highlighted the influence of L2 proficiency on the acquisition of English consonant clusters by Kurdish learners, an area that has received little attention in previous research on Kurdish EFL learners (Omer & Hamad, 2016; Keshavarz, 2017). The relationship between the results of the proficiency tasks and cluster production tasks will be thoroughly examined. It is anticipated that higher levels of L2 proficiency will correspond to more accurate and native-like production of English consonant clusters. See Chapter 1 (Literature Review) for comprehensive literature on the relevant issues and models regarding the acquisition of L2 phonology in general and of L2 consonant sequences in particular and Chapter 2 for the main research questions and hypotheses. This chapter presents the methodology used in the L2 production study and the analysis and discussion of the results.

4.1. Methodology

4.1.1. Participants

Two groups participated in the production tasks: a group of 32 English-degree students (English as a foreign language learners, henceforth EFLs) residing in the Kurdistan region of Iraq and a group of 5 native British English speakers from London and Leicester in the United Kingdom, whose data served as baseline L1 English data for comparison purposes. All participants reported normal vision and hearing abilities and voluntarily participated in this study. Even though ideally more native English participants should have been included, only 5 people had to be included due to time limitations and the difficulty of recruiting volunteers to participate in the study.

The EFL group – 18 females and 14 males – were all recruited from the same curricular level: second-year college students. They had just finished their first year of university at Zakho University. The ages of this group ranged between 18 for the youngest participants and 22 for the oldest participants. The native English group – 4 females and 1 male – included four employees from Leicester University, with a mean age of 24 years (SD = 1.8), and a 55-year-old primary school teacher from London. All native English participants were tested using the same production tasks administered to the EFL group but they did not need to take part in the proficiency tasks with English reported to be their native language.

All EFL participants were classified as foreign language learners of English because (1) their strongest language before age five was NK, not English; (2) they did not have at least one parent with English as their native or dominant language; and (3) they did not report exposure to English at home at an early age. Additionally, none of the selected participants reported having spent any time in an English-speaking country. All participants started learning English in an instructional setting at the age of 6 and few reported intermediate competence in Modern Standard Arabic (MSA) as a foreign and/or second language. This was not considered a problem given that MSA does not allow onset clusters (Ryding, 2005). All of these learners had previous knowledge of English phonetics – but not phonology – when they took part in the study. Thirty-one participants in this group reported to be Kurdish dominant and one claimed to be Assyrian dominant Kurdish-Assyrian bilingual. Because they were learners of English, the EFL group had to complete proficiency tasks – besides production tasks – and they were all given extra course credits by a faculty member at Zakho University for their participation.

4.1.2. Test Words

A total of 18 target words with 5 fillers were included in the carrier sentence reading task. To best elicit a target cluster production, only words familiar to intermediate learners were selected. All test words were matched for their syntactic category and number of syllables: they are all monosyllabic nouns except the words ‘glory’ and ‘structure’, which are disyllabic. These included 14 double-onset and 4 triple-onset cluster words. Double onset words included consonant clusters representing all degrees of sonority difference. In these clusters, a one-point difference in sonority was not considered important. It was assumed that voiced and voiceless stops would present similar challenges; therefore, participants’ performance on clusters like /bl-/, /dr-/, /gr-/, /gl-/, and /br-/ was expected to be similar to their performance on /pl-/, /tr-/, /kr-/, /kl-/, and /pr-/. However, either the voiced (+V) or voiceless (-V) specification was chosen to represent a given sonority level. The primary focus was on how greater sonority differences between a cluster's members could influence production.

Listed in Table 4.1 are words included in the reading task representing all possible sonority differences in English: three words for sonority difference '-2'; two words for sonority difference '2', '3'; four words for sonority difference '4'; 1 word for sonority difference '5' and two words for sonority difference '6'. Note that these sonority differences are based on the sonority scale proposed by Hogg & McCully (1987). The reason behind selecting double onset clusters that cover all sonority differences in English was to investigate the influence of L1 transfer and markedness by sonority on the production of such clusters by Kurdish EFL learners, drawing upon the SSP (Clements, 1990) and the Minimal Sonority Distance Principle (Broselow & Finer, 1991). To test the L1 positive transfer effect on L2 cluster acquisition, the sonority reversal in the fricative /s/ + stop cluster combination in /sp-/, /st-/ and /sk-/ clusters was selected. The inclusion of /s/ + stop clusters allowed us to examine if L1 transfer will have a more prominent effect than the SSP in the pronunciation of this sequence, especially since /s/ + stop clusters have been established perceptually and acoustically as true clusters in the L1 Kurdish study (see Chapter 3). To test the influence of L1 negative transfer, we aimed to assess whether certain consonant combinations identified as non-clusters in the L1 study would also exhibit decreased accuracy in the L2 study. Specifically, we selected English cluster combinations (/br-/, /tr-/, and /kr-/) in stop + approximant combinations, and /fr-/ and /θr-/ in fricative + approximant combinations, which corresponded to those onset combinations heavily epenthesised in the L1 study, i.e., stop + approximant in /tri/ and /kʰɾɑs/ and fricative + approximant in /sɾuʃt/. Moreover, English fricative /s/ + nasal combinations were chosen due to their correspondence with Kurdish fricative /s/ + nasal combinations in words such as /snel/, which was consistently perceived with vowel epenthesis in the L1 perception task. The remaining 2-consonant cluster words involving a fricative or a +V stop followed by approximant /l/ were used to test the influence of sonority differences based on the Minimal Sonority Distance Principle. Finally, words comprising triple clusters were chosen to explore the impact of markedness by syllable margins. This choice is informed by the absence of these clusters in the learners' L1 (Shokri, 2002; Hasan, 2009) and their universal status as marked structures (Greenberg, 1965; Kaye & Lowenstamm, 1981; Eckman, 1977, 1991).

Sonority difference	General cluster combination	Specific cluster combination	L1 cluster	Target word
-2	fricative /s/ + stop	/st-/	Yes	stake
-2	fricative /s/ + stop	/sk-/	Yes	skate
-2	fricative /s/ + stop	/sp-/	Yes	spy
2	fricative /s/ + nasal	/sm-/	No	smoke
2	fricative /s/ + nasal	/sn-/	No	snail
3	fricative + approximant /l/	/sl-/	No	sleep
3	fricative + approximant /l/	/fl-/	No	fly
4	+V stop + approximant /l/	/bl-/	No	blond
4	+V stop + approximant /l/	/gl-/	No	glory
4	fricative + approximant /r/	/fr-/	No	frog
4	fricative + approximant /r/	/θr-/	No	threat
5	+V stop + approximant /r/	/br-/	No	break
6	-V stop + approximant /r/	/tr-/	No	trial
6	-V stop + approximant /r/	/kr-/	No	crown
N/A	fricative /s/ + stop + approximant /r/	/str-/	No	structure
N/A	fricative /s/ + stop + approximant /r/	/spr-/	No	spring
N/A	fricative /s/ + stop + approximant /r/	/skr-/	No	screen
N/A	fricative /s/ + stop + approximant /l/	/spl-/	No	splash
Filler words	N/A			Baby, Wall, Paper, Mice, Toy

Table 4.1 Words used in the reading task. Sonority differences of the target clusters are given along with their general and specific combinations, and whether the combinations are L1 clusters. Note: +V and -V represent the presence and absence of voicing, respectively, and N/A indicates no sonority difference is applied.

Regarding the cluster cues used in the second production task, the phonemic verbal fluency task, in which participants had to produce as many words as possible starting with a given sequence (see the next section), a total of 15 target cluster cues were used, with the addition of 3 fillers, whose cues consisted of a single letter, i.e., ‘f ’. These included 11 double-onset cluster cues and 4 triple-onset cluster cues. The former represented all possible sonority levels in English. They included three cues for sonority differences ‘-2’ and ‘6’, two cues for sonority difference ‘5’, and one cue for sonority differences ‘2’, ‘3’ and ‘4’. As in the reading task, the (+V) and (-V) specifications for stop consonants were chosen to represent a given sonority level. See Table 4.2. Finally, the remaining four cues were used to elicit triple-onset cluster words.

Sonority difference	General cluster combination	Specific cluster combination	L1 cluster	Target cue
-2	fricative /s/ + stop	/st-/	Yes	st
-2	fricative /s/ + stop	/sk-/	Yes	sk
-2	fricative /s/ + stop	/sp-/	Yes	sp
2	fricative /s/ + nasal	/sn-/	No	sn
3	fricative + approximant /l/	/sl-/	No	sl
4	fricative + approximant /r/	/fr-/	No	fr
5	stop + approximant /l/	/pl-/	No	pl
5	+V stop + approximant /r/	/br-/	No	br
6	-V stop + approximant /r/	/tr-/	No	tr
6	-V stop + approximant /r/	/kr-/	No	kr
6	-V stop + approximant /r/	/pr-/	No	pr
N/A	fricative /s/ + stop + approximant /r/	/str-/	No	str
N/A	fricative /s/ + stop + approximant /r/	/spr-/	No	spr
N/A	fricative /s/ + stop + approximant /r/	/skr-/	No	skr
N/A	fricative /s/ + stop + approximant /l/	/spl-/	No	spl
Filler cluster cues	N/A			d, f, v

Table 4.2 Cluster cues used in the phonemic verbal fluency task. Sonority differences of the target cluster cues are given along with their general and specific combinations, and whether the combinations are L1 clusters. Note: +V and -V represent the presence and absence of voicing, respectively, and N/A indicates no sonority difference is applied.

4.1.3. Task Design

4.1.3.1. Production Tasks

The production experiment consisted of two tasks: a verbal fluency task and a carrier sentence reading task. A verbal fluency task – in its standard form – can be implemented in different ways to elicit different measures: category fluency (also known as semantic verbal fluency, Benton (1968)) and letter fluency (also called phonemic verbal fluency, Newcombe (1969)). In a standard verbal fluency task, participants are given one minute to generate as many distinct words as possible within a specific semantic category. For instance, if the category given is 'fruit', participants might list words like 'apple' and 'banana'. Alternatively, participants may be asked to generate words beginning with a designated letter. For example, if the letter 'l' is given, words such as 'love' and 'label' would be produced. The participant's score in each task is the number of correct words/sequences produced.

Contrary to the majority of studies that use single letters as cues in the phonemic verbal fluency task, Sandoval et al. (2010) and de Leeuw et al. (2021) have used double-letter or 2-consonant cluster cues, e.g., /sp-/ and /sm-/. In these studies, the accuracy score was based on accurate or native-like cluster production in each unique word. The phonemic verbal fluency task used in the current thesis was partly inspired by the type used in de Leeuw et al. (2021), which tested the production of a prothetic vowel in six /s/-clusters by Spanish-English sequential bilinguals. The task used in this thesis was different from de Leeuw's in three regards. First, 3-consonant cluster cues, e.g., /spr-/ and /skr-/, were used – besides 2-consonant cluster cues – for the purpose of eliciting words with 3-consonant onsets. Second, the task included both /s/-clusters and non-/s/ clusters. Finally, and due to the inclusion of a total of 15 clusters (see Table 4.2 for all cluster cues), the task took 2 minutes and 30 seconds – 10 seconds per cluster – which was a deviation from the standard 1-minute time span in a standard fluency task. In this way, it could be argued that the task was too demanding for L2 speakers. To test its feasibility, a pilot phonemic verbal fluency task was conducted with five EFL learners who were excluded from the main task. The results of this pilot task showed that L2 speakers performed quite well on the task and did not leave any cluster cues unnamed. Thus, the proposed version of the verbal fluency task was adopted in this thesis as the EFL group in the current study was considered to be capable of performing the phonemic verbal fluency task.

The motivation for using the phonemic fluency task in the L2 English study was, on the one hand, to control for orthographic interference because it was thought that the full orthographic representation of words in Task 2 – i.e., the sentence reading task – would enable the participants to focus more on their pronunciation, and in this way, the task may not reflect what they would normally produce in everyday speech. On the other hand, the phonemic task is a relatively new practical tool for extracting L2 speech production (see Leeuw et al., 2021).

In the reading task, test words (see Table 4.1) were presented to the participants embedded in the carrier sentence '… is the next word'. The target word appeared in the absolute initial position to control for any phonetic environment effects that may affect the pronunciation of the word-initial cluster. The same carrier sentence was used for all test items. The sentences were presented to the participants on a laptop screen. Participants had to read through a total list of 23 sentences, distributed between 18 sentences that contained the target words, and 5 sentences that had filler words (see Appendix F).

4.1.3.2. Proficiency Tasks

Proficiency is measured rather variably in L2 studies. This measurement ranges from studies using C-tests (see C-test bibliography in Grotjahn (2016)) and vocabulary size tests (see Meara & Jones, 1988; Lemhöfer & Broersma, 2012; Koizumi & In'nami, 2013) to those employing internationally standardised and validated four-skill (reading, writing, speaking, and listening) tests such as Test of English as a Foreign Language (TOEFL) and International English Language Testing System (IELTS) (see reviews by Thomas, 1994; Tremblay, 2011). A C-Test is a gap-filling assessment designed to evaluate language proficiency in both first and second languages, and it comprises four to eight short, independent texts in which the second half of every second word is deleted (Shoahosseini et al., 2024).

In recent years, there has been a growing trend in L2 research to use the Elicited Imitation Task (EIT, also known as the sentence repetition task), as a means of assessing oral linguistic proficiency in L2 learners (see Gailard & Tremblay, 2016; Tracy-Ventura et al., 2014; McManus & Liu, 2020) and as evidence of their interlanguage (Ellis, 2005; Kim et al., 2016). In an EIT, participants are asked to repeat a set of sentences of varying length and complexity usually after listening to it once. The task is, thus, dependent on fast language processing and producing speech in real time and it is therefore argued to best reflect oral language ability (Duran-Karaoz & Tavakoli, 2020). In this study, English proficiency was measured using Wu et al.'s (2022) English EIT task conjoined with a vocabulary size task using Meara & Miralpeix's (2016) V_YesNo v1.0 online vocabulary size test. Several studies (Meara & Jones, 1988; Lemhöfer & Broersma, 2012; Koizumi & In'nami, 2013) have claimed that vocabulary size and knowledge can also be good predictors of proficiency level in L2 learners. In this study, the motivation for using these measures of language proficiency which test two different kinds of language knowledge – procedural knowledge or the ability to use the language via the EIT task and vocabulary knowledge via V_YesNo v1.0 vocabulary size test – was based on the assumption that a more complete profile of the learner proficiency would give a more valid interpretation of the role of proficiency in the production of L2 consonant clusters. Moreover, these two tasks are particularly appealing due to their practicality: they can be conducted within approximately 10 minutes per participant and are also economical to administer and assess.

The EIT materials used in this study – adapted from Wu et al. (2022) – consisted of a total of 30 sentences in English designed to test L2 proficiency with a combination of grammatical features, syntax, and vocabulary. A complete list of EIT sentences is provided in Appendix G. These sentences varied in length (between 7 to 19 syllables), ordered from the fewest syllables to the most. The maximum score on this task is 120. A detailed description of how the sentences were scored is provided in (4.2.1). The task also involved a practice session using an additional 5 Kurdish sentences at the beginning of the test to make sure the procedures were well understood and followed. Concerning the V_YesNo v1.0 vocabulary test, it covers a wider range of vocabulary ability (0 to 10,000 words.). The participants on this test have to indicate whether they know the meaning of a word or not (see Appendix G for a screenshot of the vocabulary test). The maximum score is 10,000 words for a total of 200 items.

4.1.4. Procedure and Task Order

The EFL group was tested in a soundproof room at the Humanities Lab of Zakho University. A CAROL Dynamic Vocal Microphone GS-67 was used. Each participant was individually tested by a staff member from the English Department at Zakho University. Recordings were made with the software Audacity and the files were saved in WAV format. In the native English group, four participants were tested in a silent room at David Wilson Library located at Leicester University. A Xiaomi Redmi Note 11 built-in microphone was used to record their data. Data from the last participant – a school teacher from London – was sent via email with the use of a personal smartphone recorder. All participants signed a consent form, digitally or conventionally by hand, just before the beginning of the tasks (see Appendix E).

Participants were first provided with instructions in English, as a way to control for the activation of the target language mode in the EFL group (Grosjean, 2001). Following this, they had to complete the verbal phonemic fluency task first to ensure they were not exposed to the cluster words embedded in the sentence reading task. In the instructions for the phonemic task, it was stated that they would see two or three letters, like ‘br’ or ‘spr’, and should name – within 10 seconds per letter combination – as many English words as possible which begin with the sounds that those letters spell. An example of ‘br’ was given, for which one should say ‘brown’ but not ‘bounce’ because the latter word does not begin with ‘br’. Participants were asked to only name unrelated words, e.g. they should avoid naming both ‘spy’ and ‘spied’ for the ‘sp’ letter combination.

All clusters were embedded in a PowerPoint presentation and were presented to the participants on a laptop screen. Each cluster was visible at a time, and participants were instructed not to click on any slide because every slide was timed to automatically move on to the following slide after 10 seconds, following de Leeuw et al.’s (2021) 10-second-per-cluster scheme. The task took 2.5 minutes to finish: 10 seconds per cluster for a total of 15 clusters. After the completion of the phonemic verbal fluency task, participants had to complete the reading task. Similar to the phonemic task, test words were presented to them in a PowerPoint presentation on a laptop screen, with the target words already embedded in the carrier sentence. Each sentence – shown on a slide - was visible at a time, and the participants were instructed to read each sentence twice in a natural manner. They could then move on to the following slide/sentence by clicking on the right arrow key on a computer keyboard. The task took approximately 4 minutes.

After a 10-minute break, the EFL group had to complete the proficiency tasks. The EIT task was conducted first, followed by the vocabulary test. EIT recorded materials – a total of 30 English sentences – were kindly provided by Prof. Joan Carles Mora and colleagues from the University of Barcelona. In the implementation of the EIT, the procedures in Gaillard and Tremblay (2016) were followed. Following the practice session in Kurdish, the participants were presented with the English sentences one by one while they were recorded. They were asked to listen to each of the sentences, which were followed by a beep sound, and then were required to repeat it. There were two seconds between the end of each sentence and the beginning of the beep sound, and the participants had only one attempt to repeat the sentences. The rationale for this arrangement was informed by prior studies (Gaillard & Trembly, 2016; Wu et al., 2022; Tracy-Ventura et al., 2014) which suggested this procedure to ensure the test takers do not only mimic the stimuli but rather would process them (Duran-Karaoz & Tavakoli, 2020). The total duration of the EIT task was about 8 minutes. Immediately after that, participants had to complete the vocabulary test online after they had all been provided with a unique ID code to help save their results. They simply had to click ‘Yes’ if they knew the meaning of the word displayed, or ‘Next’ if they did not know or were not sure of the meaning of the word displayed. The test took approximately 7 minutes to complete. In total, it took the EFL group around 15 minutes to complete the proficiency tasks, and 7 minutes to complete the production task. As the native English group did not participate in the proficiency tasks, they took only 7 minutes of the production tasks.

4.2. Data Analysis

This section will explain the analysis of the proficiency data for the EFL group, obtained from both the EIT task and the vocabulary test. Following that, the analysis of production data for the same group from the phonemic verbal fluency task and the sentence reading task will be presented, focusing on the identification of an epenthetic vowel and its acoustic characteristics. All results of these analyses are then presented in the following section (4.3).

4.2.1. Analysis of Proficiency Data

All participants in the EFL group successfully completed both proficiency tasks – i.e., the EIT task and the vocabulary test – therefore 32 participants were included in the analysis for the proficiency tasks. Participants' repetitions on the EIT were evaluated holistically based on a five-point scoring rubric (0-4) developed by Ortega et al. (2002) and employed in several studies (e.g., Gaillard & Tremblay, 2016; Kim et al., 2016; Tracy-Ventura et al., 2014; Wu & Ortega, 2013). Table 4.3 shows the criteria followed in this study. According to this scale, four points were awarded for exact repetitions, three points for accurate repetitions that maintained the content's meaning but included minor structural changes, two points for repetitions with grammatical changes that could affect the sentence's meaning, one point for repeating half or less than half of the sentence, and zero points for repeating only one word or providing no repetition at all.

Score	Criterion
4	perfect repetition
3	accurate content repetition with some (un-) grammatical changes
2	changes in content or changes in form that affect content
1	repetition of half or less of the stimulus
0	silence, only one word repeated, or unintelligible repetition

Table 4.3 The EIT scoring criteria from Ortega et al. (2002).

All repetitions were first rated by the author of this thesis, who listened to participants' repetitions sentence by sentence – several times if deemed necessary – and then gave a score to each sentence, following the criteria described in Table 4.3. To assess rater reliability, a total of 20% percent of the participants' repetitions were randomly selected and scored independently by a second rater, who was a native speaker of Catalan and highly proficient in English. Following this procedure, each participant's repetitions took between 30-35 minutes to score. The maximum score one could obtain on the EIT was 120 (30 x 4). Agreement between raters was highest for giving scores 0 and 4, while scores 1, 2, and 3 resulted in very few cases of inter-rater disagreement, due to the small difference between the criteria for scores 1 and 2, and for 3 and 4. For example, if participants repeated half of a sentence or less, it was still scored 1, and if one or more content words were changed, the score given remained 2. Additionally, for score 3, it was not always easy to decide how many or what structural changes to consider ungrammatical. To assess the overall reliability of the measurements between the raters, intraclass correlation coefficients (ICCs) were calculated. The resulting ICC value was 0.936, with a 95% confidence interval ranging from 0.915 to 0.951, indicating an excellent level of agreement between the raters. Given this high ICC, only the first rater's rating was considered for further analysis, following the procedure adopted by Zeynep & Tavakoli (2020).

Concerning participants' scores on the vocabulary test, the test results were automatically displayed on the computer screen once a participant completed the test. The score was an estimate of the number of words a participant knew. The maximum score was 10,000 words: scores over 9000 were typical for educated native English speakers and highly fluent learners. Scores in the 7500 – 9000 range indicated a high or advanced level of proficiency. Scores in the 4500 – 7500 range were typical of high intermediate-level learners, while those in the 2500 – 4500 range were typical of intermediate-level learners. Scores below 1500 were typical for competent beginners, and the test was considered unreliable at this level by Meara & Miralpeix (2016).

4.2.2. Analysis of Production Data

The production of all EFL participants (32 people) from the reading task and the phonemic fluency task was analysed acoustically. The aim was to identify whether an epenthetic vowel was present in the participants' production of word-initial English clusters. An epenthetic vowel indicated a non-target/non-native production of a cluster. Recall that in the sentence reading task, the participants had to read a total of 18 carrier sentences with target words that contained the target clusters. A total of 576 tokens were produced in the reading task (32 x 18). Each participant read every sentence provided.

In the phonemic verbal fluency task, participants were asked to name as many English words as possible within 10 seconds for each of the 15 target cluster cues provided. These words had to begin with the specified target cluster cues. A total of 933 tokens were generated, (see Appendix H for the complete list of words produced by each participant). Participants produced different numbers of words in the phonemic verbal fluency task. Some participants managed to produce up to 5 tokens per cluster cue within the allotted 10-second timeframe. In contrast, in some instances no words were produced, resulting in an unequal distribution of tokens among participants. Only seven participants (P11, P22, P23, P26, P27, P30, P32) produced no tokens for the /pl-/ cluster cue. This lack of response might have been attributed to the /pl-/ cluster being the first to appear in the task. Participants might have attempted to click the slide containing this cluster, despite being instructed not to do so, as clicking would have caused them to miss the slide, which was automatically timed to advance every 10 seconds. Nevertheless, all tokens generated accurately matched their respective cluster cues. Considering the whole production experiment, the EFL group produced a total of 1,509 tokens across both production tasks.

The English group produced a total of 90 tokens (5 x 18) in the reading task, and 220 in the phonemic verbal fluency task. These data were used as control data for the production data of the EFL group, i.e., the native speakers' performance in both tasks served as a reference against which the EFL group's performance was compared. This was done using the author's auditory perception and acoustic evidence. More specifically, auditory perception of the absence of an epenthetic vowel in the cluster words produced by the native speakers served as one of the cues used to determine whether the vowel epenthesis was present or absent in the EFL group's production. Also, the acoustic absence of vowel epenthesis in their production served as another cue. All data produced by both the EFL group and the native English group were analysed acoustically through spectrographic analysis in order to determine the presence or absence of an epenthetic vowel in a given cluster and to examine the acoustic characteristics of the vocalic element, when present. This analysis involved examining both the duration and formant frequencies of the identified epenthetic vowels. Since no epenthetic vowel was identified acoustically in the production of the native English group (see Figur 4.1), as was expected, this acoustic data was used to determine the absence of the vocalic element in the production of the EFL group.

On the other hand, evidence of a vocalic element produced by the EFL group was assessed through the author's auditory perception, comparing it with the production of the native speakers, and by a visual inspection of consonant sequences on the waveform and spectrogram. The existence of a vocalic element was associated with the presence of vertical striations in the spectrogram, greater amplitude than neighbouring sounds, and vowel-like formant structure. The first acoustic parameter measured was vowel length. The epenthetic vowel identified, as well as the corresponding main vowel in each word, were delimited and annotated using textgrids in Praat (Boersma & Weenink, 2021). A Praat script was used to calculate the duration of all labelled vowels. To exemplify the difference between tokens produced with and without an epenthetic vowel, Figures 4.2 and 4.3 display the waveform, spectrogram, and annotated textgrids for the words ‘screen’ (with an epenthetic vowel) and ‘stake’ (without an epenthetic vowel) produced by participant 17.

In the acoustic analysis of the 1,509 examined tokens, a vocalic element was acoustically identified as present in 141 tokens. The second acoustic analysis involved the analysis of the formant structure of the identified vowels. This involved F1 and F2 frequencies, which were measured at the midpoint of 141 identified epenthetic vowels and their corresponding main vowels (i.e., the vowel in the stressed syllable in the word) – totalling 282 vowels – using a Praat script. Using the NORM web-based interface for normalising formant data (Thomas & Kendall, 2007), the resulting vowel measurements in Hertz were normalised and scaled back to Hertz-like values for clarity of interpretation of the normalised values, using Lobanov’s (1971) normalisation method.

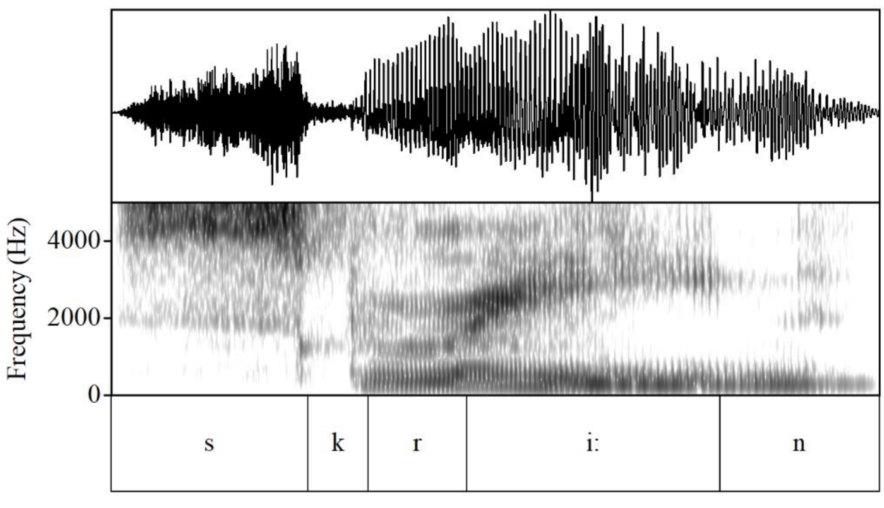

Figure 4.1 Waveform and spectrogram of the word ‘screen’ produced by a native English speaker participant without vowel epenthesis /skri:n/.

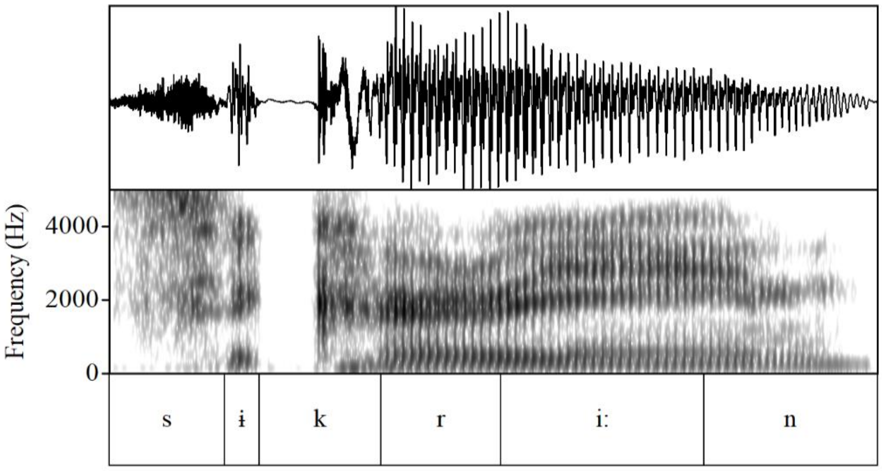

Figure 4.2 Waveform and spectrogram of the word 'screen' produced by the EFL participant 17 with vowel epenthesis /sɨkri:n/.

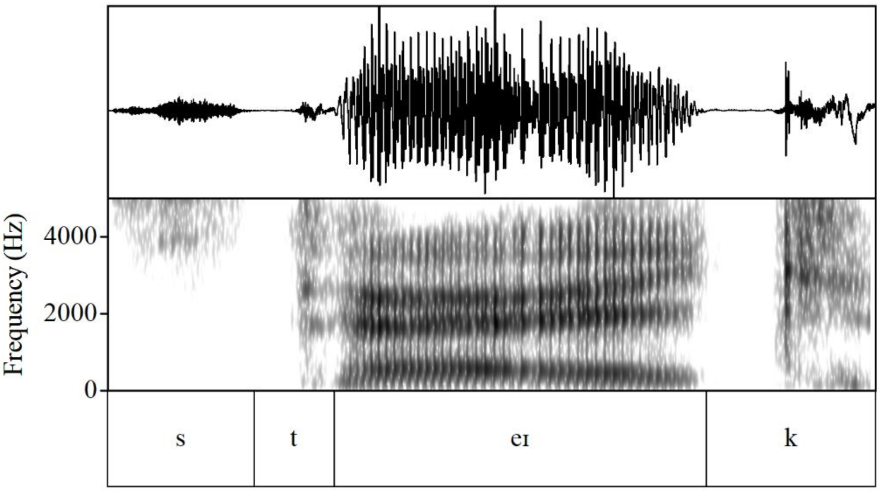

Figure 4.3 Waveform and spectrogram of the word 'stake' produced by the EFL participant 17 without vowel epenthesis /steɪk/.

4.3. Results

4.3.1. Proficiency Tests Results

The results of the EIT task and the vocabulary test for all participants are given in Table 4.4. Remember that the highest score to be obtained on an EIT task is 120 and the maximum score on the vocabulary test is 10,000 words for a total of 200 items. All EFL participants completed both proficiency tasks. Regarding their performance on the EIT task, it was noted that their scores were quite varied, indicating diversity in their oral proficiency level. Out of the 32 participants, the average score was 64.3, with a median score of 65.5 and a standard deviation of 23.3. Half the participants, specifically 16 individuals, scored above the average, ranging from 69 to 108. On the other hand, the remaining half of the participants scored below the average, with scores ranging from 21 to 62. Among these, four participants (P17, P23, P25, P32) scored quite low (21-27). It was observed that as the length and complexity of the sentences increased, particularly from the 11th sentence onward in the EIT task (see Appendix G for a complete list of EIT sentence transcripts), their ability to accurately repeat the sentences greatly diminished. Two factors may account for the comparatively low performance exhibited by these individuals on the EIT task. These include limited exposure to English and/or potential challenges in pronunciation that could have impeded their overall proficiency in oral expression. It is also possible that the task itself exceeded their current linguistic competencies.

In relation to the participants' performance on the vocabulary test, variability in the scores was also found. The average score was 2932.5, with a median score of 2959.5 and a standard deviation of 1343.6. Just in the case of the EIT task, nearly half of the participants, specifically 17 individuals, scored above the average, ranging from 2939 to 5088. The remaining half of the participants, totalling 15 individuals, scored below the average, with scores ranging from 400 to 2840. Four participants (P9, P27, P29, P4) scored quite low (400-658). It is noted that those people were not the same who performed poorly on the EIT task.

According to Meara & Miralpeix (2016), the current vocabulary test scores suggested that they did not indicate an advanced language proficiency level (7500 – 9000). Only 5 participants achieved scores typical of high intermediate-level learners (4500 – 7500). These were P6 (4823), P16 (4636), P8 (4517), P13 (4574), and P14 (5088). Most participants, totalling 18 people, scored between (2500 – 4500), a range characteristic of intermediate-level learners. These were P12 (4299), P15 (2998), P18 (3952), P19 (2939), P7 (3850), P20 (2675), P2 (2710), P21 (2840), P5 (2823), P3 (2980), P1 (4045), P31 (2981), P30 (3360), P22 (2633), P26 (3480), P23 (2510), P32 (3980), and P25 (4252). Finally, it is recommended to interpret the results of the remaining nine participants, who scored below 2,500, with caution, following the guidance provided by Meara & Miralpeix (2016). The scores of these participants are as follows: P9 (400), P4 (658), P11 (1360), P27 (554), P28 (2366), P24 (1379), P29 (555), P10 (1423), and P17 (2200). The performance of this group may be attributed to a limitation of the Yes/No vocabulary test format, which may not be suitable for low-level learners. Meara (1996) believes that certain learners may perform less well on this test due to their tendency to incorrectly claim knowledge of pseudowords included in the test.

To obtain a holistic profile of the participants' proficiency levels, the relationship between their oral language knowledge, assessed by the EIT task scores, and vocabulary knowledge, measured by the Yes/No vocabulary size test scores, was examined. The aim was to use both scores combined to measure the proficiency level of each participant. However, the results of a Pearson correlation analysis revealed a non-significant small positive relationship between the EIT scores and the vocabulary test scores ($r(30) = .197$, $p = .280$), suggesting that factors beyond vocabulary may have influenced participants' oral language proficiency. Figure 4.4 illustrates this relationship. As a result of this finding, the association between proficiency levels and accurate production of English clusters will be investigated independently. That is, the association between EIT scores and accurate cluster production will be examined separately for each participant, as will the association between vocabulary scores and production accuracy.

Participant	EIT task score	Vocabulary test score	Participant	EIT task score	Vocabulary test score
P12	108	4299	P11	62	1360
P6	101	4823	P1	61	4045
P15	95	2998	P27	59	554
P18	95	3952	P28	56	2366
P19	91	2939	P31	55	2981
P16	88	4636	P24	55	1379
P7	83	3850	P14	50	5088
P20	79	2675	P29	48	555
P8	78	4517	P30	46	3360
P2	76	2710	P10	45	1423
P21	76	2840	P22	43	2633
P5	75	2823	P26	43	3480
P3	75	2980	P17	27	2200
P9	75	400	P23	24	2510
P4	74	658	P32	23	3980
P13	69	4574	P25	21	4252

Table 4.4 The EIT test and vocabulary test scores per participant, sorted by their score on the EIT task.

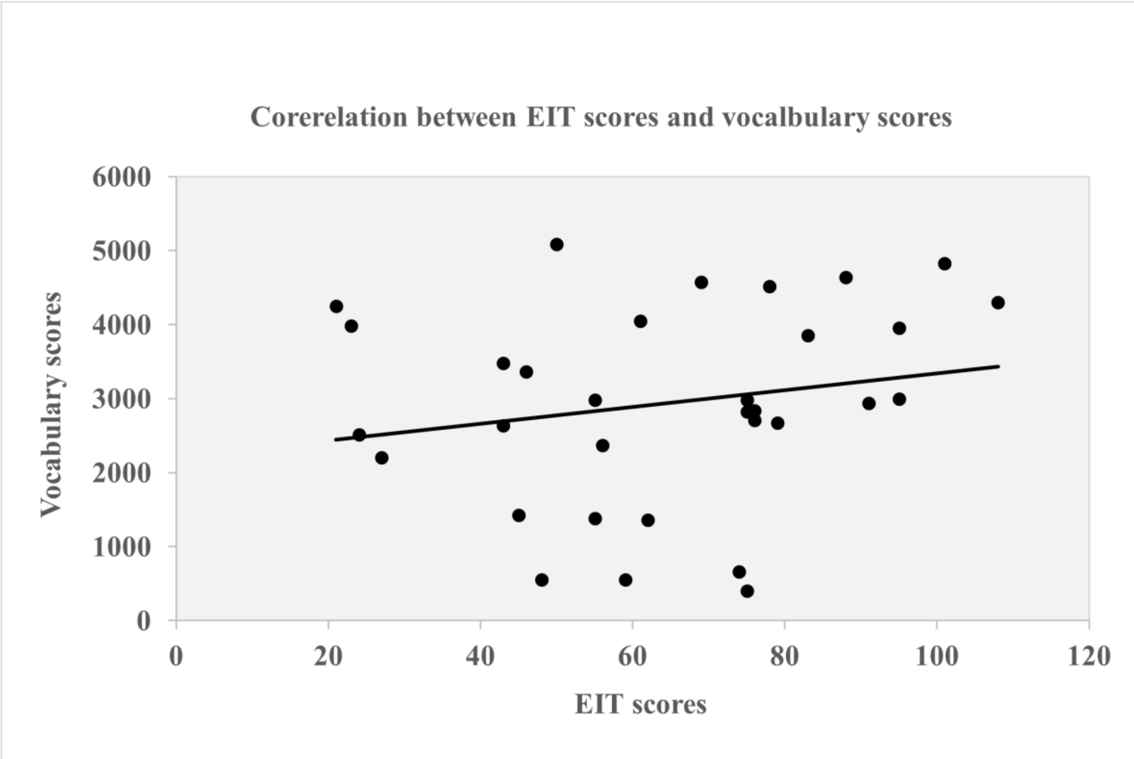

Figure 4.4 Relationship between the EIT scores and vocabulary scores.

4.3.2. Production Tasks Results

4.3.2.1. Non-Target Productions

Following the view that production 'errors' represent the interlanguage of the L2 learner at a particular time (Corder, 1971), the term 'non-target' will be used to refer to productions that deviate from the target. It is important to note that these productions have all involved anaptyxis, which is the insertion of an epenthetic vowel between the first two consonants of a cluster, whether it is a double or triple consonant cluster – consistent with findings from previous studies on Kurdish learners' production of English clusters (see Nasr, 2011; Omer & Hamad, 2016; Keshavarz, 2017). Thus, non-target productions have always been equated with epenthetic vowel presence in a given cluster. However, the specific epenthetic vowel used is to be confirmed later, whether it aligns with the typical L1 /ɨ/ or /ə/. The latter vowel is not part of the L1 vowel system, but it occurs in the interlanguage of learners from other L1 backgrounds (Silveira, 2007).

The results presented in Table 4.5 show the average percentages of non-target productions across participants and clusters in the reading task. These findings, along with those from the verbal fluency task, are based on the author's impressionistic analysis and on acoustic analyses. The results for 2-consonant clusters are organised according to sonority difference. The average percentage of non-target productions across all participants and the 18 cluster combinations examined in the reading task was 11% (N = 18, Md = 6.3, SD = 12). Interestingly, sonority reversals in fricative /s/ + stop clusters were consistently accurately produced (0% of non-target production). This provides strong evidence that the participants were transferring the syllable structure of this sequence from their L1.

Sonority difference	General cluster combination	Specific cluster combination	L1 cluster	Non-target production/ total production	Average % of non-target production
-2	fricative /s/ + stop	/st-/	Yes	0/32	0
-2	fricative /s/ + stop	/sk-/	Yes	0/32	0
-2	fricative /s/ + stop	/sp-/	Yes	0/32	0
2	fricative /s/ + nasal	/sm-/	No	3/32	9.4
2	fricative /s/ + nasal	/sn-/	No	1/32	3.3
3	fricative + approximant /l/	/sl-/	No	6/32	18.8
3	fricative + approximant /l/	/fl-/	No	8/32	25
4	+V stop + approximant /l/	/bl-/	No	5/32	15.6
4	+V stop + approximant /l/	/gl-/	No	14/32	43.8
4	fricative + approximant /r/	/fr-/	No	1/32	3.3
4	fricative + approximant /r/	/θr-/	No	0/32	0
5	+V stop + approximant /r/	/br-/	No	2/32	6.3
6	-V stop + approximant /r/	/tr-/	No	1/32	3.3
6	-V stop + approximant /r/	/kr-/	No	1/32	3.3
across 2-member clusters				42/448	9.4
N/A	fricative /s/ + stop + approximant /r/	/spr-/	No	9/32	28.1
N/A	fricative /s/ + stop + approximant /r/	/skr-/	No	8/32	25
N/A	fricative /s/ + stop + approximant /r/	/str-/	No	2/32	6.3
N/A	fricative /s/ + stop + approximant /l/	/spl-/	No	2/32	6.3
across 3-member clusters				21/128	16.4
across all clusters				63/576	11

Table 4.5 Numbers and average percentages of non-target productions across participants in the sentence reading task. Results for 2-member clusters are given based on sonority differences. Total numbers and percentages of non-target productions across 2-member clusters, 3-member clusters, and across both cluster types are also given.

Within the production of fricative /s/ + nasal clusters, /sm-/ is found to be more inaccurately produced (9.4%) than /sn-/ clusters (3.3%). This difference in production accuracy aligns with findings by Carlise (1988), who identified a significant difference in the production of these two clusters among Spanish learners of English. However, the difference in the current study is not large, as both /s/ + nasal clusters are accurately produced more than 90% of the time, and the two clusters are equal in terms of markedness (i.e., they have the same sonority level), therefore this difference will not be further investigated.

The difference in production accuracy between /s/ + nasal clusters and /sl-/ is particularly relevant to this study for investigation. These two clusters, both being s/-clusters, differ in markedness as they possess different sonority levels. Interestingly, it was observed that /sl-/ was more inaccurately produced (18.8%) compared to the combined inaccuracy of /s/ + nasal clusters (6.3%). The order in which these clusters were produced contradicts the order predicted by sonority (where > means more accurate or acquired before): /sl-/ > /s/ + nasal > /s/ + stop. Just like the /sl-/ cluster, the /fl-/ cluster was more inaccurately produced (25%) compared to /s/ + nasal clusters (6.3%), despite having a higher sonority level between its consonants.

The results for sequences with a 4-point sonority difference show variability in production inaccuracy. The fricative + approximant /r/ clusters in /fr-/ and /θr-/ exhibit very low percentages of inaccuracy (3.3% and 0%, respectively). These findings support the Minimal Sonority Distance Principle, which posits that as sorority differences between the members of a cluster increase, the cluster becomes less marked and accordingly easier to produce. However, this prediction does not hold true for the voiced stop + approximant /l/ clusters in /bl-/ and /gl-/. Despite their high sonority difference, these clusters seem more challenging, particularly evidenced by the notably high inaccuracy frequency in the case of /gl/ (43.8%).

As the sonority difference increases to 5 and 6, involving voiced and voiceless stop + approximant /r/ combinations, the percentage of non-target productions decreases to 6.3 % and 3.3%. For these combinations, sonority seems to play a more influential role than L1 transfer. The results for these two sonority differences support the Minimal Sonority Distance principle, indicating that clusters with greater sonority differences are indeed less challenging to produce.

Concerning the production of the four 3-member clusters examined, the percentage of non-target productions is higher (N = 4, M = 16.4, Md = 15.7, SD = 11.8) than that for 2-member clusters (N = 14, M = 9.4, Md = 3.3, SD = 12.6). These results are in line with the predictions of the Markedness Differential Hypothesis (Eckman, 1977) and the Structural Conformity Hypothesis (Eckman, 1991). However, it is worth noting that the production challenges were not consistently distributed across all 3-member clusters. The reasons behind participants finding /spr-/ and /skr-/ clusters more challenging than /str-/ and /spl-/ (28.1% and 25% of non-target production for the former, vs. 6.3% for the latter two, respectively) remain unclear at least in the reading task.

In the verbal fluency task (see Table 4.6), the average percentage of non-target productions – and accordingly the average percentage of vowel epenthesis – across all participants and the 15 cluster combinations examined was slightly lower than in the reading task, reaching 8.7 (N = 15, Md = 4.8, SD = 10.1). Similar to the reading task results, no clear effect of sonority level differences was found within 2-member clusters, with sonority reversals being consistently accurately produced. Also, 3-member clusters showed higher percentages of non-target productions (N = 4, M = 16.3, Md = 17.1, SD = 13.4) than 2-member clusters (N = 11, M = 5.6, Md = 4, SD = 7.4), mirroring the patterns observed in the reading task. These findings suggest a consistent trend across both tasks, with 3-member clusters consistently exhibiting higher percentages of non-target productions compared to 2-member clusters. They also showed minimal variation between the reading task (N = 18, M = 11, Md = 6.3, SD =

12) and the verbal fluency task (N = 15, M = 8.7, Md = 4.8, SD = 10.1) in terms of the percentages of non-target productions across specific cluster combinations. This observation was also confirmed by the results of a related-samples Wilcoxon Signed-Rank test which indicated no significant difference in non-target productions resulting from the reading task (N = 13, Md = 3.1) and the verbal fluency task (N = 13, Md = 4.8), $W = 38$, $Z = 0.989$, $p = 0.322$, with a medium effect size $r = 0.31$. These findings suggest that neither the complete orthographic representation of the target words in the reading task nor the partial representation in the clusters provided in the phonemic verbal fluency task significantly influenced the production of the tested clusters. The full orthographic representation of the target words in the reading task was believed to enable participants to focus more on their pronunciation (de Leeuw, 2021). Consequently, it was expected that the percentages of non-target productions would be lower in the reading task compared to the phonemic verbal fluency task, which was anticipated to reflect better what they would produce in normal conversation. The lack of significant influence from either task on cluster production can be attributed to two factors. Firstly, the phonetics classes attended by the participants may have enhanced their overall pronunciation skills. Pronunciation teaching has generally been proven effective in improving both the segmental and suprasegmental aspects of English (see Lee, Jang & Plonsky (2014) for a meta-analysis of the overall effect of pronunciation instruction). Secondly, as English major students, it is plausible that the participants had instructors who might have served as effective pronunciation models. Being highly proficient in English, these instructors might have provided consistent and accurate examples of both segmental and suprasegmental features of English. Finally and as non-target productions in both production tasks yielded comparable results (see Table 4.5 and Table 4.6), the combined data from both tasks along clusters included in either task will be used in the following section to discuss in more detail the effect of the

SSP, the Minimal Sonority Distance principle, markedness in terms of syllable margin length, and cluster combination role.

Sonority difference	General cluster combination	Specific cluster combination	L1 cluster	Non-target productions/ total productions	Average % of non-target production
-2	fricative /s/ + stop	/st-/	Yes	0/61	0
-2	fricative /s/ + stop	/sk-/	Yes	0/54	0
-2	fricative /s/ + stop	/sp-/	Yes	0/73	0
2	fricative /s/ + nasal	/sn-/	No	7/63	11.1
3	fricative + approximant /l/	/sl-/	No	17/68	25
4	fricative + approximant /r/	/fr-/	No	5/64	7.8
5	-V stop + approximant /l/	/pl-/	No	0/42	0
5	+V stop + approximant /r/	/br-/	No	4/84	4.8
6	-V stop + approximant /r/	/tr-/	No	2/70	2.9
6	-V stop + approximant /r/	/kr-/	No	3/75	4
6	-V stop + approximant /r/	/pr-/	No	5/91	5.5
across 2-member clusters				43/745	5.8
N/A	fricative /s/ + stop + approximant /r/	/spr-/	No	13/42	31
N/A	fricative /s/ + stop + approximant /r/	/skr-/	No	14/63	22.2
N/A	fricative /s/ + stop + approximant /r/	/str-/	No	8/67	11.9
N/A	fricative /s/ + stop + approximant /l/	/spl-/	No	0/16	0
across 3-member clusters				35/188	18.6
across all clusters				81/933	8.7

Table 4.6 Numbers and average percentages of non-target productions across participants in the phonemic verbal fluency task. Results for 2-member clusters are given based on sonority differences. Total numbers and percentages of non-target productions across 2-member clusters, 3-member clusters, and across both cluster types are also given.

4.3.2.2. Factors Affecting Non-target Productions

The results presented in Table 4.7 show the average percentages of non-target productions across participants and clusters from both production tasks combined. The results for 2-member clusters are categorised based on sonority differences. For example, the results for fricative + approximant /r/ and voiced stop + approximant /l/ clusters are presented together as both combinations have the same sonority level.

The SSP effect in the sonority reversal in fricative /s/ + stop onset clusters does not seem to play any effect, as all sequences belonging to this combination were consistently produced in a native-like manner (0% of non-target production). This suggests a positive transfer from L1, as the Kurdish equivalent of this combination was established perceptually and acoustically as a true cluster in the L1 study (see Chapter 3). Thus, for this sequence combination, it can safely be argued that the influence of L1 outweighs the SSP effect, which posits that sonority reversals in /s/ + stop onset clusters are the most challenging among all /s/-clusters.

The results for the remaining 2-consonant clusters with increasing levels of sonority do not appear to fully align with the predictions of the Minimal Sonority Distance principle (Broselow & Finer, 1991). Cluster combinations with a sonority difference of 3, such as fricative + approximant /l/, show a higher percentage of non-target productions (23.5%) compared to those with a sonority difference of 2, like fricative /s/ + nasal (8.7%). These outcomes contradict the Minimal Sonority Distance principle, which posits that onset clusters containing consonants closer in sonority should present greater difficulty (i.e., manifest a higher percentage of non-target productions) compared to those with larger sonority differences. Therefore, according to this principle, cluster combinations with a sonority difference of 3 should have been less challenging than those with a sonority difference of 2.

As the sonority difference increases to 4 in fricative + approximant /r/ and voiced stop + approximant /l/ combinations, and to 5 in voiceless stop + approximant /l/ and voiced stop + approximant /r/ combinations, the percentage of non-target productions decreases to 13.1% and 3.8%, respectively. The results for these two sonority differences support the Minimal Sonority Distance principle, indicating that clusters with greater sonority differences are indeed less challenging to produce. However, when the sonority difference is 6, involving voiceless stop + approximant /r/ combinations, the percentage of non-target productions is (4%), which is very close to the results obtained for voiceless stop + approximant /l/ and voiced stop + approximant /r/ combined (3.8%). Yet, it notably differs from the results obtained for sonority difference 4, involving fricative + approximant /r/ and voiced stop + approximant /l/ combinations (13.1%). This suggests that while the Minimal Sonority Distance principle holds true for clusters with sonority differences of 4 and 5, it might not fully account for the production difficulty found in clusters with a sonority difference of 6

Regarding the effect of markedness based on syllable margin length, the results for 3-member onsets combined are in line with the predictions of the Markedness Differential Hypothesis (Eckman, 1977) and the Structural Conformity Hypothesis (Eckman, 1991) in that they were more inaccurately produced (17.7%) than with two-member onsets (7.1%), thereby confirming the predictions of both hypotheses. This was expected given that 3-member clusters do not exist in NK (Shokri, 2002; Hasan, 2009, 2012), and are widely acknowledged as universally marked structures (Greenberg, 1965; Kaye & Lowenstamm, 1981). Thus, the length-based complexity of syllable margins seemed to have played a more influential role than sonority in the acquisition of L2 onset clusters by Kurdish learners. Carlisle (1997, 1998, 2002) found similar findings with Spanish learners of English. The researcher investigated the production of 2-member onsets, specifically /sp-/ and /sk-/, alongside 3-member onsets, namely /spr-/ and /skr-/. Across all three studies, participants consistently demonstrated greater accuracy in producing the less marked 2-member onsets compared to the more marked 3-member onsets.

Sonority difference	General cluster combination	Specific cluster combination	Non-target productions/ total productions	Average % of non-target production
-2	fricative /s/ + stop	/st-/, /sk-/, /sp-/	0/284	0
2	fricative /s/ + nasal	/sn-/, /sm-/	11/127	8.7
3	fricative + approximant /l/	/sl-/, /fl-/	31/132	23.5
4	fricative + approximant /r/ +V stop + approximant /l/	/fr-/, /θr-/ /gl/-/, /bl-/	25/192	13.1
5	-V stop + approximant /l/ +V stop + approximant /r/	/pl-/ /br-/	6/158	3.8
6	-V stop + approximant /r/	/tr-/, /kr-/, /pr-/	12/300	4
across 2-member clusters			85/1,193	7.1
across 3-member clusters		/spr-/, /str-/, /skr-/, /spl-/	56/316	17.7

Table 4.7 Numbers and average percentages of non-target productions across participants in both production tasks combined. Results for 2-member clusters are given based on sonority differences. Total numbers and percentages of non-target productions across 2-member clusters and 3-member clusters are also given.

To look into a cluster's combination effect to determine the most challenging cluster for all participants, irrespective of markedness effects – i.e., sonority or syllable margin effects – the average percentage of non-target productions was calculated across participants for all clusters – totalling 20 onsets – in both production tasks. The results are given in Table 4.8, which demonstrate varying levels of difficulty in producing specific cluster combinations, as indicated by the average percentage of non-target productions. Clusters such as /gl-/, /bl-/, /fl-/, /sl-/, /spr-/, and /skr-/ exhibited the highest percentages of non-target production, ranging from 15.6% to 43.8%. This suggests greater difficulty in producing these clusters. Conversely, clusters like /sm-/, /sn-, /fr-/, /pr-/, /br-/,/kr-/, /tr-/, /str-/, and /spl-/ demonstrated moderate percentages of non-target production, ranging from 3% to 10.1%. In the case of /st-/, /sk-/, /sp-

/, /pl-/, and /θr-/ clusters, no instances of non-target productions were found, demonstrating easier production for all participants.

The above differences in non-target productions among the clusters were found to be significant after conducting an independent-sample Kruskal-Wallis test. The test was applied to all data produced by the participants, with the type of cluster serving as the independent variable and the average percentage of non-target productions per cluster type as the dependent variable. The analysis revealed a statistically significant difference among the tested clusters ($\chi^2(19) = 98.46$, $p = .001$). Pairwise comparisons with a Bonferroni correction confirmed that /gl-/ was the most challenging cluster to produce ($p = .0001$) and differed from /bl-/, /br-/, /fr-/, /kr-/, /pl-/, /pr-/, /sk-/, /sm-/, /sp-/, /spl-/, /st-/, /tr-/, /θr-/. Moreover, /skr-/ and /sl-/ were also found to be challenging differing from /st-/, /sk-/, /sp-/, /pl-/, and /θr-/ ($p = .0002$). However, no significant differences were found between the remaining clusters using Bonferroni correction pairwise comparisons ($p > .0003$ for all groups, with a Bonferroni correction level set to 0.0003).

Specific cluster combination	Average % of non-target production	SD	Range
/gl-/	43.8	50.7	0-100
/spr-/	29.7	38.1	0-100
/fl-/	25	45.7	0-100
/skr-/	23.2	41.6	0-100
/sl-/	20	31.4	0-100
/bl-/	15.6	33.6	0-100
/str-/	10.1	27.1	0-100
/sm-/	9.4	29.6	0-100
/sn-/	8.4	19.8	0-66.7
/fr-/	6.3	15.7	0-75
/pr-/	5.5	20.1	0-100
/br-/	5.3	16.1	0-75
/spl-/	4.2	24.6	0-100
/kr-/	3.7	18.6	0-100
/tr-/	3	18.6	0-100
/st-/	0	0	0
/sk-/	0	0	0
/sp-/	0	0	0
/pl-/	0	0	0
/θr-/	0	0	0

Table 4.8 Average percentages of non-target productions across participants in both production tasks combined, ordered by cluster difficulty. Standard Deviation (SD) and range are also given.

It was predicted, based on the results of the L1 study, that Kurdish EFLs may encounter difficulties with English stop + approximant and fricative + approximant onset clusters due to negative transfer from their native language. Regarding voiced and voiceless stop +

approximant clusters, from a selection of seven clusters tested (/gl-/, /bl-/, /pr-/, /br-/, /kr-/, /tr-/, and /pl-/), only /gl-/ and /bl-/ were found to be challenging to produce (see Table 4.8). The results for these two clusters were derived from reading only a single word during the reading task. Including these clusters in the verbal fluency task could have yielded different results, as participants might have produced more instances of these clusters in other English words. It is also possible that the difficulty associated with the production of /gl-/ cluster, in particular, might have been influenced by its occurrence in the English loanword ‘glass’, frequently used in NK to mean a small container for drinks. In NK, this cluster is often orally but not orthographically repaired by epenthesis, resulting in /gɨlɑːs/. Similarly, the results concerning fricative + approximant clusters (/fl-/, /sl-/, and /fr-/) do not seem to entirely align with the predictions of the L1 study. While /fl-/ and /sl-/ clusters proved somewhat more difficult to produce accurately, the /fr-/ cluster appeared easier to produce. The difficulty associated with the production of /fl-/ might be due to reading only a single word containing this cluster. However, interference from the native language may better explain the difficulty with the /sl-/ cluster. In NK, the sequence /sl-/ is epenthesised in the word for greetings, /sɨlav/, which, to the best of my knowledge, is the only Kurdish word containing this consonant combination and is often interrupted by an epenthetic vowel. The frequency of this word in the participants’ native language may have affected their pronunciation of the same sequence as a cluster in their target language. In general, it appears that voiced stop and fricative consonants followed by the approximant /l/ pose more challenges compared to when these consonants are followed by the approximant /r/.

This observation, however, does not hold true for 3-consonant clusters. The /spl/ cluster, with the approximant /l/ following the sp sequence, is only 4.2% of the time produced inaccurately compared to /spr-/ (29.7%), /skr-/ (23.2%), and /str-/ (10.1%). The ease of producing the /spl-/ cluster could be attributed to the number of tokens produced for this cluster during the verbal fluency task. Compared to /spr-/ (42 tokens), /skr-/ (63 tokens), and /str-/ (67 tokens), only 16 words were produced with the /spl-/ sequence (see Appendix H for the list of words produced per participant in the phonemic verbal fluency task). If a greater number of words had been produced, the ease of articulating this sequence might have been different. Finally, the heightened difficulty in producing the /spr-/ and /skr-/ clusters, as compared to /str-/ and /spl-/, can be attributed to the frequency of these clusters in English words. In the Brown online corpus (Kucera & Francis, 1967), the /spr-/ cluster occurs 43 times, the /skr-/ cluster 70 times, and the /str-/ cluster 194 times. This indicates that clusters with lower frequency tend to be more challenging to produce. Overall, the results for the clusters with the highest percentages of non-target production suggest that L1 negative transfer and cluster frequency play only a marginal role in the production of the tested clusters by Kurdish EFL learners.

4.3.2.3. Acoustic Analysis

This section presents the results of the acoustic analysis conducted on non-target consonant clusters to determine the acoustic characteristics of the epenthetic vowels produced. Remember that the presence of an epenthetic vowel in a cluster was first determined perceptually by comparing the production of the given cluster with that of native speakers producing the same cluster. Then, evidence of a vocalic element was assessed through visual inspection of the clusters on the waveform and spectrogram. The presence of a vocalic element was determined by the presence of vertical striations in the spectrogram, higher amplitude compared to neighbouring sounds, and a vowel-like formant structure. This section begins with the results of vowel duration, followed by the results of formant frequencies.

4.3.2.3.1. Vowel Duration

The average duration of the epenthetic vowels identified across all tokens within a general cluster combination, together with the average duration of their corresponding main vowels is given in Table 4.9. Notably, for all 2-member and 3-member clusters, the epenthetic vowel was consistently identified between the first two consonants of a given cluster, i.e., between the first and second consonants in 3-member clusters (svCC) and between the consonants in 2-member clusters (CvC), where 'v' stands for an inserted epenthetic vowel. The insertion of epenthetic vowels in such contexts is cross-linguistically common among other L2 learners of English, including Egyptian learners (Broselow, 1987), Hindi learners (Singh, 1985), and Farsi learners (Akbari, 2013). In no cases was the insertion of a prothetic vowel observed (vCC), a phenomenon common among Spanish learners (Carlisle, 1991). For fricative /s/ + stop clusters, fricative + approximant /r/ in /θr-/, and voiceless stop + approximant /l/, the main vowel duration was not calculated because no epenthetic vowel was produced in any of the tokens belonging to these clusters. Note that the results for epenthetic and main vowel duration combine data from clusters sharing the same general cluster combination. For example, /sn-/ and /sm-/are collectively reported for fricative /s/ + nasal combination. The results for 2-consonant clusters are given based on their sonority levels, whereas the results for 3-consonant clusters are reported together.

Duration values for male and female speakers were combined. The average duration for all epenthetic vowels identified across clusters and participants in both production tasks combined was 40 ms (SD = 14), and the average duration of the corresponding main vowels was 120 ms (SD = 75). Thus, identified epenthetic vowels were much shorter than their corresponding main vowels, comprising only 33.3% of their duration. These findings are in line with those from the L1 study (see Chapter 3), where the identified epenthetic vowels were also greatly shorter than their corresponding main vowels, comprising only 34.2% of their duration. Additionally, the duration of epenthetic vowels identified in this study (40 ms) did not differ much from those identified in the L1 study (46.6 ms). It is possible that the participants were transferring the epenthetic vowel from their L1 into their L2. However, this can not be confirmed unless the F1 and F2 of the epenthetic vowels in L2 are also looked at.

Finally, regarding examining the effect of markedness by sonority and syllable margin length on epenthetic vowel duration, it appears that within 2-consonant clusters, no important impact of sonority level on epenthetic vowel duration was observed. The average duration was 43 ms (Md = 46, SD = 5) across all consonant clusters. The epenthetic vowel duration remained somehow consistent across different sonority levels, ranging from 35 ms to 48 ms. Also, no big difference in duration existed between epenthetic vowels identified in 2-consonant clusters and 3-consonant clusters (43 and 40 ms, respectively), indicating the absence of any potential effect of syllable margin length.

Sonority difference	General cluster combination	Specific cluster combination	Total tokens examined	Identified CvC tokens	Average epenthetic vowel duration	Average main vowel duration
2	fricative /s/ + nasal	/sn-/, /sm-/	127	11	48	176
3	fricative + approximant /l/	/sl-/, /fl-/	132	31	35	202
4	fricative + approximant /r/ +V stop + approximant /l/	/fr-/ /gl/-/, /bl-/	92	25	38	160
5	+V stop + approximant /r/	/br-/	158	6	46	144
6	-V stop + approximant /r/	/tr-/, /kr-/, /pr-/	300	12	46	168
vowel duration across 2-member clusters					43	176
Vowel duration across 3-member clusters		/spr-/, /str-/,/skr-/, /spl-/	316	56	40	116
vowel duration across all clusters					40	120

Table 4.9 Average duration (in ms) of epenthetic and main vowels in CvC tokens per general cluster combination. Results for 2-member clusters are given based on sonority differences, and then combined and for 3-member clusters are given together. Clusters that were always produced without epenthetic vowels have been omitted. Average epenthetic and main vowel duration across all cluster types are also given.

4.3.2.3.2. Vowel Quality

F1 and F2 frequencies were measured at the midpoint of 141 identified epenthetic vowels in 2-member clusters and 2-member clusters and their corresponding main vowels, totaling 282 vowels. These measurements were taken using a Praat script. The resulting measurements in Hertz were normalised and scaled back to Hertz-like values for clarity of interpretation of the normalised values, using Lobanov's (1971) normalisation method and applying the NORM web-based interface for normalising formant data (Thomas & Kendall, 2007). Because of the inherent variations in vocal tract dimensions between male and female speakers, distinct formant frequencies were often observed. To account for this, the mean F1 and F2 frequencies for identified epenthetic vowels and their corresponding main vowels are presented separately across 10 male participants/speakers and 15 female participants/speakers in Table 4.10 for unnormalised values, and Table 4.11 for normalised scaled back to Hertz-like values. Note that this analysis did not include the results for 4 male speakers (S1, S9, S14, S15) and 3 female speakers (S3, S18, and S20) because of their completely accurate production of all target clusters, resulting in no instances of epenthetic vowels for analysis. See Appendix D for mean F1 and F2 values (unnormalised and normalised scaled back to Hertz-like values) for each identified epenthetic vowel and its corresponding main vowel per speaker.

To determine the differences in the F1 and F2 values between epenthetic and their corresponding main vowels, only visual representations using vowel plots were used (see Figures 4.5 and 4.6 for female and male speakers, respectively), but the statistical analyses conducted in the L1 study were not replicated in this study because of the limited occurrence of epenthetic vowels in the environments of a few corresponding main vowels. For example, within the context of the main vowel /aɪə/, only a single epenthetic vowel was produced across all participants. Similarly, in the environments of main vowels /æ/ and /aʊ/, only four instances of epenthetic vowels were produced per main vowel. Thus, given the small amount of data for each category, the analysis presented is limited to descriptive statistics and a visual acoustic display.

Similar to the findings observed in the L1 study, the quality of the identified epenthetic vowels for both male and female speakers did not appear to be completely determined by their corresponding main vowels. Instead, these epenthetic vowels tended to group around the mid-central position within the vowel space, especially noticeable among male speakers although in the case of female speakers, a few epenthetic vowels exhibited characteristics of high-back vowels. These results, along with the results obtained for epenthetic vowel duration, suggest that the participants were more apt to transfer their L1 epenthetic vowels to simplify English L2 clusters. Thus, the inserted epenthetic vowel used in the L2 study appears to align more closely with the typical characteristics of L1 /ɨ/.

Speaker	Epenthetic vowel	No. of vowel	F1 (Hz)	F2 (Hz)	Main Vowel	F1 (Hz)	F2 (Hz)
Male	epV_ɒ	2	524	1142	ɒ	643	884
	epV_æ	1	438	1336	æ	571	1176
	epV_aɪ	11	503	1436	aɪ	633	1386
	epV_ɔ:	8	554	1636	ɔ:	470	1058
	epV_eɪ	2	355	1677	eɪ	413	1831
	epV_əʊ	9	436	1499	əʊ	459	1030
	epV_ɪ	8	483	1783	ɪ	416	1845
	epV_i:	20	396	1729	i:	375	2019
	Epenthetic vowel	**No. of vowel**	**F1 (Hz)**	**F2 (Hz)**	**Main Vowel**	**F1 (Hz)**	**F2 (Hz)**
Female	epV_ɒ	5	495	1202	ɒ	699	1361
	epV_æ	3	458	1545	æ	885	1549
	epV_aɪ	5	566	1352	aɪ	731	1703
	epV_aɪə	1	577	1621	aɪə	726	2098
	epV_aʊ	4	613	1599	aʊ	738	1229
	epV_ɔ:	7	466	1549	ɔ:	582	1226
	epV_eɪ	6	462	1558	eɪ	514	2251
	epV_əʊ	7	498	1590	əʊ	589	1381
	epV_ɪ	16	494	1854	ɪ	530	2522
	epV_i:	22	493	2055	i:	455	2352
	epV_ʌ	5	507	1537	ʌ	801	1347

Table 4.10 Average F1 and F2 (unnormalised Hz values) for epenthetic vowels and their corresponding main vowels across 10 male and 15 female speakers. 'epV_x' refers to epenthetic vowels, with 'x' representing the main/lexical vowel within the word.

Speaker	Epenthetic vowel	No. of vowel	Scaled to Hz-like F1	Scaled to Hz-like F2	Main Vowel	Scaled to Hz-like F1	Scaled to Hz-like F2
Male	epV_ɒ	2	448	1395	ɒ	569	1189
	epV_æ	1	389	1389	æ	569	1256
	epV_aɪ	11	446	1403	aɪ	540	1398
	epV_ɔ:	8	452	1696	ɔ:	419	1170
	epV_eɪ	2	336	1617	eɪ	369	1746
	epV_əʊ	9	400	1542	əʊ	420	1202
	epV_ɪ	8	411	1624	ɪ	369	1699
	epV_i:	20	369	1634	i:	343	1863
	Epenthetic vowel	**No. of vowel**	**Scaled to Hz-like F1**	**Scaled to Hz-like F2**	**Main Vowel**	**Scaled to Hz-like F1**	**Scaled to Hz-like F2**
Female	epV_ɒ	5	397	1374	ɒ	541	1386
	epV_æ	3	306	1430	æ	624	1432
	epV_aɪ	5	427	1326	aɪ	576	1509
	epV_aɪə	1	394	1517	aɪə	510	1786
	epV_aʊ	4	441	1519	aʊ	524	1310
	epV_ɔ:	7	395	1395	ɔ:	521	1223
	epV_eɪ	6	388	1395	eɪ	430	1768
	epV_əʊ	7	386	1411	əʊ	471	1310
	epV_ɪ	16	391	1476	ɪ	435	1868
	epV_i:	22	437	1528	i:	395	1722
	epV_ʌ	5	358	1473	ʌ	588	1314

Table 4.11 Average F1 and F2 (normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels across 10 male and 15 female speakers. 'epV_x' refers to epenthetic vowels, with 'x' representing the main/lexical vowel within the word.

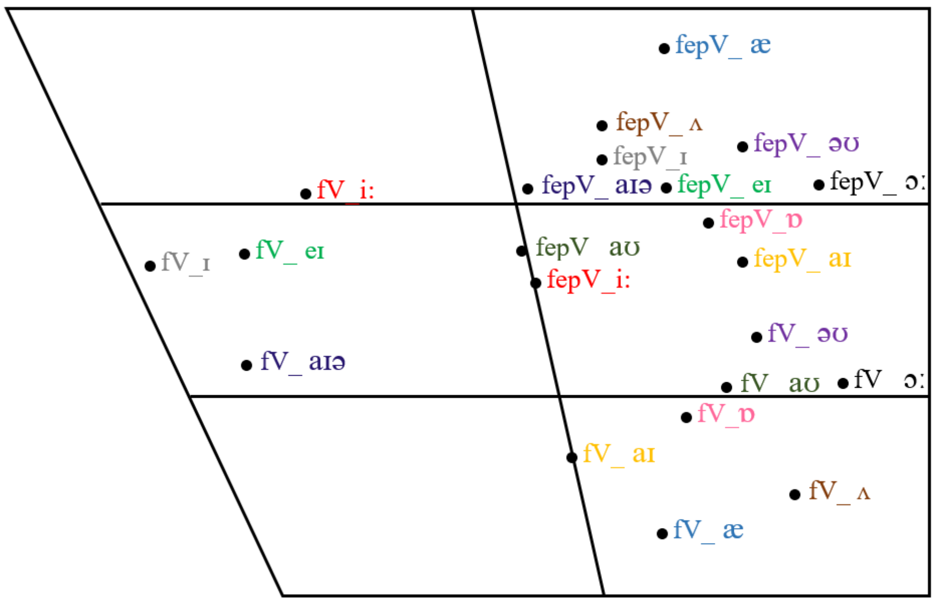

Figure 4.5 Vowel plot of the average F1 and F2 (using scaled back to Hertz-like values) for 15 female speakers. 'fV' refers to a main corresponding vowel for a female speaker 'f' and 'fepV' is its epenthetic vowel (epV) for the same female speaker. Each main vowel is color-coded along with its corresponding epenthetic vowel for clarity.

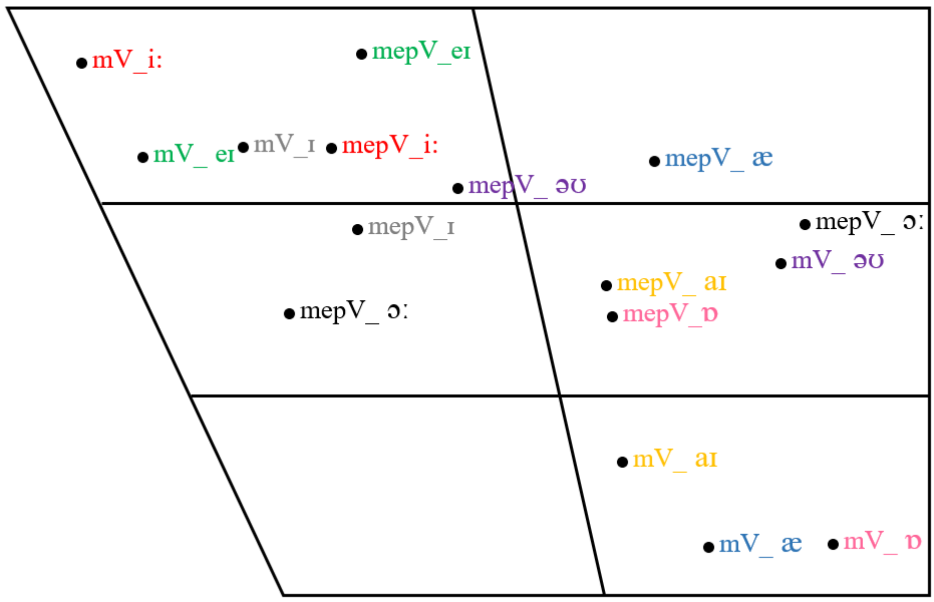

Figure 4.6 Vowel plot of the average F1 and F2 (using scaled back to Hertz-like values) for 10 male speakers. 'mV' refers to a main corresponding vowel for a male speaker 'm' and 'mepV' is its epenthetic vowel (epV) for the same male speaker. Each main vowel is color-coded along with its corresponding epenthetic vowel for clarity.

4.4. Relationship between Proficiency and Production Results

It has been anticipated that the proficiency levels of individual learners, as assessed in this thesis through an EIT task and an online vocabulary test, will more accurately reflect the impact of enhanced L2 proficiency on the production of L2 clusters. In other words, it was expected that learners with higher L2 proficiency levels – i.e., higher EIT scores and/or vocabulary test scores – would produce fewer non-target productions of onset clusters be they marked or less marked structures. However, no association between EIT scores and non-target cluster production was found, as confirmed by the results of a Spearman correlation (r =.277, N = 32, p = 125). These findings can be interpreted in terms of two possible factors. First is the nature of the EIT task, which assesses oral language proficiency. Given that our participants had never lived or studied abroad, they likely lacked high-quality exposure to native language environments. This limited exposure might have resulted in less developed listening and/or speaking skills in the target language. Second, the participants might have relied on rote repetition of the stimuli sentences because their performance declined as the sentences became longer, particularly from the 11th sentence onward in the EIT task. In fact, the EIT task has long been criticised for its possible dependence on rote repetition, particularly in short sentences (Yan et al., 2016). This suggests that longer sentences might have exceeded the participants' current comprehension and/or production capabilities, making it difficult for them to either comprehend or reproduce the utterances within the time provided (Eisenstein, Bailey & Madden, 1982). As a result, the participants – more likely at lower proficiency levels – might have resorted to rote repetition.

The vocabulary test results indicated a significant association between L2 proficiency and L2 cluster production than the measure provided by the EIT, despite the modest correlation (r = .367, N = 32, p = .039). These findings differ from those of Uchihara & Saito (2019), who although discovered notable correlations between productive vocabulary size and speech rate among Japanese learners of L2 English, they did not find significant associations with ratings of accent or comprehensibility. Also, Mariano & Santiago (2020) found that receptive vocabulary size, as measured by the Dialang vocabulary test, exhibited moderate correlations with speech rate among Italian learners of L2 French. Yet, similar to Uchihara and Saito, they did not find correlations with ratings of foreign accentedness or with acoustic measures of vowels.

It is worth noting that, upon inspecting the individual data, it appeared that our vocabulary test results did not seem to affect non-target cluster production for all of our participants. For example, out of the 32 participants assessed, 7 individuals (P1, P3, P9, P14, P15, P18, and P20) consistently demonstrated accurate production across all tested onset sequences. This consistency held true regardless of their performance on the EIT task or the vocabulary test. Surprisingly, among these individuals is P9, who attained the lowest score on the vocabulary test (400). There are two possible explanations for why the proficiency test results or the participants' proficiency levels did not appear to greatly impact their accurate production of the tested clusters. Firstly, it is possible that their prior knowledge of English phonetics could have enhanced their ability to produce English clusters accurately. However, it is worth noting that this topic is not included in the phonetics syllabus followed by Zakho University (Aveen Hasan, personal communication, January 4, 2021). Secondly, the sample size of 32 participants might have been insufficient to detect subtle differences in cluster production accuracy. With a larger sample size, more obvious variations in L2 cluster production could potentially be observed, thereby revealing a potential role of L2 proficiency, as measured by the tasks used in this study.

Participant	EIT task score	Vocabulary test score	Average % of non-target production
P1	61	4045	0
P3	75	2980	0
P9	75	400	0
P14	50	5088	0
P15	95	2998	0
P18	95	3952	0
P20	79	2675	0
P6	101	4823	2
P5	75	2823	2
P25	21	4252	2
P21	76	2840	4
P26	43	3480	5
P11	62	1360	5
P30	46	3360	6
P22	43	2633	7
P13	69	4574	8
P12	108	4299	9
P8	78	4517	9
P19	91	2939	10
P10	45	1423	11
P32	23	3980	11
P16	88	4636	13
P2	76	2710	13
P4	74	658	15
P31	55	2981	16
P29	48	555	16
P23	24	2510	17
P17	27	2200	19
P28	56	2366	20
P7	83	3850	27
P27	59	554	34
P24	55	1379	37

Table 4.12 The EIT test scores, vocabulary test scores, and percentages of non-target cluster productions across all tested clusters in both production tasks combined presented per participant, and sorted by non-target cluster production (last column).

4.5. General Discussion

This section offers a general discussion of the main findings regarding the production of English onset clusters by Kurdish EFL learners and the factors that may affect how these clusters are produced inaccurately. The first finding of this study concerns the production of English 2-consonant onset clusters. Out of 16 double consonant clusters, three fricative /s/ + stop clusters were consistently accurately produced, as they never triggered vowel epenthesis in any of the tokens produced by all participants. The findings regarding these three combinations provide strong evidence that the participants were transferring the syllable structure of this sequence from their L1, as established from the results of the L1 study (see Chapter 3). Thus, the effect of L1 positive transfer was more influential in producing these sequences than the effect of the SSP (Clements, 1990). Even though the fricative /s/ + stop combination is a marked structure in the onset position, i.e., it is a sonority reversal, it was not challenging to produce due to L1 positive transfer.

Although the remaining 13 double consonant clusters were not generally challenging to produce, the results obtained for these sequences did not consistently support the predictions of the Minimal Sonority Distance Principle (Broselow & Finer, 1991) in that decreasing levels of sonority between the members of a cluster did not always result in more non-target cluster production. For example, cluster combinations with a sonority difference of 3, such as fricative + approximant /l/, revealed a higher percentage of non-target productions (23.5%) compared to those with a sonority difference of 2, like fricative /s/ + nasal (8.7%). These results replicate the findings of Yavaş & Somaillan (2005), who examined the acquisition patterns of SSP-violating and non-SSP-violating English double clusters by Spanish English bilingual children. They found that although the overall accuracy of cluster production increased as the sonority level decreased, participants tended to group fricative /s/ + stop and fricative /s/ + nasal clusters together, rather than with fricative /s/ + approximant /l/ and fricative /s/ + approximant /w/ clusters. That is, fricative /s/ + nasal sequences exhibited similar levels of difficulty to fricative /s/ + stop sequences for their participants. In the opposite direction, our participants found both groups similarly easy to produce. Our findings support Yavaş and Someillan's proposal that nasals are more closely related to stops than fricatives, as both are [-continuant]. This characteristic, they suggest, seems to influence how participants group these clusters in terms of ease or difficulty of production. However, the Minimal Sonority Distance Principle predictions were supported by sonority differences 4, 5, and 6, where the percentages of non-target productions aligned closely with expectations (see Table 4.7).

Regarding the production of 3-consonant onset clusters, both the Markedness Differential Hypothesis (Eckman, 1977) and the Structural Conformity Hypothesis (Eckman, 1991) were validated in that triple clusters combined were more inaccurately produced (17.7%) than two-member onsets combined (7.1%). It is very likely that the absence of 3-consonant clusters in NK (Shokri, 2002; Hasan, 2009, 2012) and their status as universally marked structures (Greenberg, 1965; Kaye & Lowenstamm, 1981) contributed to this discrepancy. These findings are consistent with results reported in other studies (Eckman, 1991; Carlisle, 1997, 1998, 2002; Hancin-Bhatt, 2000; Rauber & Baptista, 2004; Alosaimi, 2023). Additionally, these results suggest that the effect of markedness based on syllable margin length was more prominent than the effect of markedness based on sonority. Notably, sonority reversals were consistently produced accurately, while clusters with differing sonority levels only marginally adhered to the predictions of the Minimal Sonority Distance Principle

An analysis aimed at identifying challenging clusters, irrespective of markedness effects, identified six clusters that presented difficulty: /gl-/, /bl-/, /fl-/, /sl-/, /spr-/, and /skr-/. The difficulty of these specific combinations cannot be only attributed to L1 negative transfer, as many other clusters tested were also absent in NK. Methodological limitations and interference from the native language may explain why voiced stop + approximant /l/ clusters (/gl-/ and /bl-/) were more challenging compared to other voiced or voiceless stop + approximant /l/ clusters. These factors may similarly contribute to why fricative + approximant /l/ clusters (/fl-/ and /sl-/) posed greater difficulty than other fricative + approximant clusters. Finally, the increased difficulty in producing 3-member clusters like /spr-/ and /skr-/ compared to other 3-member clusters such as /spr-/ and /spl-/ is likely influenced by their frequency in English words.

The comparison of non-target cluster productions between the reading task and the verbal fluency task revealed no statistically significant difference. This finding suggests that the type of task, whether it involves complete written input (sentence reading task) or partial written input (phonemic verbal fluency task), did not significantly influence the occurrence of non-target productions in the current study. This result may be attributed to the participant sample, which consisted of English major students who generally did not find the production of English clusters, whether marked or less marked, challenging. Their phonetics classes likely enhanced their overall pronunciation skills, including their performance with English clusters. Additionally, it is plausible that these participants benefited from instructors who possibly served as effective pronunciation models. Future research involving Kurdish EFL learners from diverse academic backgrounds, particularly those not specialising in English studies, may provide deeper insights into the differential impact of task variations on the production of English consonant clusters.

Regarding the acoustic properties of the identified epenthetic vowels, the acoustic analysis revealed notable differences in terms of duration and formant frequencies compared to their corresponding main vowels. Specifically, the identified epenthetic vowels consistently exhibited shorter durations, comprising only about one-third of the duration of the corresponding main vowels. Additionally, they displayed distinct spectral characteristics, with their F1 and F2 values largely unaffected by those of the corresponding main vowels. These findings suggest that the inserted vowels may represent a common epenthetic vowel, displaying acoustic traits typical of L1 /ɨ/. Consequently, it is plausible that the L2 participants were transferring their L1 epenthetic vowel characteristics to simplify L2 clusters.

Finally, regarding the effect of L2 proficiency on L2 cluster production, it appeared that the vocabulary measure was more indicative or better related to cluster production than the measure provided by the EIT task. However given that the participants did not generally find L2 cluster production challenging, the predictions of the Ontogeny Phylogeny Model (Major, 2001), suggesting that as learners' proficiency in their L2 increases, the tendency for transfer from their first language diminishes, cannot be confirmed or disproven due to the participants' generally non-challenging experience in producing L2 clusters. The lack of an apparent effect of proficiency levels on L2 cluster production in this thesis could be related to two main factors. Firstly, participants' prior knowledge of English phonetics could have boosted their ability to accurately produce English clusters. Secondly, the sample size of 32 participants might have been insufficient to detect subtle variations in cluster production accuracy.

4.6. Summary

This chapter examined the production of various English 2-consonant clusters and 3-consonant clusters by Kurdish EFL learners, focusing primarily on the effect of such factors as L1 transfer, markedness based on sonority and syllable margin length, and L2 English proficiency. Even though results from both production tasks showed that the participants did not generally find the production of L2 clusters challenging, these factors were found to have some effect on L2 cluster production.

Among the sixteen double clusters tested, three sonority reversals belonging to fricative /s/ + stop clusters were consistently accurately produced, opposing the predictions of the SSP. Positive transfer from L1 may account for production accuracy in these sequences. In the remaining double clusters, the effect of markedness based on sonority was only marginally attested as increasing levels of sonority between the members of a cluster did not consistently result in fewer challenges in L2 cluster production. For example, clusters with a sonority difference of 3 revealed a higher percentage of non-target productions compared to those with a sonority difference of 2. Furthermore, little influence from L1 was found in these sequences. Methodological limitations and the impact of cluster frequency using an English corpus provided a better explanation than the L1 effect for the results obtained with some challenging clusters.

When considering the production of 3-consonant clusters, the influence of markedness based on syllable margin length played a more important role. Generally, triple clusters were more challenging than 2-consonant clusters, even though not all were more demanding than double clusters. Finally, L2 proficiency, as measured by the EIT task, was not found to have a determining effect on the participants' production of L2 clusters. In contrast, vocabulary measures were found to be more closely related, though moderately, to L2 cluster production. The following chapter provides a global discussion of the findings from the two studies comprising this thesis. It also addresses the methodological limitations encountered and outlines potential directions for future research.

Chapter Five

5. General Discussion and Conclusions

The current chapter discusses the findings reported in the L1 Kurdish study (Chapter 3), and L2 English study (Chapter 4), offering a broad global perspective to the study. The discussion will revolve around the research questions presented in Chapter 2, which will be confirmed or falsified in light of the empirical results and their alignment with existing literature. The studies' limitations will be acknowledged, and avenues for potential future research will be identified. Lastly, the chapter will conclude with final remarks and the implications of this thesis.

5.1. General Discussion

The goal of the current thesis is twofold. First, it attempts to settle the cluster status of a number of consonant sequences in NK by providing the first perceptual and acoustic analysis of these sequences (L1 Kurdish Study). Second, it aims to investigate, in light of the results of the Kurdish study and language universals factors, the specific challenges and difficulties Kurdish EFLs face when producing English consonant clusters (L2 English study). The thesis involved three groups: native speakers of the NK dialect exclusively spoken in Duhok Governorate in the Kurdistan region of Iraq, Kurdish EFL learners enrolled as second-year English-degree students at Zakho University, and a control group consisting of native British English speakers from London and Leicester cities in the United Kingdom, who were included in the L2 study.

In the L1 study, the examined consonant sequences included both onset and coda combinations, whereas only onset clusters were investigated in the L2 study. The target L1 sequences tested in the onset position included approximant + fricative, nasal + fricative, stop

+ stop, fricative + stop, stop + nasal, fricative + nasal, nasal + approximant, stop + approximant, affricate + nasal, fricative + approximant, and stop + fricative. In the coda position, target L1 sequences comprised stop + nasal, stop + approximant, fricative + approximant, fricative + nasal, approximant + nasal, affricate + stop, approximant + fricative, approximant + stop, approximant + affricate, fricative + stop, and nasal + stop. Both sets of sequences were categorised based on whether they violated the SSP or not. In the L2 study, target clusters were categorised based on markedness by sonority for double clusters and markedness based on syllable margin length for triple clusters. Within double clusters, the combinations were as follows: fricative /s/ + stop represented sonority level -2, fricative /s/ + nasal represented sonority level 2, fricative + approximant /l/ represented sonority level 3, fricative + approximant /r/ and voiced stop + approximant /l/ represented sonority level 4. Voiced and voiceless stop + approximant /r/ representing sonority levels 5 and 6, respectively. Within triple clusters, the combinations were as follows: fricative /s/ + stop + approximant /r/ or approximant /l/.

To determine the cluster status of L1 sequences, two tasks were designed: a perception task and a production task. The perception task involved a forced-choice goodness task, accompanied by confidence ratings. The production tasks included a carrier sentence reading task and a picture-naming task. Participants in the perception task were presented with two productions of the same word, one with an epenthetic vowel (e.g., /sɨteɾ/) and one without it (e.g., /steɾ/). They were instructed to select the option that sounded more Kurdish-like/natural to them, and then provide a confidence rating using a 6-point scale, where 6 meant ‘confident’ about the option selected, and 1 meant ‘not confident’, with the remaining points indicating intermediate levels of confidence. In the production tasks, participants were tasked with reading a series of words placed at the absolute beginning of carrier sentences. Additionally, they were instructed to name a list of pictures to elicit the target words/clusters. To investigate the production of L2 clusters, two production tasks were designed: a carrier sentence reading task and a phonemic verbal fluency task. Similar to the L1 reading task, EFL participants had to read a sequence of onset cluster words positioned at the very beginning of carrier sentences. In the phonemic verbal fluency task, they were presented with double ‘e.g., sp-’ and triple ‘e.g., spr-’ cluster cues and had to name within 10 seconds as many English words as possible beginning with the cluster cues provided. In addition to the production tasks, the L2 study included two proficiency tasks: an Elicited Imitation Task (EIT) and a vocabulary task. These tasks were designed to assess the participants’ L2 proficiency and its potential impact on L2 cluster production. The EIT measured oral language proficiency, while the vocabulary task evaluated vocabulary size. The goal was to combine the results of both tasks to obtain a holistic profile of the participants’ L2 proficiency level.

The perception task in the L1 study (see Chapter 3) showed that native speakers of NK generally perceived most of the onset and coda sequences tested as more Kurdish-like/natural when they contained a vocalic element. However, there was one sequence, namely the combination of a fricative /s/ + stop in the onset position, that all participants consistently perceived as more Kurdish-like/natural without a vocalic element. Regarding production (see Chapter 3), the results of impressionistic analysis and acoustic analysis were aligned and revealed that the majority of the sequences tested revealed a moderately high rate of vowel epenthesis. Only three sequences, namely fricative /s/ + stop in the onset and coda positions and nasal + stop in the coda position never triggered vowel epenthesis in any of the tokens produced by all participants. Having obtained these results, a straightforward relationship was observed between perception and production of the onset and coda sequences tested.

There was no clear effect of SSP violation and sequence combination in onset combinations. All onset sequences, regardless of SSP violation, were perceived as more typically Kurdish when a vocalic element was present and consistently produced with a vocalic element. The only exception was the fricative /s/ + stop combination, which was neither perceived nor produced with a vocalic element. Additionally, SSP violation had no impact on the duration of the epenthetic vowel produced in both SSP-violating and non-SSP-violating onset sequences. In coda combinations, the effect of the SSP violation and sequence combination was more obvious. Sequences that violated the SSP were more frequently produced with a vocalic element, and the duration of the epenthetic vowel produced was longer. Two combinations, namely the fricative /s/ + stop and nasal + stop combinations were never produced with a vocalic element. Finally, regarding whether onset or coda combinations triggered more epenthetic vowel insertions in production, onset sequences were found to be more frequently produced with vowel epenthesis than coda sequences because all onset combinations, regardless of SSP violation, were consistently produced with a vocalic element, with the only exception of the fricative /s/ + stop combination.

The production tasks in the L2 study (see Chapter 4) revealed that the EFL participants did not generally find the production of the selected clusters challenging, with only a few sequences posing difficulty. Therefore, no clear effect of L1 negative transfer or markedness by sonority was observed, especially in relation to double consonant clusters. For triple clusters, a more influential role of L1 negative transfer and markedness based on syllable margin length was found. Additionally, the proficiency levels of individual learners were not found to greatly influence L2 cluster production. Lastly, the epenthetic vowels produced in both the L1 and L2 studies were consistently shorter than their corresponding main vowels. They also exhibited distinct spectral characteristics, with their F1 and F2 values not being entirely influenced by those of the corresponding main vowels. These findings suggested using a common epenthetic vowel to repair consonant sequences in both L1 and L2, displaying acoustic traits typical of the /ɨ/ vowel. The following sections will discuss the research questions addressed in this thesis, one by one, in light of the results of the empirical studies.

5.1.1. RQ.1: The Perception of Native NK Onset and Coda Sequences

The first research question **(RQ.1)** addressed the issue of whether native NK speakers perceive certain onset and coda consonant combinations as more Kurdish-like/natural with or without the addition of a vocalic element. More specifically, the perception of 10 onset sequences: nasal + fricative, stop + stop, approximant + fricative, fricative + stop, stop + nasal, nasal + approximant, stop+ fricative, fricative + approximant, stop + approximant, and fricative + nasal. Additionally, it analysed 5 coda sequences: fricative + nasal, stop + approximant, fricative + approximant, stop + nasal, and approximant + nasal. It was hypothesised in this study that these sequences described in previous studies (e.g., Kahn, 1976; Hasan, 2009) as actual clusters will be perceived as more 'Kurdish-like/natural' with the addition of a vocalic element/an epenthetic vowel because most of these combinations violate the SSP (Clements, 1990) and, therefore, they were universally less likely to constitute actual clusters (Carsile, 2001). Factors such as consonant sequence combination and position (onset vs coda) were not expected to play an important role in the perception of a sequence as more Kurdish-like/natural had it violated the SSP **(RQ.3).**

The findings from the perception task confirmed the hypothesis, revealing a consistently high preference for stimuli with a vocalic element across all tested sequences. High confidence ratings further supported participants' confidence in their choices. Despite violating the SSP, only the fricative /s/ + stop combination in the onset position was consistently perceived as more Kurdish-like/natural without a vocalic element. This combination also received the highest confidence rating. For this combination, it was suggested that /s/ possibly behaved as a direct dependent of the syllable, as proposed by the ‘adjunct’ approach to /s/-clusters (Giegerich, 1992; Kenstowicz, 1994). The finding regarding this combination was also consistent with Shokri’s (2002) descriptions of onset clusters in NK (see Chapter 1) where the fricative + stop combination was identified as the only combination capable of constituting a true onset cluster in NK. On the other hand, the results obtained for the remaining sequences tested – which were perceptually preferred as more Kurdish-like/natural with a vocalic element – do not conform to the descriptions of onset and coda clusters provided in Hasan (2009). In Hasan’s analysis, all these combinations were described as true clusters, likely because the study is based on the way words are spelled in NK, which typically omits epenthetic vowels. The possible impact of factors such as violation of the SSP, consonant sequence combination, and consonant sequence position (onset vs coda) on the perception of these findings are discussed in **5.1.3 (RQ.3)**.

5.1.2. RQ.2: The Production of Native NK Onset and Coda Sequences

The second research question **(RQ.2)** addressed the issue of whether native NK speakers will produce their native onset and coda consonant combinations more frequently with or without the addition of a vocalic element. Specifically, the study examined the production of 11 onset sequences, all of which were previously tested perceptually except for the last sequence: nasal + fricative, stop + stop, approximant + fricative, fricative + stop, stop + nasal, nasal + approximant, stop+ fricative, fricative + approximant, stop + approximant, fricative + nasal, and affricate + nasal. The study also examined the production of these 11 coda sequences, the first five of which were also perceptually tested: fricative + nasal, stop + approximant, fricative + approximant, stop + nasal, and approximant + nasal, affricate + stop, approximant + affricate, approximant + fricative, approximant + stop, fricative + stop, and nasal + stop. Given that previous descriptions of these combinations as clusters in the literature (see Kahn, 1976; Hasan, 2009; Shokri, 2002) relied either on the orthographic representation of Kurdish words, which typically omits epenthetic vowel representations, or on the respective author's native intuitive phonetic segmentation of words, it was hypothesised that the experimental analyses conducted in this study would offer a more accurate assessment of the true cluster status of these combinations and that the participants would produce the selected onset and coda combinations more frequently with the addition of a vocalic element/an epenthetic vowel.

The findings from both impressionistic and acoustic analyses were very much aligned and jointly confirmed the study's hypothesis, revealing a moderately high occurrence of vowel epenthesis in the majority of the sequences tested (both onsets and codas). Among the total of 11 onsets and 11 coda sequences examined, only three sequences, namely fricative /s/ + stop in the onset and coda positions and nasal + stop in the coda position acted consistently as actual clusters, as they never triggered vowel epenthesis in any of the tokens produced by all participants. The finding regarding the fricative /s/ + stop in the onset position was consistent with the perceptual finding obtained for this sequence, indicating that this sequence is indeed a true cluster in NK. The fricative /s/ + stop and nasal + stop coda combinations were not tested perceptually. However, the results obtained for these combinations as actual clusters were expected given that the two sequences do not violate the SSP in the coda position, and they were also described as actual clusters in previous studies (Hasan, 2009; Shokri, 2002). The presence of homorganic consonants in the selected example words for these sequences, i.e., /-st/ in /dæst/ and /-nd/ in /gʊnd/ was less likely to account for why these combinations constituted actual clusters because equivalent sequences involving non-homorganic consonants like /-sp/ in /hæsp/ 'horse' and /-ʃk/ in /mɾiʃk/ 'chicken' for fricative + stop, and /-mt/ in /sʊmt/ 'drilled' for nasal + stop are also expected to form true clusters. It is more likely that, in accordance with the claims made by Shokri (2002), the phonotactic constraints within NK exhibit more flexibility toward the formation of coda clusters compared to onset clusters. It is possible that NK, despite being genetically unrelated to Arabic, has developed similar restrictions on onset cluster formation due to the Sprachbund effect (Andersson, Sayeed & Vaux, 2017). The coexistence of these languages in the same geographical area has likely led to a convergence in their phonological patterns, resulting in comparable constraints on forming onset clusters.

The findings for the remaining 10 onset sequences showed that an epenthetic vowel was consistently produced in these sequences irrespective of whether the sequences violated or adhered to the SSP, indicating the robustness of the perceptual findings and underscoring the disagreement with the existing literature (Kahn, 1976; Hasan, 2009). For example, Hasan (2009) reported all these sequences as actual onset clusters in NK.

Regarding the findings obtained for the remaining 9 coda sequences, all these 5 sequences: stop + nasal, stop + approximant, fricative + approximant, fricative + nasal, and approximant + nasal are very unlikely to form actual coda clusters in NK because – based on acoustic analysis – they have been consistently produced with vowel epenthesis (73.3-100% of CvC production) and highly preferred perceptually with vowel epenthesis. Again, this finding does not align with the previous classification of coda clusters given by Hasan (2009). Regarding the affricate + stop combination, it was only moderately produced with vowel epenthesis (60% of CvC production). Since it does not violate the SSP in its respective position, it is likely for this sequence to form an actual coda cluster. Further investigation may be necessary to determine its cluster status in NK, possibly involving a wider selection of words. The results for other sequences, namely approximant + fricative, approximant + stop, and approximant + affricate, indicated a variable cluster status for these combinations. These sequences may potentially form actual clusters in NK due to their comparatively low rates of vowel epenthesis (13.3-33.3% of CvC production) and adherence to the SSP. However, it was also observed that a vocalic element may occasionally break them up.

In relation to the acoustic characteristics of the identified inserted vowels, the inserted vowels exhibited many properties described for epenthetic vowels by Hall (2006). There were important differences in duration and F1 and F2 frequencies between the inserted vowels and their corresponding main vowels, indicating that the inserted vowels were not copies of nearby vowels. Instead, they often showed, as described in (Hamid, 2016), a more centralised and relaxed articulation and were partly independent of their corresponding main vowels. Generally, the inserted vowels did not differ from one another revealing a common vowel quality regardless of the main/lexical vowel in the word, but at the same time, in a few of the cases, the epenthetic vowels also did not differ so much from the corresponding main vowels either. It is possible that including a larger set of data in the analyses would help to assess which of the two factors, the tendency towards a common articulation or the effect of the main vowel, is a more determining factor.

Even though the inserted vowel did not consistently function to repair marked structures – i.e., it was also present in onset and coda sequences that did not violate the SSP (unmarked structures) – it could still be categorised as epenthetic in such contexts as well. In all onset combinations – excluding the fricative /s/ + stop combination – the consistent presence of vowel insertion in these sequences suggested a higher likelihood of vowel epenthesis and not vowel intrusion. If the vowel had been considered intrusive in these sequences, its rates of insertion would likely have been lower, as intrusive vowels are typically more optional in speech (Hall, 2006). In this context, NK behaves similarly to the colloquial Levantine Arabic dialects spoken in Lebanon, Syria, Israel, Palestine, and Jordan, where epenthetic vowels are optionally used in consonant clusters that do not violate the SSP (Hall, 2012). Regarding coda sequences adhering to the SSP – i.e., approximant + fricative, approximant + stop, and approximant + affricate – the inserted vowels could be classified as intrusive due to their low frequency in these sequences and their lack of repair function for these sequences. However, the dependence of these inserted vowels on speech rate needs to be tested to fully determine if they are indeed intrusive. In contrast, vowels inserted in coda sequences that violate the SSP – i.e., stop + nasal, stop + approximant, fricative + approximant, and fricative + nasal – are more likely epenthetic, as they serve to repair the marked structures (Clements, 1990). For the remaining two coda sequences – i.e., approximant + nasal and affricate + stop – I would argue that the inserted vowels are also epenthetic, despite not repairing the given sequences because they occur relatively frequently in these contexts. In short, the presence of inserted vowels in both marked and unmarked structures strongly suggests that they can be categorised as epenthetic rather than intrusive, particularly given their consistent occurrence in onset combinations.

5.1.3. RQ.3: The Effect of the SSP, Consonant Sequence Combinations, and Consonant Sequence Positions on the Perception and Production of Native NK Onset and Coda Sequences.

The third research question **(RQ.3)** addressed the potential impact of SSP violation, sequence combinations, and sequence positions (onset vs coda) on the perception and production of the tested sequences. It was hypothesised that the impact of SSP violation would be more influential than the effects of consonant sequence combinations and positions (onset vs coda). This means that all sequence combinations were expected to be perceived as more Kurdish-like/natural when containing a vocalic element, and produced more frequently with a vocalic element if they violated the SSP, regardless of their consonantal makeup or their positions within a syllable (onset vs coda).

The effect of SSP violations was examined separately for onset and coda combinations in both perception and production tasks. The results of the perception task did not entirely confirm the study’s hypothesis. Excluding the fricative /s/ + stop sequence, all other onset sequences were perceived as more Kurdish-like/normal with a vocalic element regardless of whether they violated the SSP. Despite violating the SSP, the fricative /s/ + stop sequence was consistently perceived as more typically Kurdish in the absence of an epenthetic vowel. Concerning the influence of the SSP violation on the perception of coda sequences, across four SSP-violating sequences, there was a high and consistent preference for stimuli with vowel epenthesis, aligning with SSP predictions that sequences violating the SSP are perceived more naturally with a vocalic element, making them less likely to form actual clusters across languages. But, even for the only coda sequence adhering to the SSP, i.e., approximant + nasal, there was a substantial preference for the stimulus with vowel epenthesis. Due to the limited sample of SSP-adhering sequences tested, it remains unclear how adherence to the SSP influences the perception of stimuli with vowel epenthesis in coda positions. Yet, a greater number of coda combinations were included in the production task and the results do point to a possible effect of the SSP, as discussed below.

Regarding the effect of sequence combinations on the perception of the tested sequences, there was a generally high and consistent preference among participants for stimuli with epenthetic vowels across most sequence types, except the fricative + stop onset combination. Notably, certain combinations, such as stop + nasal, nasal + approximant, and stop + fricative (in the onset position), were invariably perceived with vowel epenthesis. Conversely, the stop + nasal combination in the coda position was perceived the least frequently with vowel epenthesis (reaching 67% preference for CvC). The results for the stop

+ nasal combination might be influenced by the frequency of the word used, i.e., /tʰæqɨn/ 'mud' might be a high-frequency word. Because these findings are based on a single word, it is difficult to determine whether they truly represent the general acceptability of stop + nasal codas in the language. Further research using a wider range of words would be needed to draw more reliable conclusions.

Lastly, a difference was observed between onset and coda combinations in the perception of the sequences tested. Participants showed a slightly higher preference for stimuli with vowel epenthesis in onset sequences, except for the fricative /s/ + stop sequence. A potential explanation for this finding is that participants may have been more inclined to perceive a vocalic element in onset positions than in coda positions. This tendency could be related to the stricter phonotactic constraints that NK imposes on the formation of onset clusters compared to codas (Shokri, 2002).

The study's hypothesis regarding the impact of the SSP on the production of the tested sequences was disproven for onset combinations but confirmed for coda combinations. For onset combinations, both impressionistic and acoustic analysis results aligned with perceptual findings, indicating no important effect of the SSP. Onset sequences that violated the SSP, except the fricative /s/ + stop combination, were produced with vowel epenthesis like sequences that did not violate the SSP. Despite this consistency, a few onset sequences that did not violate the SSP were produced without epenthetic vowels more often such as stop + fricative and fricative + approximant (40-30% acoustically, and 33-43% impressionistically). Additionally, no effect of the SSP was observed on the duration of the epenthetic vowel in both SSP-violating and non-SSP-violating onset sequences. In contrast, coda sequences that violated the SSP were more frequently produced with a vocalic element ((97-100% SSP obeying vs 0-93% SPP abiding), and the duration of the inserted vowel was longer, indicating that SSP is a reliable phonological predictor for the sequencing of consonant sequences in NK coda combinations. The findings regarding the impact of the SSP on vowel epenthesis in onset combinations appear to contradict the SSP predictions proposed by Clements (1990). Instead, they suggest that NK, likely influenced by Arabic, imposes stricter phonotactic constraints on the formation of onset clusters. As a result of these constraints, the SSP seems to have little to no clear effect on onset cluster formation in NK.

In examining the impact of consonant combinations on the production of the tested sequences, acoustic measurements, and impressionistic judgment assessments were very much aligned regarding sequences produced both with and without epenthetic vowels. Specifically, there was unanimous agreement on the absence of a vocalic element in the fricative /s/ + stop combination, regardless of whether it was in the onset or coda position. This observation aligns with Shokri's (2002) characterisation of this sequence as a true cluster in NK in both positions. The resistance to vowel insertion in the onset position of this combination can be explained by the adjunct approach to /s/-clusters which assumes an extra syllabic position for initial fricative /s/ + stop clusters (Giegerich, 1992; Kenstowicz, 1994). Furthermore, no epenthetic vowel was detected, either impressionistically or acoustically, in the nasal + stop coda sequence. This result is consistent with the descriptions by Shokri (2002) and Hasan (2009) of this sequence as a true coda cluster. This outcome was anticipated, given that the nasal + stop sequence conforms to the SSP in the coda position (Clements, 1990).

In contrast to the aforementioned sequences, the stop + nasal sequence, irrespective of its position within the syllable – whether initial or final – was always produced with a vocalic element by all participants. These findings support the results obtained from the perception task, wherein the same sequence when in the syllable onset position, was perceived as more typically Kurdish in the presence of an epenthetic vowel. Based on these results, it is highly likely that the stop + nasal sequence does not constitute a true onset or coda cluster, contradicting Hasan's (2009) characterisation of this combination as an actual cluster in NK.

This finding supports the argument that the description of this sequence and other sequences as a cluster in NK may be influenced by orthographic conventions, where the epenthetic vowel is not represented in writing. Overall, the effect of sequence combinations was not evident in onset combinations. Acoustic measurements showed that all sequences were either predominantly produced with an epenthetic vowel, with 80-100% of cases resulting in CvC production – this includes sequences like stop + nasal, approximant + fricative, fricative + nasal, nasal + fricative, nasal + approximant, stop + stop, stop + approximant, and affricate + nasal – or were moderately produced with an epenthetic vowel, with 60-66.7% CvC production, as seen in fricative + approximant and stop + fricative sequences.

In coda combinations, acoustic measurements indicated some influence of sequence combination. For example, sequences with an approximant as the first element were either moderately produced with vowel epenthesis – such as the approximant + nasal sequence (73.3% CvC production) – or only slightly produced with vowel epenthesis, as in the approximant + fricative, approximant + stop, and approximant + affricate sequences (13.3-33.3% CvC production). This low rate might be attributed to the frequency of these combinations in NK rather than the homogeneity of the place of articulation of the consonants involved. In other words, the selected sequences or the words used in these sequences may be high-frequency sequences or words. In sequences that violated the SSP, such as stop + nasal, stop + approximant, fricative + approximant, and fricative + nasal, no clear effect of sequence combination was observed, possibly because the given sequences violated the SSP. Despite this, vowel insertion was generally less frequent in coda sequences than in onset sequences.

All in all, the investigation into the impact of SSP violation, consonant sequence combinations, and sequence positions on the perception and production of native NK onset and coda sequences yielded nuanced findings. While the initial hypothesis anticipated a predominant influence of SSP violation over other factors, the results presented a more intricate picture. Notably, while the SSP played an important role in the production of coda sequences, its influence on onset sequences was less obvious. Sequence combinations also demonstrated varying effects, with certain combinations consistently eliciting epenthetic vowel insertion, particularly in onset positions. Additionally, the study found that vowel insertion was more frequent in onset positions compared to coda positions, suggesting a higher susceptibility to vocalic elements in the former. NK may have mirrored Arabic in imposing strict constraints on the formation of onset clusters while maintaining more lenient restrictions on coda clusters. Although these languages are not genetically related, their coexistence in the Kurdistan region of Iraq has likely led to a convergence in phonotactic patterns under the Sprachbund effect. In NK, only the fricative /s/ + stop combination, often described as occupying an extrasyllabic position (Giegerich, 1992; Kenstowicz, 1994), is permitted as an onset cluster. Consequently, this restriction results in a higher occurrence of epenthetic vowels in other onset combinations and a diminished influence of the SSP. Conversely, NK imposes fewer constraints on coda clusters (Shokri, 2002), allowing the SSP to function as a reliable phonological predictor for the sequencing of consonant clusters in NK coda positions.

5.1.4. RQ.4: The Relationship between the Perception and Production of NK Consonant Sequences.

The fourth research question addressed the relationship between the perception and production of the sequences tested to determine which sequence(s) could potentially constitute an actual cluster or not, that is, to finally determine the cluster status of the sequences tested. Specifically, the relationship between the perception and production of 10 onset sequences – i.e., approximant + fricative, nasal + fricative, stop + stop, fricative + stop, stop + nasal, fricative + nasal, nasal + approximant, stop + approximant, fricative + approximant and stop + fricative – and 5 coda sequences – i.e., – stop + nasal, stop + approximant, fricative + approximant, fricative + nasal and approximant + nasal, was examined. These specific combinations were selected as they were both perceptually and acoustically examined. As anticipated, a strong positive correlation was found between the perception and production of these sequences. Furthermore, an analysis of individual data revealed a strong association between perception and production values for the majority of the sequences tested.

The results for all onset combinations, except the fricative + stop combination, indicated that these sequences are unlikely to form actual onset clusters in NK because of the consistent production of vowel insertion in these sequences (60-100% of CvC production) and the strong preference for stimuli with a vocalic element (86-100% of CvC perception). Although the affricate + nasal sequence was not tested in the perception task, the substantial occurrence of vowel epenthesis in this sequence (80% of CvC production) suggests that it is also unlikely to form an actual onset cluster. Thus, the only onset combination exhibiting characteristics of a true cluster is the fricative /s/ + stop sequence, which was neither perceptually preferred with vowel epenthesis (0% CvC perception) nor produced with vowel epenthesis (0% CvC production).

Regarding coda combinations, all these sequences: stop + nasal, stop + approximant, fricative + approximant, fricative + nasal, and approximant + nasal are very unlikely to form actual coda clusters in NK because of the consistent occurrence of vowel insertion within these sequences (73.3-100% of CvC production) and the prevalent preference for stimuli containing a vocalic element (67-76% of CvC perception). The production results for the remaining 6 coda sequences, which were not perceptually tested – i.e., affricate + stop, approximant + fricative, approximant + stop, approximant + affricate, fricative + stop, and nasal + stop – yielded partial insights into their cluster status. The affricate + stop sequence showed moderate occurrence of vowel insertion (60% of CvC production), yet its adherence to the SSP suggests it is unlikely to prevent its potential as an actual coda cluster. Further investigation, possibly involving a broader range of words, may be required to better determine its cluster status in NK. Conversely, the findings for sequences with an approximant as the first element – approximant + fricative, approximant + stop, and approximant + affricate – suggest a variable cluster status. While they displayed a slight occurrence of vowel insertion (13.3-33.3%) and adhered to the SSP, indicating potential as actual clusters, they were occasionally broken by a vocalic element. Although not assessed in the perception task, it can be confidently stated that, among all coda combinations, the only sequences forming actual clusters in the coda position are the fricative + stop and nasal + stop combinations, as they were never produced with a vocalic element.

In summary, it appears that among onset combinations, only the fricative /s/ + stop combination can be conclusively considered an actual cluster, while the likelihood of others forming clusters is low. Regarding coda combinations, the fricative + stop and nasal + stop combinations can be confidently classified as actual clusters. However, the cluster status of the remaining coda combinations is either variable or requires further examination involving a broader range of words to be definitively determined.

5.1.5. RQ.5: Production of English Onset Consonant Clusters by Kurdish EFL Learners

The fifth research question focused on the production of English 2-consonant onset clusters (RQ.5.1), 3-consonant onset clusters (RQ.5.2), and the influence of factors such as L1 transfer, the SSP, and markedness (RQ.5.3) on the production of these clusters. It was hypothesised that English 2-consonant clusters, determined as non-clusters in the L1 study, would pose more challenges for Kurdish learners, leading to frequent epenthesis (L1 negative transfer). This phenomenon was predicted to be more prominent among learners in the early stages of language acquisition, in accordance with the predictions of the Ontogeny Phylogeny Model (Major, 2001). Conversely, L1 positive transfer from Kurdish was expected in the acquisition of English consonant combinations that were identified as true clusters in the L1 study.

Among 2-consonant clusters and based on the Minimal Sonority Distance principle (Broselow & Finer, 1991), English onsets consisting of greater sonority differences between their members – i.e., less marked structures – were expected to be less challenging and accordingly produced more accurately than those with a smaller sonority difference between their members – i.e., more marked structures. However, the production of the English sonority reversal in the fricative /s/ + stop onset cluster was not expected to be problematic, despite constituting a sonority reversal (Carlisle, 2001), as this sequence had been perceptually and acoustically validated as a true cluster in the L1 study. Consequently, it was hypothesised that the effect of L1 positive transfer would supersede the influence of the SSP in the production of this particular sequence.

Regarding the production of English 3-consonant onset clusters, it was anticipated that Kurdish EFL learners would acquire these sequences later or modify them more frequently than shorter sequences. This expectation was based on the fact that such clusters do not exist in Kurdish (Shokri, 2002; Hasan, 2009, 2012) and are widely recognised as universally marked structures (Greenberg, 1965; Kaye & Lowenstamm, 1981). Furthermore, it was predicted that Kurdish learners would predominantly use epenthesis as their primary and preferred simplification strategy, with the inserted vowel corresponding to the epenthetic vowels identified in the L1 study as a means to repair illicit consonant sequences.

The hypotheses of the study concerning the production of 2-consonant clusters were partially confirmed. Firstly, the influence of L1 positive transfer was evident in the production of all fricative /s/ + stop clusters in /st-/, /sk-/, /sp-/ combinations. Specifically, these clusters were always produced accurately, as they never induced vowel epenthesis in any of the tokens produced by the participants. Despite their absence in the L1, the production of the remaining 2-consonant clusters was not generally challenging for all participants, and the results obtained for these sequences did not completely support the predictions of the Minimal Sonority Distance principle (Broselow & Finer, 1991). Specifically, decreasing levels of sonority between the members of a cluster did not consistently lead to an increased production of non-target clusters. Cluster combinations with a sonority difference of 3, such as fricative + approximant /l/, showed a higher percentage of non-target productions compared to those with a sonority difference of 2, like fricative /s/ + nasal, contrary to the Minimal Sonority principle. The absence of a sonority difference effect in these combinations can be accounted for in light of Yavaş and Somaillan's (2005) proposal. These authors argue that nasals, being more closely related to stops than to fricatives due to their shared [-continuant] feature, lead L2 learners to group clusters containing these consonants together in terms of production ease or difficulty. Consequently, fricative /s/ + stop and fricative /s/ + nasal clusters present similar levels of production difficulty for L2 learners. This likely explains why the participants in this study found both groups similarly easy to produce. However, the Minimal Sonority Distance predictions were maintained by sonority differences 4, 5, and 6, where the percentages of non-target productions aligned closely with expectations.

The study's hypothesis regarding the production of English 3-consonant onset clusters was fully confirmed. Both the Markedness Differential Hypothesis (Eckman, 1977) and the Structural Conformity Hypothesis (Eckman, 1991) were validated, as 3-consonant clusters were found to be more challenging than 2-consonant onsets. The absence of 3-consonant clusters in NK (Shokri, 2002; Hasan, 2009, 2012) and their universal markedness (Greenberg, 1965; Kaye & Lowenstamm, 1981) likely contributed to this difficulty. These findings align with other studies (Eckman, 1991; Carlisle, 1997, 1998, 2002; Hancin-Bhatt, 2000; Rauber & Baptista, 2004; Alosaimi, 2023). Additionally, the results indicate that markedness based on syllable margin length had a greater impact than markedness based on sonority. That is, sonority reversals were consistently accurately produced, while clusters with varying sonority levels only minimally followed the Minimal Sonority Distance predictions.

Irrespective of considerations of markedness effects, an analysis aimed at identifying challenging clusters revealed that only six clusters posed some difficulty: /gl-/, /bl-/, /fl-/, /sl-/, /spr-/, and /skr-/. In contrast, the remaining clusters were either slightly challenging – i.e., /sm-/, /sn-/, /fr-/, /pr-/, /br-/, /kr-/, /tr-/, /str-/, and /spl-/ – or not challenging at all – i.e., /st-/, /sk-/, /sp-/, /pl-/, and /θr-/. The challenges associated with /gl-/, /bl-/, and /fl-/clusters could not be attributed to L1 negative transfer alone, as these clusters were not the only clusters absent in the participants' L1. A potential factor could be the methodological limitations outlined in section 5.2. The results for these three clusters were based on reading a single word. If these clusters had been included in the verbal fluency task, where more examples could be produced, there would have been more evidence to support this outcome. Another factor that may have influenced the production of the /gl/ cluster, in particular, is the regular use of the English loanword 'glass' in NK, where the /gl-/ cluster is often broken up through epenthesis, resulting in a pronunciation like /gɨlɑːs/. As a result, participants in this study may have adopted this pronunciation when producing the target language cluster. Similarly, interference from the native language may better explain the difficulty associated with the /sl-/ cluster. In NK, the sequence /sl-/ is epenthesised in the word for greetings, /sɨlav/, which, to the best of my knowledge, is the only Kurdish word containing this consonant combination and is often interrupted by an epenthetic vowel. The frequency of this word in the participants' native language may have affected their pronunciation of the same sequence as a cluster in their target language.

Finally, the increased difficulty in producing the /spr-/ and /skr-/ clusters compared to /str-/ and /spl-/ can be partially attributed to cluster frequency. In the Brown online corpus (Kucera & Francis, 1967), the /spr-/ cluster appears 43 times, the /skr-/ cluster 70 times, and the /str-/ cluster 194 times. This suggests that the lower the frequency of a cluster, the more challenging it is to produce. However, this pattern does not hold for the /spl-/ cluster, which, despite being the least frequent in the corpus (31 instances), was the least challenging among the 3-consonant clusters. A possible explanation for the relative ease of producing the /spl-/ cluster may lie in the number of tokens generated during the verbal fluency task. Specifically, only 16 words containing the /spl-/ sequence were produced, compared to 42 tokens for /spr-/, 63 tokens for /skr-/, and 67 tokens for /str-/. If more /spl-/ words had been produced, a more representative sample might have revealed a different difficulty level for this cluster.

In relation to the effect of production tasks, this study found no significant difference in non-target cluster productions between the reading task and the verbal fluency task, suggesting that neither complete written input (sentence reading task) nor partially written input (phonemic verbal fluency task) influenced how the participants produced the target clusters. The participant sample, which comprised English major students, may have influenced these findings. These students did not generally find the production of English onset clusters, whether marked or less marked, particularly challenging. Their phonetics classes likely enhanced their overall pronunciation skills, including their ability to produce English clusters. Furthermore, it is plausible that these participants benefited from instructors who might have served as effective pronunciation models.

Finally, the acoustic analysis of the identified epenthetic vowels revealed significant differences in duration and formant frequencies compared to the corresponding main vowels. The epenthetic vowels exhibited shorter durations, approximately one-third that of the main vowels, and distinct spectral characteristics, with F1 and F2 values largely unaffected by the main vowels. These findings indicated that the inserted vowels likely represented a common epenthetic vowel, and displayed acoustic properties characteristic of the L1 vowel /ɨ/.

Overall, the EFL participants in this study did not generally find the production of the selected clusters challenging, with only a few sequences posing difficulty. Consequently, there was no clear effect of L1 negative transfer or the Minimal Sonority Distance principle, especially in relation to 2-consonant clusters. This could be attributed to two main factors. Firstly, the participants' prior knowledge of English phonetics likely enhanced their ability to accurately produce English clusters. Secondly, the small number of words tested per cluster combination. However, the study did observe an effect of L1 positive transfer and markedness based on syllable margin length, despite relatively low rates of inaccurate cluster production.

5.1.6. RQ.6: The Relationship Between L2 Proficiency and the Production of English Onset Consonant Clusters by Kurdish EFL Learners.

The final research question addressed the relationship between L2 proficiency and the production of L2 onset clusters. This study followed the assumption of the Ontogeny Phylogeny Model (Major, 2001) and hypothesised that Kurdish learners with better L2 proficiency levels would exhibit more native-like patterns in producing both marked and less marked English clusters. In other words, with increased proficiency, the influence of L1 was expected to decrease, along with a reduced impact of language universals/markedness. The participants' L2 proficiency was assessed by the use of an Elicited Imitation task (EIT) – which tested their oral language knowledge – and a vocabulary task, which measured their vocabulary size. Since both task results were not correlated, the association between EIT scores and inaccurate cluster production was examined separately, as was the association between vocabulary scores and production accuracy.

The study's hypothesis was partially confirmed: no significant association was found between EIT scores and non-target cluster production. These findings can be explained by two factors. First, the EIT task assesses oral language proficiency, and the participants, having never lived or studied abroad, likely had limited exposure to native language environments. This may have led to less developed listening and/or speaking skills. Second, participants' performance declined with longer sentences, suggesting a reliance on rote repetition, particularly from the 11th sentence onward. Therefore, longer sentences may have exceeded the participants' comprehension and production abilities, leading those with lower proficiency to rely on rote repetition (Yan et al., 2016).

Vocabulary knowledge was more closely linked to cluster production than the measure provided by the EIT. A weak but statistically significant association was found between vocabulary knowledge and L2 cluster production. This suggests that participants' lexical knowledge may have enhanced their familiarity with a broader range of words and their phonological structures, including clusters. This finding aligns with Bundgaard-Nielsen et al. (2011), who identified a relationship between L2 vocabulary knowledge and L2 vowel intelligibility. However, it contrasts with the results of Uchihara and Saito (2019) and Mariano and Santiago (2020), who found correlations between vocabulary size and speech rate, but not with ratings of accent, comprehensibility, or foreign accentedness.

Finally and given that the participants did not generally find L2 cluster production challenging, the predictions of the Ontogeny Phylogeny Model (Major, 2001) cannot be confirmed or disproven due to the participants' generally non-challenging experience in producing L2 clusters. Two potential factors could explain why the participants' proficiency levels did not appear to significantly impact their production of the tested clusters. Firstly, it is possible that the participants' prior knowledge of English phonetics could have enhanced their ability to produce English clusters accurately. Secondly, the sample size of 32 participants might have been insufficient to detect subtle differences in L2 cluster production accuracy. With a larger sample size, more obvious variations in L2 cluster production could potentially be observed, thereby revealing a potential role of L2 proficiency. Some of these issues are discussed further in the next section.

5.2. Limitations and Further Research

The studies comprising this thesis have a number of methodological limitations that could be addressed in future research. One of the main limitations of the L1 study was the small number of words included in the tasks, with sometimes one example of word per sequence combination, and the uneven distribution of SSP-obeying vs SSP-adhering sequence combinations. As a result, no clear effect of the SSP, particularly on the perception of the tested sequences, was found. For instance, contrary to universal predictions, all onset sequences violating the SSP – including the fricative /s/ + stop combination – were perceived as more typically NK in the absence of an epenthetic vowel than sequences adhering to the SSP. In the same way, the effect of the SSP on the perception of coda sequences could not be thoroughly examined, as only one sequence adhering to the SSP was tested. Therefore, future research should involve more words per sequence combination and more sequences to determine better the SSP's effect on the perception of onset and coda sequences in NK.

Another issue with the sequences tested was that not all coda sequences included in the production tasks were also included in the perception task. Although this was necessary due to the limitations imposed by the 2020 pandemic, it would have been better for example to include the affricate + stop combination in the perceptual analysis as well. This combination's acoustic analysis results did not determine its cluster status as it was only moderately produced with a vocalic element. Future research should involve a wider selection of words for each sequence combination and perceptual testing of all sequences. This approach will provide more comprehensive data, thereby offering a clearer determination of whether the given sequences indeed constitute actual clusters.

A further limitation of the L1 study was the relatively small sample size (15 people). Although the selected participants demonstrated consistent perception and production of the tested sequences, the results, particularly from the perception tests, should be interpreted with caution. There were two main reasons for not analysing a larger sample size. First, due to COVID-19 and Spanish residency travel restrictions, the researcher was unable to travel to Kurdistan to collect the data in person. Consequently, the data collection process had to be conducted with the help of a colleague from the English Department at Zakho University, supervised distantly by the author of this thesis through e-mail and other means of communication. Second, the lack of funds to compensate participants further hindered the recruitment of a larger sample size.

Similar to the L1 study, the L2 study had several limitations that could be addressed in future research. One of the main limitations was the absence of a perceptual task, which was initially included in the analysis but later discarded to simplify task implementation because the L2 tasks, similar to the L1 tasks, also had to be conducted remotely with the assistance of a faculty member from the English Department at Zakho University. Although the EFL participants in this study generally did not have difficulty producing the L2 clusters, it remains to be seen whether their perception of these clusters is equally overall accurate, considering previous studies, such as Sperbeck (2010) and Silveira (2013), which found a strong link between the perception and production of L2 English clusters among Japanese and Brazilian learners of English, respectively.

Another limitation to acknowledge is that fewer sequences were tested in the phonemic verbal fluency task compared to the reading task. This decision was made to control the duration of the fluency task as much as possible. Our fluency task was 2 minutes and 30 seconds long – 10 seconds per cluster – which was already a deviation from the standard 1-minute time span in a standard fluency task. It is possible that the results for sequences like the voiced stop + approximant combinations in /gl-/ and /bl-/ and the fricative + approximant combination in /fl-/ were different because they were based only on reading a single word in the reading task. These clusters were among the hardest to produce. However, the results for these clusters might have been different if they had been included in the verbal fluency task, where more examples of these clusters in other English words could have been produced. Again, the task limitations described were partly the consequence of the difficulty of carrying out an empirical study during the pandemic and remotely.

Finally, it should be noted that only 32 English major students were tested to represent Kurdish EFL learners in this study. Ideally, more participants would have been preferable, particularly given the relatively small amount of data collected per cluster condition, and also with regards to the lack of greater differences in proficiency. Future research should involve a larger and more diverse group of Kurdish EFL learners, including those from lower proficiency levels. Additionally, controlling for other learner variables, such as exposure to authentic English, frequency of L2 use, and other factors related to L2 acquisition (as discussed by Piske et al., 2001; Flege & Bohn, 2021) could provide more comprehensive insights into the challenges of producing English consonant clusters by Kurdish EFL learners.

5.3. Implications and Final Conclusions

The L1 study in this thesis makes two main contributions to the field of Kurdish phonology. The first concerns the importance of settling the cluster status of certain onset and coda sequences in NK. This study is the first of its kind that has experimentally investigated – perceptually and acoustically – the actual cluster status of NK onset and coda combinations. Previous studies (e.g., Shokri, 2002; Kahn, 1976; Hasan, 2009) have only analysed the status of these consonant combinations as clusters in NK theoretically, and as a result, inconsistent descriptions were available in the literature about the actual cluster status of these combinations. Furthermore, the current thesis not only settled the cluster status of these sequences but also provided relevant implications for the acquisition of foreign onset and coda clusters by adult Kurdish learners. In light of these results, the effect of the L1 was investigated in the acquisition of English clusters in this study (L2 study). The second important contribution of this study involves the acoustic analysis conducted on the epenthetic vowel in NK. To my knowledge, only Hamid (2016) had previously provided a small-scale acoustic analysis of lexical vowels in Kurdish. However, Hamid's study did not examine the acoustic characteristics of the epenthetic vowel and involved only five participants. In contrast, the results of this study are based on data from 15 participants. Understanding the acoustic characteristics of vowels can aid in teaching Kurdish as a second/foreign language. Additionally, knowledge of the acoustic properties of Kurdish vowels can assist speech-language pathologists in diagnosing and treating speech disorders in Kurdish-speaking individuals.

Regarding the contribution of the L2 study in this thesis, it is relevant to the field of L2 speech acquisition in that it investigated the effect of L2 proficiency on L2 cluster production in the context of Kurdish EFL learners. As a matter of fact, to my knowledge, no previous studies – except (Nasr, 2011) – have investigated the effect of L2 proficiency among Kurdish EFLs. Furthermore, the current thesis did not only examine proficiency role in L2 cluster production, but rather used two different measures of language knowledge, procedural knowledge through the EIT task, and vocabulary knowledge. In Nasr's study, L2 proficiency was measured rather vaguely using the number of English major study years, which is more likely to overlook important individual proficiency differences. Another contribution of this study is its examination of L2 English cluster production after first analysing L1 clusters. This approach allowed for a more comprehensive evaluation of the influence of L1, along with other factors such as markedness – an aspect not addressed in previous research. A further contribution of this study concerns examining the acoustic characteristics of the epenthetic vowel used by Kurdish EFL. The acoustic characteristics of this vowel have been understudied in the literature, especially when it comes to Kurdish learners. As a matter of fact, to my knowledge, no previous study has examined the nature of the inserted epenthetic vowel by Kurdish EFLs.

Finally, the outcomes of the L2 study in this thesis have some implications for understanding the role of L2 proficiency, additional factors, and L2 instruction on cluster production. The primary factor examined in this thesis was L2 proficiency, measured through an EIT task and a vocabulary task. The results indicated that the EIT task did not impact L2 cluster production, while vocabulary knowledge had a moderate effect. This suggests that other factors, such as L2 instruction and pronunciation teaching, may also play a role in influencing L2 cluster production.

In conclusion, this thesis has analysed the perception and production of L1 NK consonant sequences and the production of the L2 English clusters by Kurdish EFL learners. Perception and production results were very much aligned for the L1 study revealing that only three sequences – namely fricative + stop in the onset and coda positions and nasal + stop in the coda position – acted consistently as actual clusters, as they never triggered vowel epenthesis in any of the tokens produced by all participants, nor were they perceptually perceived.

The findings regarding the remaining sequences tested provide no support for previous analyses that described these sequences as actual clusters given the preference for the presence of an epenthetic vowel. Thus, previous descriptions of NK should be revisited. Furthermore, the study did not identify a significant role of the SSP or sequence combinations in the perception and production of onset sequences, possibly because these combinations were mischaracterised as actual clusters in earlier studies, especially in Hasan (2009). The influence of the SSP and sequence combinations was more obvious with coda combinations, potentially supporting Shokri's (2002) claim that the phonotactic constraints within NK exhibit greater flexibility towards the formation of coda clusters compared to onset clusters.

Key findings regarding the production of L2 clusters revealed that participants in this study did not generally find the production of 2-member clusters challenging. Consequently, interference from the native language did not play an important role. However, markedness based on sonority appeared to be more influential, although its effect was not consistently observed across all 2-member cluster productions. Additionally, the role of the SSP was not effective, as sonority reversals in fricative /s/ + stop onset clusters were consistently produced in a native-like manner by all participants. This consistency may be attributed to the confirmation of this same sequence as an actual cluster in the L1 study, potentially reflecting positive transfer from the native language. Moreover, the study found that markedness effects based on syllable margin length were more influential than those based on sonority. Specifically, the production of 3-member clusters proved to be more challenging than that of 2-member clusters, supporting both the Markedness Differential Hypothesis (Eckman, 1977) and the Structural Conformity Hypothesis (1991). The study also found that the EFL participants in this study resorted primarily to vowel epenthesis as their only method of simplifying L2 clusters. Furthermore, the acoustic analysis of these epenthetic vowels revealed distinct durations and formant frequencies compared to their corresponding main vowels, indicating the transfer of L1 epenthetic vowel characteristics into L2. Finally, regarding the role of L2 proficiency, vocabulary knowledge was found as a more relevant factor for L2 cluster production than oral proficiency knowledge as measured by the EIT task. However, the generally high performance of the participants in this thesis indicated that the effect of L2 proficiency on cluster production might be less obvious among learners with prior phonetics training. Future work will need to verify some of the main outcomes of the current study by including a larger set of words per cluster condition. In addition, the study could be extended to a greater variety of L2 proficiency levels and also to other data collection methods such as more spontaneous speech samples. Still, this study remains to date the most comprehensive study examining the status of consonant cluster sequences in native NK and the production of L2 English clusters by native speakers of NK.

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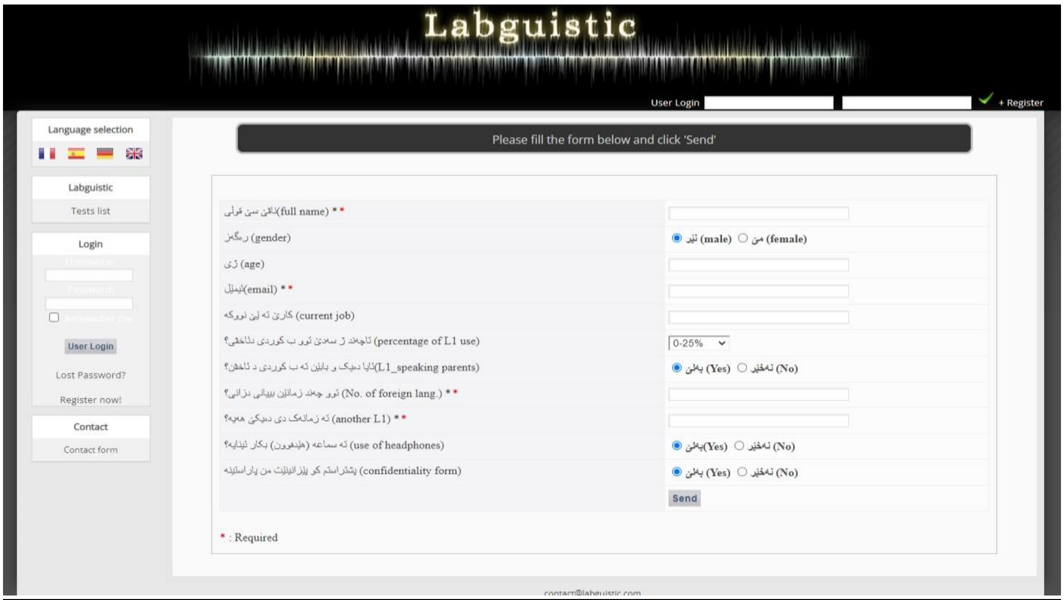
Appendices

Appendix A. Participants' information form, statement of confidentiality, and statement of consent in the L1 study.

Appendix A1. A screenshot of the participants' information form using the Labguistic online platform. An English translation is provided below the screenshot.



Full name:___________________________
Gender:_____________________________
E-mail:_____________________________
Current job:_________________________
Percentage of L1 use:_________________
Another L1:__________________________
L1 speaking parents: __________________
Number of foreign language(s): _________
Use of headphones: ___________________
Confidentiality form:__________________

Appendix A2. Statement of confidentiality in the L1 study (An English translation is provided below the Kurdish text).

<u>نهێنییا پێزانینێت کەسایەتی</u>

ناڤێ پشکداری یان پشکدارێ ناهێتە ئاشکرا کرن و بکارئینان دڤێ ڤەکولینێ دا ، و هەروەسا هەمی جورێن پێزانینێت کەسایەتی ڤەشارتینە و پاراستینە، بتنێ ڤەکوولەرا ماف هەیە بەرسڤێت پشکداری یان پشکدارێ بکاربهینن بو مەراما ڤەکولینێ بێ ناڤ بهێتە دیارکرن.

Your name and other information gathered in this study will not be disclosed to anyone other than the investigator and his/her collaborators, and will only be used for statistical purposes without reference to individual participants' personal information.

Appendix A3. Statement of consent in the L1 study (An English translation is provided below the Kurdish text).

<u>فورما رازیبوونێ</u>

ئەز ______________________ رازیمە پشکدارببم ل ئەڤێ ڤەکولینێدا.
ئە ز پێ ئاگەهدارم کوو دەنگێ من دێ هێتە توومارکرن، وهەروەسا ئەز پشتراستم پێزانینێت کەسایەتییێت من پاراستینە و بەرسڤێت من دێهێنە بکارئینان بێ ئاشکرا کرنا ناڤێ من.

مێژوو:_______________

واژوو_______________

I, ____________________________ agree to take part in this speech perception and production study. I understand that the investigator may record my production. I understand that my name and my specific answers will remain confidential and that I will not be identified in any report or presentation that may arise from the study.

Date:______________

Signature:__________

Appendix B. Words used in the L1 perception and production tasks.

Word	Grammatical category	Gloss	Sequence position	Sequence combination	SSP violation	Task
/dæst/	Noun	hand	Coda	fricative + stop	No	picture-naming
/kʊʧk/	Noun	palace	Coda	affricate + stop	No	sentence reading
/ʃæɾm/	Noun	shyness	Coda	approximant + nasal	No	sentence reading & perception
/ʤæʒn/	Noun	Eid	Coda	fricative + nasal	Yes	picture-naming, sentence reading & perception
/bæfɾ/	Noun	snow	Coda	fricative + approximant	Yes	picture-naming, sentence reading & perception
/tʰæqn/	Noun	mud	Coda	stop + nasal	Yes	picture-naming, sentence reading & perception
/kæpɾ/	Noun	pergola	Coda	stop + approximant	Yes	picture-naming, sentence reading & perception
/gʊnd/	Noun	village	Coda	nasal + stop	No	sentence reading
/mæɾʤ/	Noun	condition	Coda	approximant + affricate	No	sentence reading
/biɾs/	Noun	hanger	Coda	approximant + fricative	No	sentence reading
/bælg/	Noun	leaf	Coda	approximant + stop	No	picture-naming
/pʰtiɾ/	Determiner	more	Onset	stop + stop	Yes	sentence reading & perception
/pʰʃik/	Noun	cat	Onset	stop + fricative	No	sentence reading
/bnɑɣ/	Noun	basis	Onset	stop + nasal	No	sentence reading & perception
/znɑɾ/	Noun	personal name	Onset	fricative + nasal	No	sentence reading
/sɾuʃt/	Noun	nature	Onset	fricative + approximant	No	sentence reading & perception
/mɾiʃk/	Noun	chicken	Onset	nasal + approximant	No	picture-naming, sentence reading & perception
/nveʒ/	Noun	prayer	Onset	nasal + fricative	Yes	picture-naming, sentence reading & perception
/kʰɾɑs/	Noun	dress	Onset	stop + approximant	No	sentence reading
/lvin/	Infinitive verb	movement	Onset	approximant + fricative	Yes	sentence reading & perception
/spi/	Adjective	white	Onset	fricative + stop	Yes	picture-naming & sentence reading
/ʧnɑɾ/	Noun	a tree name	Onset	affricate + nasal	No	sentence reading
/pʰdi/	Noun	gum	Onset	stop + stop	Yes	picture-naming
/tri/	Noun	grape	Onset	stop + approximant	No	picture-naming
/ɾʒɑndɨn/	Infinitive verb	to spill	Onset	approximant + fricative	Yes	picture-naming
/tʰfæɳg/	Noun	rifle	Onset	stop+ fricative	No	picture-naming & perception
/bɾin/	Noun	wound	Onset	stop + approximant	No	perception
/snel/	Noun	teenage	Onset	fricative + nasal	No	perception
/steɾ/	Noun	star	Onset	fricative + stop	Yes	perception

Table B. Words used in the L1 study with their grammatical categories and glosses. Specifications of the target sequences (position, combination, and SSP violation) are also given.

Appendix C. L1 production elicitation lists.

Appendix C1. Carrier sentence reading task lists (filler words are not included).

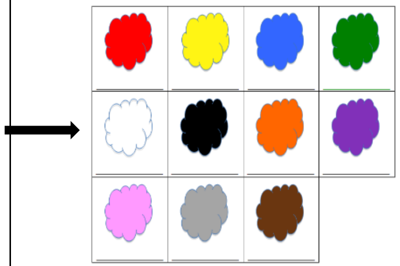
Read the following sentences twice:

1. I am saying more now.
2. I am saying cat now.
3. I am saying basis now.
4. I am saying palace now.
5. I am saying Zinar now.
6. I am saying nature now.
7. I am saying chicken now.
8. I am saying prayer now.
9. I am saying movement now.
10. I am saying shyness now.
11. I am saying Eid now.
12. I am saying dress now.
13. I am saying snow now.
14. I am saying mud now.
15. I am saying pergola now.
16. I am saying white now.
17. I am saying village now.
18. I am saying condition now.
19. I am saying hunger now.
20. I am saying Chinar now.
21. I am saying hand now.

ئەڤان ڕستان دوو جاری بخوینە:

١. ئەز دبێژم پتر نووکە.
٢. ئەز دبێژم پشیک نووکە.
٣. ئەز دبێژم بناغ نووکە.
٤. ئەز دبێژم کوچک نووکە.
٥. ئەز دبێژم زنار نووکە .
٦. ئەز دبێژم سرووشت نووکە.
٧. ئەز دبێژم مریشک نووکە.
٨. ئەز دبێژم نڤێژ نووکە.
٩. ئەز دبێژم لڤین نووکە .
١٠. ئەز دبێژم شەرم نووکە.
١١. ئەز دبێژم جەژن نووکە.
١٢. ئەز دبێژم کراس نووکە.
١٣. ئەز دبێژم بەفر نووکە .
١٤. ئەز دبێژم تەقن نووکە.
١٥. ئەز دبێژم کەپر نووکە.
١٦. ئەز دبێژم سپی نووکە.
١٧. ئەز دبێژم گوند نووکە.
١٨. ئەز دبێژم مەرج نووکە.
١٩. ئەز دبێژم برس نووکە.
٢٠. ئەز دبێژم چنار نووکە.
٢١. ئەز دبێژم دەست نووکە.

Appendix C2. Picture-naming task lists.

Illustrations	Picutres	Illustrations	Picutres
Someone performing a Muslim prayer, to elicit the word /nveʒ/ ‘prayer’.		Spilled coffee, to elicit the word /ɾʒɑndɨn/ ‘to spill’.	
An arrow pointing to the color white to elicit the word /spi/ ‘white’.		A cluster of grapes, to elicit the word /tri/ ‘grape’	
A human gum, to elicit the word /$\mathrm{p^{h}di}$/ ‘gum’.		A rifled gun, to elicit the word /$\mathrm{t^{h}}$fæŋg/ ‘rifle’.	

A hen, to elicit the word /mɾiʃk/ ‘hen/chicken’.		A side garden with a pergola, to elicit the word /kæpɾ/ ‘pergola’.	
A ‘Happy Ramadhan Eid’ statement, to elicit the word /ʤæʒn/ ‘Eid’.		A human hand, to elicit the word /dæst/ ‘hand’.	
A ‘muddy road’, to elicit the word /tʰæqn/ ‘mud’.		A tree leaf, to elicit the word /bælg/ ‘leaf’.	

Appendix D. Mean F1 and F2 (unnormalised Hz values and normalised scaled back to Hz-like values) for each epenthetic vowel and its corresponding main vowel for L1 (D1) and L2 (D2) participants.

Speaker	Epenthetic vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2	Main vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2
S1	epV_ɑ	454	341	1560	1397	ɑ	640	454	1040	1012
	epV_æ	493	365	1449	1315	æ	600	430	1452	1317
	epV_e	412	315	1668	1477	e	450	338	1918	1663
	epV_ɨ	432	328	1658	1469	ɨ	437	330	1512	1361
	epV_i	404	310	1808	1581	i	333	267	2190	1864
	epV_ʊ	422	321	1756	1543	ʊ	389	301	1271	1183
	epV_u	433	328	1341	1235	u	408	313	1058	1025
S4	epV_ɑ	412	349	1621	1312	ɑ	517	418	1209	1059
	epV_æ	449	374	1770	1404	æ	556	443	1655	1333
	epV_e	387	333	1688	1353	e	396	339	1975	1530
	epV_ɨ	372	323	1605	1302	ɨ	412	349	1669	1342
	epV_i	342	303	1939	1508	i	286	267	2379	1778
	epV_u	327	294	1780	1410	u	300	277	1147	1021
S5	epV_ɑ	341	345	1679	1356	ɑ	414	362	1457	1210
	epV_æ	479	377	1729	1389	æ	565	398	1624	1320
	epV_e	375	353	1777	1420	e	404	360	1942	1529
	epV_ɨ	290	332	1785	1426	ɨ	274	329	1675	1353
	epV_i	335	343	1875	1485	i	255	324	2201	1699
	epV_ʊ	469	375	1958	1539	ʊ	372	352	909	850
	epV_u	261	325	1785	1426	u	315	338	1126	993
S8	epV_ɑ	272	327	1719	1321	ɑ	471	362	1142	1000

	epV_æ	448	358	1829	1383	æ	801	421	1809	1372
	epV_e	230	319	1771	1350	e	426	354	1886	1415
	epV_ɨ	1790	599	2894	1977	ɨ	520	371	1770	1350
	epV_i	270	326	1969	1461	i	236	320	2350	1674
	epV_ʊ	921	443	2145	1559	ʊ	171	309	1249	1059
	epV_u	248	322	1743	1335	u	277	328	1379	1131
S10	epV_ɑ	431	332	1566	1235	ɑ	630	423	1251	963
	epV_æ	479	354	1617	1280	æ	691	452	1687	1340
	epV_e	395	315	1893	1519	e	433	333	2089	1688
	epV_i	420	327	1911	1534	i	332	286	2178	1766
	epV_ʊ	399	317	1953	1571	ʊ	380	309	1317	1020
	epV_u	394	315	1733	1380	u	383	310	1485	1165
S12	epV_ɑ	352	342	1565	1370	ɑ	452	376	1040	982
	epV_æ	393	356	1569	1373	æ	488	388	1467	1297
	epV_e	366	347	1514	1332	e	403	359	1664	1442
	epV_ɨ	344	340	1537	1349	ɨ	399	358	1513	1331
	epV_i	538	405	1910	1624	i	276	317	1931	1640
	epV_u	344	339	1594	1391	u	276	317	1012	962
S15	epV_ɑ	412	337	1673	1304	ɑ	673	481	1256	1023
	epV_æ	449	357	1679	1308	æ	566	422	1669	1301
	epV_e	371	315	1822	1404	e	402	332	2126	1608
	epV_ɨ	409	335	1721	1336	ɨ	452	359	1662	1297
	epV_i	393	326	2047	1555	i	328	291	2578	1913
	epV_ʊ	379	319	1474	1170	ʊ	387	323	1856	1427
	epV_u	399	330	1741	1349	u	369	313	1462	1162

Table D1.1. Mean F1 and F2 (unnormalised and normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels per male speaker. 'epV_x' refers to epenthetic vowels, with 'x' representing the main vowel within the word.

Speaker	Epenthetic vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2	Main vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2
S2	epV_ɑ	463	440	1947	1453	ɑ	505	472	505	969
	epV_æ	558	513	1980	1473	æ	690	613	690	1480
	epV_e	417	405	2181	1599	e	422	409	422	1855
	epV_ɨ	415	404	2051	1518	ɨ	566	519	566	1619
	epV_i	406	397	2349	1704	i	358	360	358	1937
	epV_u	390	385	1981	1475	u	328	338	328	954
S3	epV_ɑ	517	482	1589	1473	ɑ	503	470	952	1223
	epV_æ	520	485	1658	1500	æ	660	600	1751	1537
	epV_e	510	476	2049	1653	e	435	414	2015	1640
	epV_ɨ	488	457	659	1108	ɨ	597	549	1869	1583
	epV_i	437	416	1984	1628	i	371	361	1708	1520
	epV_ʊ	436	415	3181	2098	ʊ	377	366	995	1239
S6	epV_ɑ	336	401	1979	1334	ɑ	436	482	2599	1740
	epV_æ	438	483	2112	1421	æ	594	608	2058	1386
	epV_e	374	432	2142	1441	e	444	488	2390	1603
	epV_ɨ	377	434	2086	1404	ɨ	422	471	1988	1339
	epV_i	395	449	2324	1560	i	297	370	2565	1718
	epV_ʊ	360	421	2375	1593	ʊ	422	471	2707	1811
S7	epV_ɑ	426	414	1631	1306	ɑ	575	492	1209	989
	epV_æ	543	475	1926	1528	æ	792	607	1862	1480
	epV_e	385	392	1887	1499	e	494	449	2208	1739
	epV_ɨ	502	453	1953	1548	ɨ	458	430	1753	1398
	epV_i	441	421	2222	1750	i	348	372	2254	1774
S9	epV_ɑ	547	454	1653	1357	ɑ	705	556	1227	1096
	epV_æ	605	492	1805	1451	æ	792	612	1776	1434

	epV_e	409	366	2036	1593	e	505	427	2282	1745
	epV_ɨ	448	391	1955	1543	ɨ	617	500	1832	1468
	epV_i	440	386	2292	1751	i	349	327	2879	2112
	epV_ʊ	416	370	2063	1610	ʊ	457	397	1444	1229
	epV_u	465	402	1710	1393	u	436	383	1272	1123
S11	epV_ɑ	522	443	2040	1569	ɑ	731	591	1475	1170
	epV_æ	585	488	1874	1452	æ	728	589	1739	1356
	epV_e	526	445	2089	1603	e	534	451	2182	1668
	epV_ɨ	553	465	2067	1588	ɨ	530	449	1965	1516
	epV_i	469	405	2104	1614	i	379	342	2574	1945
	epV_u	418	369	2007	1546	u	383	344	1254	1015
S13	epV_ɑ	505	434	2211	1619	ɑ	763	623	1177	1118
	epV_æ	580	489	1777	1409	æ	709	584	1835	1436
	epV_e	437	384	2427	1723	e	487	421	2298	1661
	epV_ɨ	529	452	1637	1341	ɨ	546	465	1364	1209
	epV_i	460	402	2295	1659	i	402	358	2474	1746
S14	epV_ɑ	607	493	1962	1393	ɑ	741	594	1510	1141
	epV_æ	585	477	2092	1466	æ	719	578	2157	1502
	epV_e	545	447	2304	1584	e	465	387	2989	1967
	epV_ɨ	466	387	2096	1468	ɨ	564	461	2081	1460
	epV_i	505	417	2702	1806	i	386	328	2531	1711
	epV_ʊ	399	337	2426	1652	ʊ	410	345	1594	1188
	epV_u	450	375	2044	1439	u	448	374	1547	1162

Table D1.2. Mean F1 and F2 (unnormalised and normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels per female speaker. 'epV_x' refers to epenthetic vowels, with 'x' representing the main vowel within the word.

Speaker	Epenthetic vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2	Main vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2
S11	epV_ ɔ:	460	327	1839	1839	ɔ:	606	494	1065	1268
S16	epV_aɪ	495	435	979	1353	aɪ	659	626	1285	1572
	epV_i:	384	306	1535	1752	i:	399	324	2201	2231
	epV_ɒ	480	417	975	1350	ɒ	610	570	930	1318
	epV_ɔ:	465	400	1128	1459	ɔ:	491	431	956	1336
	epV_əʊ	451	384	1018	1381	əʊ	482	420	926	1315
S17	epV_ æ	438	389	1336	1389	æ	571	569	1176	1256
	epV_aɪ	544	533	1114	1206	aɪ	460	419	1882	1837
	epV_i:	461	420	1452	1483	i:	374	303	2007	1941
	epV_əʊ	492	462	1581	1590	əʊ	433	383	973	1090
S23	epV_aɪ	570	435	1159	986	aɪ	904	613	1431	1262
	epV_ɪ	604	453	1738	1574	ɪ	461	377	1860	1697
	epV_i:	292	287	2075	1916	i:	535	416	1912	1751
	epV_ɔ:	513	404	1713	1549	ɔ:	519	408	1139	966
S26	epV_eɪ	377	347	1715	1746	eɪ	375	378	1856	756
	epV_ɔ:	415	387	1472	1499	ɔ:	587	422	1058	1800
S28	epV_aɪ	446	443	1725	1450	aɪ	560	527	1497	1253
	epV_ɪ	350	372	1730	1454	ɪ	283	322	2290	1938
	epV_i:	357	377	1824	1535	i:	302	337	2181	1844
	epV_ɔ:	760	676	2060	1739	ɔ:	333	359	1122	929
S30	epV_aɪ	559	458	1068	1312	aɪ	695	538	1582	1946
	epV_ɔ:	276	292	1553	1911	ɔ:	270	288	1400	1722
	epV_əʊ	479	411	997	1224	əʊ	589	475	982	1206
S31	epV_aɪ	314	343	1534	1559	aɪ	601	554	1016	1150

	epV_ɪ	333	357	1567	1585	ɪ	326	352	1801	1770
	epV_i:	328	354	1872	1826	i:	405	410	1932	1873
	epV_əʊ	370	384	1436	1481	əʊ	509	487	1181	1280
S4	epV_aɪ	487	409	1127	1293	aɪ	657	553	1143	1306
	epV_ɪ	458	383	1651	1717	ɪ	350	291	2048	2037
	epV_i:	464	389	1614	1686	i:	329	273	2076	2060
	epV_ɒ	569	478	1310	1441	ɒ	676	569	838	1060
	epV_ɔ:	456	381	1500	1594	ɔ:	474	397	1022	1208
S7	epV_aɪ	742	557	2509	2079	aɪ	650	505	1276	1240
	epV_eɪ	332	325	1638	1487	eɪ	452	393	1806	1601
	epV_ɪ	505	423	1946	1697	ɪ	483	410	1634	1484
	epV_i:	452	393	1731	1550	i:	384	354	1804	1600
	epV_ɔ:	1083	750	2359	1977	ɔ:	478	407	703	850
	epV_əʊ	470	403	2286	1928	əʊ	309	312	959	1024

Table D2.1. Mean F1 and F2 (unnormalised and normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels per male speaker. 'epV_x' refers to epenthetic vowels, with 'x' representing the main vowel within the word.

Speaker	Epenthetic vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2	Main vowel	F1 (Hz)	Scaled to Hz-like F1	F2 (Hz)	Scaled to Hz-like F2
S10	epV_ɪ	426	277	1610	1377	ɪ	491	423	2417	1864
	epV_i:	474	385	2035	1634	i:	520	489	2513	1922
	epV_ɔ:	556	570	1523	1325	ɔ:	550	557	1267	1171
	epV_əʊ	489	419	1790	1486	əʊ	548	552	1305	1194
S12	epV_æ	486	269	1749	1578	æ	974	595	1718	1552
	epV_ɪ	828	497	1468	1346	ɪ	831	499	2181	1935
	epV_ɔ:	495	275	1365	1261	ɔ:	633	367	1315	1219
S13	epV_eɪ	403	369	1993	1303	eɪ	545	462	2085	1472
	epV_ɪ	399	366	1898	1129	ɪ	428	385	2151	1592
	epV_i:	866	672	2197	1677	i:	402	368	2349	1955
S19	epV_ɪ	462	392	2934	1630	ɪ	476	467	3067	1751
	epV_i:	480	486	2565	1291	i:	462	394	2945	1639
S2	epV_ɪ	475	490	1844	1456	ɪ	294	258	2904	1999
	epV_i:	465	477	2077	1575	i:	414	412	1923	1496
	epV_ɔ:	474	488	2069	1571	ɔ:	641	702	1128	1088
	epV_əʊ	408	403	1876	1472	əʊ	390	381	1095	1072
S5	epV_ɒ	399	537	1299	1761	ɒ	342	337	1151	1282
S6	epV_ɪ	240	337	1621	1282	ɪ	282	537	2922	1761
S8	epV_eɪ	557	519	1433	1088	eɪ	458	368	2441	1925
	epV_i:	508	443	1777	1374	i:	497	427	2145	1679
S21	epV_eɪ	276	324	538	1087	eɪ	516	610	2389	1675
	epV_i:	320	375	2058	1570	i:	374	440	2632	1753
S22	epV_ɪ	297	349	1764	1500	ɪ	280	308	2519	1826
	epV_i:	391	568	1930	1572	i:	322	406	2570	1848

	epV_ɔ:	313	387	1049	1192	ɔ:	407	605	1042	1189
S24	epV_æ	524	352	1540	1471	æ	835	595	1758	1594
	epV_aɪ	568	387	1358	1368	aɪ	657	456	1684	1552
	epV_aɪə	577	394	1621	1517	aɪə	726	510	2098	1786
	epV_aʊ	602	414	1842	1642	aʊ	848	605	1329	1352
	epV_eɪ	523	352	1858	1651	eɪ	546	370	2044	1756
	epV_ɪ	519	349	1735	1581	ɪ	773	546	2439	1979
	epV_i:	421	272	1895	1672	i:	452	296	2671	2110
S25	epV_ʌ	562	337	1546	1761	ʌ	834	537	1196	1282
S27	epV_æ	365	296	1347	1241	æ	846	682	1171	1149
	epV_aɪ	632	510	1711	1431	aɪ	805	649	1351	1243
	epV_ɪ	521	421	2032	1599	ɪ	554	448	2349	1764
	epV_i:	497	402	2071	1619	i:	469	380	2173	1673
	epV_ʌ	401	325	1629	1388	ʌ	811	654	1386	1261
	epV_əʊ	515	416	1601	1374	əʊ	641	517	1063	1092
S29	epV_aɪ	591	470	1207	1328	aɪ	728	611	1705	1591
	epV_aʊ	643	524	870	1150	aʊ	409	283	932	1183
	epV_eɪ	505	382	1763	1622	eɪ	509	385	2272	1891
	epV_ɪ	489	366	2244	1876	ɪ	454	329	2353	1933
	epV_i:	530	408	1283	1368	i:	522	399	2002	1748
	epV_ɒ	547	425	1196	1322	ɒ	863	750	1057	1249
	epV_ɔ:	495	372	1160	1304	ɔ:	644	525	1086	1264
S32	epV_aɪ	473	382	1128	1134	aɪ	811	710	2090	1608
	epV_ɪ	475	383	1820	1475	ɪ	680	582	2755	1936
	epV_i:	464	372	2146	1636	i:	441	350	2688	1903
	epV_ɔ:	451	360	1971	1550	ɔ:	475	383	1406	1271
	epV_əʊ	473	382	2053	1590	əʊ	561	467	1079	1110

Table D2.2. Mean F1 and F2 (unnormalised and normalised scaled back to Hz-like values) for epenthetic vowels and their corresponding main vowels per female speaker. 'epV_x' refers to epenthetic vowels, with 'x' representing the main vowel within the word.

Appendix E. Statement of confidentiality and statement of consent in the L2 study.

Appendix E.1. Statement of confidentiality in the L2 study.

Your name and other information gathered in this study will not be disclosed to anyone other than the investigator and his/her collaborators. They will only be used for statistical purposes without reference to individual participants' personal information.

Appendix E.2. Statement of consent in the L2 study.

I, ____________________________ agree to take part in this speech production study. The experiment will take about 30-40 minutes, with pauses if necessary, and it will occur at a convenient time and place. I understand that the investigator may record my production. I understand that I may withdraw from the study at any time. I understand that my name and my specific answers will remain confidential and that I will not be identified in any report or presentation that may arise from the study.

Date:______________

Signature:__________

Appendix F. L2 production elicitation lists.

Appendix F.1. Carrier sentence reading task lists (filler words are not included).

Read the following sentences twice:

1. Structure is the next word.
2. Splash is the next word.
3. Screen is the next word.
4. Spring is the next word.
5. Stake is the next word.
6. Spy is the next word.
7. Skate is the next word.
8. Snail is the next word.
9. Sleep is the next word.
10. Smoke is the next word.
11. Blond is the next word.
12. Glory is the next word.
13. Break is the next word.
14. Trial is the next word.
15. Crown is the next word.
16. Fly is the next word.
17. Frog is the next word.
18. Threat is the next word.

Appendix F.2. Cluster cues used in the phonemic verbal fluency task (filler cues are not included).

Name as many English words as possible which begin with the sound(s) that these letter(s) spell.

1. pr-
2. scr-
3. str-
4. spl-
5. sp-
6. br-
7. sl-
8. fr-
9. pl-
10. tr-
11. spr-
12. cr-
13. sn-
14. sk-
15. st-

Appendix G. L2 proficiency tests.

Appendix G.1. EIT sentence transcripts.

1. I have to buy a bus pass.
2. The red book is on the table.
3. The parks in this town are old.
4. He takes a shower every morning.
5. Where did you think you were going tonight?
6. I doubt that he knows how to drive that well.
7. Before lunch, I watched a funny TV show.
8. It is possible that it will rain tomorrow.
9. I dislike novels which have many characters.
10. The houses are very nice but too expensive.
11. The young man whose horse ran away yesterday is mad.
12. That restaurant is supposed to have very good food.
13. I want a large quiet yard in which I can grow flowers.
14. You really enjoy listening to country music, don't you?
15. She just started cleaning the bottom of the microwave.
16. Cross the street at the light and then just continue straight ahead.
17. The friend I am visiting has a fantastic set of guitars.
18. She only orders meat dishes and never eats vegetables.
19. I wish the cost of modern homes could become reasonable.
20. I hope it will get warmer sooner this year than it did last year.
21. A neighbour of mine always kindly helps my father's two cats.
22. The black cat that you fed yesterday was the one chased by the dog.

23. After I pick up the laundry, I plan on catching a movie.
24. The most fun I've ever had was when we went to the Opera.
25. The sweet nurse whom the patient hired was really nice and caring.
26. Would you be so kind as to hand me the book which is on the table?
27. The pool of people who meet the requirements is expanding each month.
28. I don't know if the 11:30 train has left the station yet.
29. The competition wasn't as intensive as you suggested it would be.
30. There are a lot of people who don't eat anything at all in the morning.

Appendix G.2. A screenshot of the V_YesNo v1.0 online vocabulary size test screen.

Appendix H. Words used in the phonemic verbal fluency task per participant (P)

P1	P2	P3	P4	P5	P6	P7	P8
pronoun	preintermediate	pray	pronoun	print	production	predict	prepare
product	price	prank	presentation	screen	provide	practice	preposition
pray	print	criminal	present	scriple	prose	screen	screenshot
print	proud	spoil	prefer	slip	pronunciation	scream	slave
scrap	screen	sky	screen	slay	screen	sleep	slot
scratch	scroll	free	script	slave	sleep	trip	cry
screw	sleep	snake	scream	create	slow	trump	crock
slow	crawl	trail	sly	spelt	slave	state	split
slime	stick	try	sleep	steal	slide	stole	state
cry	stuck		slim	play	crew	star	station
crowd	steal		crept	plan	crown	play	play
crown	play		crosser	plant	crash	sky	playstation
crock	Skype		crown	skim	spelling	breakfast	plot
splash	brother		split	skin	splash	breed	sky
street	brink		study	schematic	start	brown	skate
stage	structure		play	broke	starve	structure	frog
stone	string		playstation	brother	stay	stream	brink
play	strong		player	break	plural	snake	bride
plug	snow		scar	stricture	snake	snow	structure
skate	snail		screw	stroke	sky	snap	strick
school	snack		sky	snake	bright	spring	snail
frequency	spring		brother	snap	brown	track	spring
free	sprite		brown	snow	breakfast	frog	treat
brother	train		bridge	spring	structure	spy	trail
brown	translate		breakfast	spray	snake	spain	splash
street	frog		steam	train	snow	spoke	
structure	freeze		structure	try	spring		
snow	spy		breakfast	travel	track		
spring	special		strong	trail	trouser		
treasure	structure		snake	free	tricky		
trail	splash		snap	spent	travel		
fry	screen		spread	spy	frog		
spy	spring		trouser	spoon	fozen		
			tree	speak	splash		
			prome		spelling		
			space		spring		
			spy				

P9	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**P16**
prove	print	press	professor	print	promote	print	print
proof	privacy	screen	proud	prank	pray	praise	present
pronoun	proud	slime	screen	screen	prime	prose	presentation
screen	screen	crown	scream	scream	print	screen	screen
scrap	scanner	cry	slow	scary	screen	scream	scream
scroll	screenshot	split	slove	sleep	screw	scroll	sleep
slip	sleep	stick	cream	slap	scrambled	sleep	slash
slim	slap	state	create	cry	sleep	slam	slow
slide	crime	brown	spelling	crime	slap	crown	cry
crown	crowd	bruise	stat	criminal	slice	cream	create
creep	cream	brother	stuff	street	crown	split	crop
strip	spelling	street	planning	srtraight	crime	splash	splash
strawberry	still	stress	skill	play	christ	stick	splay
please	play	snow	skip	sky	split	state	street
plate	brown	sniff	scheme	friend	star	stinky	stain
skate	bread	structure	bread	fried	stinky	play	stop
skateboard	bridge	spring	breakfast	brother	plot	please	start
brown	start	track	brown	brain	play	skate	play
bright	street	frog	structure	bring	skateboard	space	plot
street	snow	friend	snow	street	frog	break	skate
structure	spring	spaghetti	snake	snore	brown	stream	sky
snow	train	spectacular	sprite	sneeze	bright	structure	skin
snake	tradition		train	snake	brought	snail	frog
sprite	try		travel	snack	string	stroke	bright
tree	fresh		track	spring	snow	snoop	brother
track	free		free	train	sneeze	spring	breathe
friend	front		spider	try	snap	troll	brought
freeze	spicy		spoon	tree	spring	trial	street
Friday	spaghetti		speak	fried	trouble	free	structure
spirit				spy	trim	freacky	special
					fry	spin	spring
					frighten	spoke	create
					free	spelling	train
					spy		trick
					spoon		fraction
					speed		frozen
							speak
							spoon

P17	**P18**	**P19**	**P20**	**P21**	**P22**	**P23**	**P24**
pronoun	prnoun	proficianl	print	pretty	print	prepare	print
slow	price	print	pray	prepared	price	screen	practice
sleep	pray	practice	proud	presentation	prove	scary	provide
scream	prepare	screen	pretent	screen	scream	slip	screen
crown	screw	slow	protect	scream	screw	slow	slow
stuck	script	slave	screen	screw	slave	crown	slam
plum	screen	sleep	scrash	sleep	slow	station	crown
plead	slow	criminal	script	slow	crown	sky	chrome
brown	sleep	critical	slow	cream	crime	scheme	special
snow	cry	crown	sly	crown	creature	break	stay
snack	crown	street	scrown	christen	structure	bring	stand
free	crept	strick	slide	spell	stick	structure	strong
speech	crash	stuck	sleep	stick	scarf	snow	stock
	split	storm	crash	stuck	bright	spring	stop
	stay	plural	crosser	plan	brain	track	plan
	steal	scarf	street	play	brought	traditional	skin
	statement	sky	stress	skin	brave	free	from
	plan	scanner	stream	skip	snake	freeze	frog
	play	bread	strong	frog	snow		brother
	skii	brought	story	brown	spring		bring
	sky	brain	play	bring	sprite		brown
	skim	brilliant	sky	brother	train		stressed
	frog	snow	skin	stream	trust		straight
	brother	snake	scream	snake	speak		sneak
	break	spring	friend	snail			snooze
	bread	free	frame	spring			trousers
	brand	freeze	break	treat			free
	snow	spy	brown	translation			frog
	spread	special	brave	spell			special
	sprout		stream	spicey			speaking
	train		structure				spouse
	triangle		snow				
	Troy		snake				
	frog		snail				
	try		spring				
	frame		sprite				
	spy		spray				
	spirit		train				
	spelling		travel				
			trick				
			trip				
			track				
			from				

P25	P26	P27	P28	P29	P30	P31	P32
present	prime	premediate	present	prepositon	preposition	proud	present
preposition	presentation	screen	praise	prepare	pronounciation	prime	proud
pro	primarily	sleep	screen	protect	scroll	price	proceed
scream	scream	slow	sleep	provision	screen	screen	program
slow	screen	cream	slide	scream	sleep	slow	scary
slime	slow	crime	slime	screen	slap	cry	scrap
cry	sleep	structure	crown	product	slow	crime	slow
chrome	cry	street	cry	script	crew	state	crime
crew	crew	skate	splash	sleep	crown	start	crown
stick	cream	break	street	cream	cry	stomache	start
stand	start	broadcast	stick	crack	splash	play	steal
plain	stop	start	stuff	crown	street	plan	strong
plan	sky	snow	stollen	state	stress	sky	skill
sky	break	snack	play	stricture	strong	brown	break
scared	stream	sneeze	please	statue	stand	brother	brown
brown	snake	spring	pleasure	stop	sky	bring	bright
brother	snow	sprite	skip	plum	break	strike	straight
snow	spread	trust	skateboard	skin	brown	strong	structure
snake	try	free	break	skate	street	stream	snow
spring	tree	Friday	bridge	schedule	strive	snow	spring
spray	freedom	frequency	structure	frog	strength	spring	TRUE
try	spelling	spy	street	brown	snake	sprite	trail
treat	speech	speaking	snow	broken	snow	trust	free
trick			snake	bread	spread	track	frog
free			spring	snow	tree	frank	spring
friend			sprite	snack	try	spot	spy
freedom			tree	friend	free	spy	speed
spell			trying	spread	frozen		
spaghetti			travelling	frog	spy		
speak			fresh	spoke	spot		
			speed	spent	spicy		
			speech	flip			