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**VOWEL REDUCTION TO SCHWA BY ESTONIAN
LEARNERS OF ENGLISH: A CASE STUDY**
MA thesis

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ABSTRACT

The aim of the study is to observe the pronunciation of schwa as a consequence of vowel reduction in the speech of Estonian learners of English. These aspects of Estonian EFL learners' pronunciation have not been empirically studied before. It was hypothesized that Estonian learners of English may transfer an acoustically similar L1 sound over to their L2 English pronunciation. A two-part pronunciation test was conducted on twenty Estonian EFL learners and ten native British English speakers, and their results were acoustically analyzed. The thesis is divided into two chapters. The first chapter focuses on reduction, the schwa vowel, and previous research. The second chapter presents the empirical analysis of the pronunciation test. The results reveal that L1 Estonians reduce vowels in a native-like manner and they have created a separate phonetic category for the English schwa vowel.

Keywords: phonetics, pronunciation, vowel reduction, schwa, Estonian learner English

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LIST OF ABBREVIATIONS

AmE	American English
BrE	British English
EFL	English as a Foreign Language
F1	first formant
F2	second formant
L1	first language
L2	second language
NS	native speaker
NNS	non-native speaker
SLA	Second Language Acquisition
SLM	Speech Learning Model
SLM-r	revised Speech Learning Model

INTRODUCTION

Researching the speech of non-native speakers of English is especially compelling when there are specific linguistic features that a speaker cannot directly transfer from their first language to English. For Estonian learners of English, one such feature is vowel reduction. Crosswhite (2004: 191) describes vowel reduction as a linguistic phenomenon in which certain vowels undergo qualitative changes when they occur in an unstressed position. In addition to becoming spectrally more centralized, reduced vowels also shorten in duration (Verbeke et al 2025: 2). Vowel reduction to a weak form or to the schwa vowel [ə] in unstressed syllables occurs in nearly all varieties of English (Carr 2013: 169). It is therefore an aspect of English pronunciation that learners should consider when learning and speaking the language.

The importance of vowel reduction in English is closely tied to word boundaries and stress. In particular, the reduction of strong vowels serves as one of the indicators of stress patterns in English (Dauer 1993: 85). According to Dauer (1993: 85), non-native speakers often do not reduce vowels enough, which may make it difficult for the listener to perceive where words begin and end. In addition, Lepage and Busà (2013: 2) maintain that word stress in English is important for word recognition and retrieval, which are consequently crucial for successful communication. Carley and Mees (2020: 1) note that accurate use of weak forms of words is essential as it determines the correct rhythm of speech. Furthermore, Poesová and Weingartová (2018: 97) emphasize that vowel reduction is fundamental to how native English sounds. Therefore, reducing vowels in unstressed syllables to create a contrast between stressed and unstressed syllables is a distinctive and defining characteristic of English speech.

Alternating between stressed and unstressed syllables is especially important in the context of English since English is a stress-timed language, meaning that the interval between stressed syllables is equal in duration (Wayland 2019: 57). Bang et al (2014: 935) have claimed

that speakers of English whose first language (L1) is a syllable-timed language might struggle with vowel reduction, causing them to stress all vowels and resulting in an unnatural pronunciation. Estonian has historically been a syllable-timed language but is in the process of becoming more similar to a stress-timed language (Asu et al 2016: 130). After applying the pairwise variability index¹ on Estonian, Nolan and Asu (2009: 73–74) concluded that Estonian language patterns coincide with syllable-timed languages in terms of syllable length, yet align with stress-timed languages in terms of foot duration. Hence, it is unclear how the features of L1 Estonian might influence vowel reduction in L2 English. All in all, mastering the process of reduction is essential for acquiring the correct rhythm of speech and identification of word boundaries in English.

As noted above, one outcome of vowel reduction in English is the spectral centralization of vowels, resulting in the production of schwa. Laufer (2019: 1908) explains that although the IPA schwa is defined as a mid-central vowel based on precise physiological formant measurements, phoneticians often use the name ‘schwa’ to refer to “a variable reduced non-defined centralized vowel”. While some sources speak about schwa by using keywords such as LETTER (/ə/ + /ɪ/ or [ə]) or COMMA ([ə]) (Ogden 2017: 70; Szigetvári 2018: 81), there is general agreement that the term ‘schwa’ is well established and therefore does not need a keyword (Carley et al 2018: 135). The term ‘schwa’ has Hebrew origins² and has been in use since the 10th century; it was first introduced into European linguistic tradition in the 19th century by the German philologist Eduard Sievers, who used it to describe a ‘neutral’ vowel (Laufer 2019: 1908, 1910). The symbol [ə] was created by another German philologist, Johann Andreas Schmeller, and was later used to describe English by Alexander John Ellis (Laufer 2019: 1910). It then entered the IPA charts through Ellis’ phonetic alphabet (Laufer 2019: 1910). In English,

¹ Pairwise variability index (PVI) is a widely used metric to quantify rhythm, often by placing them on a continuum where on the one end, there is the category of syllable-timed and the other, stress-timed (Nolan and Asu 2009: 64).

² Meaning *nothingness* in Hebrew (Gósy 2004: 15).

Priva and Strand (2023: 1) suggest defining schwa by what it lacks concerning the position: “not front, high, low, back, or round.”

The schwa vowel is the most common weak vowel in unstressed syllables, and it is consequently the most common vowel and phoneme across the English language (Carley and Mees 2020: 201). It can correspond to any of the English vowel letters <a>, <e>, <i>, <o>, or <u> (Carley and Mees 2020: 201), and its use is highly habitual, appearing in the speech of almost every native English speaker (Carr 2013: 21). Therefore, it is a vowel that non-native speakers must be aware of and taught in order to pronounce English words intelligibly. Derwing and Munro (2005: 385) define intelligibility as “the extent to which a listener actually understands an utterance.” Jenkins (2000: 159), the creator of the Lingua Franca Core (LFC)—a set of minimum requirements necessary for intelligibility among non-native speakers of English (Zoghbor 2018: 2)—does not regard schwa, weak forms or rhythm as essential features of English for non-natives to master (Walker 2022: 17). However, Jenkins has developed the LFC in a general manner, not “for a particular group of learners with a specific first language (L1)” (Zoghbor 2018: 2). Since reduction is not represented in English orthography, many non-native speakers may be unaware of it (Dauer 1993: 62).

In Standard Estonian, there is no schwa vowel. Whereas stressed and unstressed vowels differ markedly in British English, Estonian reduces vowels in a more even-handed manner (Nolan and Asu 2009: 74). Vowel reduction similar to the English vowel reduction only occurs in unstressed syllables of words in the third quantity feet (Eek and Meister 1999: 556). For example, the final vowel in *kooli* ‘school, illative case’ undergoes qualitative reduction due to its shortening. Mid-centralization to schwa is exceptional in Estonian, meaning that all vowels are “full” (Nolan and Asu 2009: 71). A possible exception may be found in the vowel system of the Võru dialect, a subdialect of Southern Estonian, which has two unrounded central vowels (Parve 2000: 241), one of which is acoustically similar to the English schwa. Nevertheless,

speakers of Standard Estonian do not encounter the schwa vowel in their L1 and only exhibit vowel reduction similar to English in specific lexical items.

Vowel reduction and the pronunciation of schwa have not yet been empirically studied in the speech of Estonian learners of English. Mutt (1978: 32) and Kostabi (1993: 90) have both claimed that Estonian learners of English tend to replace the English schwa with Estonian central vowels <ö> [ø] and <õ> [ɤ]. However, Mutt's observations are hypothetical, as he did not conduct any empirical research on the topic, and Kostabi used a small sample and drew conclusions auditorily. This thesis aims to address this research gap by focusing on the following research questions:

1. How are vowels in unstressed syllables pronounced by Estonian learners of English represented in an F1-F2 vowel space?
2. Which vowel is the most common target reduced vowel? Is it schwa?

The relationship between L1 phonetic categories and later acquired L2 categories is explained by the revised Speech Learning Model (SLM-r), developed by Flege and Bohn in 2021. One way in which it expands upon the original Speech Learning Model (SLM), proposed by Flege in 1995, is by replacing the model's "age hypothesis"³ with the "L1 category precision" hypothesis (Flege and Bohn 2021: 36). According to this updated hypothesis, the ability to discern between L2 and L1 phonetic categories depends on how precisely the learner's L1 categories are defined at the time of L2 exposure. Both the SLM and the SLM-r maintain that L1 and L2 sounds are stored in a shared "phonetic space" in the brain (Flege and Bohn 2021: 21). As a result, Flege and Bohn (2021: 42) argue that new L2 categories dissimilate from similar L1 categories to create the necessary contrast. If such contrast is not apparent and no new L2 category is formed, perceptually linked sounds may merge (Flege and Bohn 2021: 42).

³ The "age hypothesis" proposed in SLM claimed that learners of L2, who are first exposed to L2 when older, are less likely to differentiate between cross-linguistic phonetic categories as opposed to those who are exposed to the L2 when younger (Flege and Bohn 2021: 20).

Based on the SLM-r and previous claims by Mutt (1978) and Kostabi (1993), I therefore hypothesize that Estonian English as a foreign language (EFL) learners will pronounce the English schwa vowel as the Estonian <õ> [ɤ] vowel, the vowel that is perceptually closest to schwa. Thus, learners may not create a new phonetic category for schwa in English.

The aim of the thesis is to examine whether, and in what ways Estonian learners of English achieve vowel reduction and, consequently, how they realize the schwa vowel. To determine whether Estonian EFL learners' schwa productions—positioned in an F1 and F2 value space—align more closely with the English [ə] or resemble the Estonian central vowel [ɤ], an acoustic analysis is employed. According to Wiik (1991: 111), acoustic analysis is a branch of phonetics that mainly focuses on the phase where the speaker's voice exits the mouth and creates the vibration of sound waves through the phenomenon of air resonance. Acoustic phoneticians measure speech quality through formants, duration, pitch, and intensity (Yang 2022: 261). Hence, acoustic analysis allows for a less invasive and more accurate measurements of schwa, a short and ambiguous vowel.

In contemporary studies on vowels, vowels are commonly described in terms of their resonant frequencies (Weckwerth 2022: 46). As air passes through the vocal tract, some frequencies are passed while others are accentuated (Sawusch 2005: 8). The resonances that arise from the interaction between the sound source and the vocal tract are known as formants (Titze 2000: 156). Titze (2000: 156) maintains that although an infinite number of formants can be identified, only a few are relevant for phonetic analysis. This is due to the dynamic nature of speech production: the frequency composition of speech is constantly in flux as the tongue, lips, and jaw move (Sawusch 2005: 9). It is common for vowels to be arranged in a two-dimensional (F1-F2) formant center-frequency space (Strange 2007: 39). The first formant (F1) corresponds to vowel openness, i.e., vowel height, while the second formant (F2) to vowel advancement (Weckwerth 2022: 46).

When studying specific vowels, it is advisable to consider all of their qualities. Ogden (2017: 66) notes that being guided by formants is especially useful when measuring a vowel that is short in duration or has an unclear quality—both of which characterize the schwa vowel. Also, the acoustic space of F1 and F2 is often compressed in reduced speech, causing F1 to rise because of the jaw not opening as much (Uchanski 2005: 224–225). In addition, Boersma (2013: 379) asserts that duration is an important quality of speech because it may serve as a cue to various phonological distinctions, such as stress and vowel height, both relevant to the process of vowel reduction. Consequently, focusing on the measurements of F1, F2, and duration enables a comprehensive and target-based analysis.

To address the two research questions posed in this thesis, a pronunciation test was conducted on twenty Estonian learners of English (hereafter, the test group). In addition, ten native speakers were included as a control group. The pronunciation test consisted of two parts: a reading task and a storytelling task. The recording of the test group took place at the University of Tartu Phonetics Lab. The control group data were collected by Professor Claire Nance at Lancaster University. The test setup and recordings for all participants were carried out using the SpeechRecorder BAS software, and the subsequent analysis was performed using the free software Praat.

The thesis is divided into two main chapters. The first chapter outlines the theoretical background by describing phonetic reduction—particularly vowel reduction—and the realization of the schwa vowel in English. It also includes a section on reduction and vowels in Estonian. In addition, it discusses the revised Speech Learning Model and linguistic transfer as features of second language acquisition. Finally, it reviews previous studies and their relevance for the present research. The second chapter provides an overview of the pronunciation test, the participants and their linguistic backgrounds, as well as the procedure, method, and results of the test. This is followed by a detailed discussion of the findings.

1 VOWEL REDUCTION AND SCHWA

This chapter begins with an explanation of reduction from the perspective of phonetics. More specifically, it discusses vowel reduction as a characteristic feature of English and describes the properties of the English reduced vowel, schwa [ə]. In addition, the chapter provides an overview of vowel reduction in Estonian and its central vowels [ø] and [ɤ], which are acoustically the closest Estonian counterparts to the English schwa vowel. Furthermore, the chapter includes a summary of the revised Speech Learning Model as a theoretical framework and its implications for the study. Finally, this chapter reviews previous research on vowel reduction and the pronunciation of schwa in the speech of learners of English.

1.1 Phonetic Reduction

Phonetic reduction is highly variable, especially across languages (Zellers et al 2018: 2). It is also a common feature in adult speech (Dommelen 2018: 74). According to Zellers et al (2018: 1), phonetic reduction may cause segments to become shorter, “less clearly articulated, or absent, compared to ‘canonical’ or ‘dictionary’ forms”. However, the distinction between ‘reduced’ and ‘canonical’ forms is problematic as it implies that the reduced form lacks phonetic information present in the so-called ‘full’ form (Zellers 2018: 9). Therefore, while reduced forms have been previously thought of as slurred, slovenly, or deficient in a way, contemporary research has demonstrated that reduction is far more complex (Zellers et al 2018: 2). For instance, although reduction has traditionally been associated with casual speech, it is in fact a characteristic of read speech as well (Zellers et al 2018: 2).

Many contemporary scholars prefer to view phonetic reduction as a continuum, following the H&H (hypo- and hyperarticulation) theory proposed by Lindblom (1990). According to the H&H theory, speakers must either control their output (hyperspeech) or their system (hypospeech) (Lindblom 1990: 405). On the one hand, too much economic constraint by the speaker leads to a slurry pronunciation or hypospeech (Moers et al 2007: 284). On the

other hand, in certain situations (e.g., loud environments, giving instructions), speakers may excessively enunciate words or use hyperspeech, risking a loss of contrast (Moers et al 2007: 284). According to the H&H theory, the communicative goal is to maintain phonetic contrast to ensure comprehensibility (Moers et al 2007: 284). For example, Clopper and Turnbull (2018: 25–26) describe a continuum with reduced or hypoarticulated forms at one end and enhanced or hyperarticulated forms at the other. It is along this continuum that phonetic reduction is realized, coinciding with the proposed H&H dimension (Lindblom 1990: 405; Clopper and Turnbull 2018: 25–26). As opposed to the H&H continuum, Dommelen (2018: 76) positions reduction on a scale ranging from canonical realization to complete deletion. Thus, reduction is realized either on the continuum of hypo- and hyperarticulated forms or on a scale where canonical forms are at one end and complete deletion is at the other.

There is a general consensus that speakers tend to reduce highly predictable items and lengthen or hypoarticulate low-predictable ones (Gahl et al 2012: 789). Explanations of phonetic variation can be divided into two: ‘intelligibility-based’, also known as ‘listener-oriented’ and ‘production-based’ or in other words, ‘speaker-internal’ (Flemming 2004: 232; Gahl et al 2012: 789–790). Kuznetsova and Anderson (2020: 6) propose that the central idea of using language economically enough for the comfort of the speaker and for the listener to decipher the message has laid the groundwork for a functionalist/usage-based view on reduction. Gahl et al (2012: 789) define ‘listener-oriented’ as the speaker modifying their speech to ensure that otherwise difficult to understand words would be intelligible for the listener. Harris (2005: 132) expands this idea by suggesting that “reduction is part of planned speech behaviour rather than an accidental by-product of vocal-organ inertia.” Similarly, Clopper et al (2016: 38) maintain that phonetic reduction arises when lexical items are easy to access for both the speaker and the listener. The ease or difficulty of a context is determined by the articulatory and processing demands placed on the speaker or the listener (Verbeke et al 2025: 1).

The term ‘speaker-internal’ refers to mechanisms relevant to speech production, such as lexical access and encoding (Gahl et al 2012: 790). In the H&H theory, Lindblom (1990: 413) explains that when a motor system, including the speech system, is unconstrained, the default form of behavior is a low-cost one. This implies that the jaw takes a more comfortable position to necessitate pronunciation, but only enough to create the crucial contrast (Lindblom 1990: 413). Hence, Lindblom (1990: 415) argues that the speech system seems to operate to minimize ‘articulatory effort’, resulting in an undershoot of phonetic targets in some settings, i.e., in unstressed syllables. Consequently, reduction means that when articulatory gestures become automatic, they can indicate a high level of language proficiency (Kuznetsova and Anderson 2020: 10). Taken together, these perspectives suggest that the main reasons for reduction lie in linguistic economy and the minimization of articulatory effort.

Research shows that phonetic reduction can be realized in numerous ways. It may affect vowels and consonants, as well as prosody and larger linguistic units. Vowel reduction is widely attested in many languages, including English (Kuznetsova and Anderson 2020: 3). Phonetic reduction can also be observed in multi-word expressions: for example, the semi-modal *want to* is frequently reduced to *wanna* (Leech et al 2009: 97). Ellipsis or omission of a word is another example of reduction, as in *We gotta go now*, where *gotta go* replaces *have got to go* (Leech et al 2009: 106). According to Jaeger and Buz (2018: 41), complex codas are often reduced in many varieties of English. For instance, the final plosives /t d/ are often deleted in high-frequency words in American English (Gahl and Garnsey 2004: 750). Thus, phonetic reduction is a largely applicable phenomenon across languages.

1.2 Vowel Reduction and Schwa in English

When a vowel appears in an unstressed syllable, it is often neutralized in English (Flemmings and Johnson 2007: 83). This type of neutralization is also known as vowel reduction (Kuznetsova and Anderson 2020: 5). Long vowels are seldom reduced as they are

perceived as more salient compared to short vowels (Burzio 2007: 156; Szigetvári 2018: 85). Thus, an unstressed environment and short vowels are crucial conditions for vowel reduction in English. Vowels that typically occur in unstressed syllables are known as weak vowels as opposed to strong vowels, which appear in stressed syllables (Carley et al 2018: 135). Compared to unstressed vowels, stressed vowels in English tend to be longer, louder, and higher (Poesová and Weingartová 2018: 98). As a result of vowel reduction, English vowels in unstressed syllables are more often replaced with the schwa vowel, but also with the KIT vowel /ɪ/, the FOOT vowel /ʊ/, or syllabic consonants (e.g., *funnel* /'fʌnl/) (Duckinowska 2021: 279).

In addition to changes in qualitative or spectral dimensions, vowel reduction also involves alterations in temporal or durational features. According to Kuznetsova and Verkhodanova (2019: 203), scholars long assumed that reduction resulted from decreased vowel duration caused by formant undershoot. This view originates from a study by Lindblom (1963). Lindblom (1963: 1779) asserted that speech organs fail to achieve the vowel's full or target pronunciation because of the short duration of a vowel in an unstressed syllable. Many have since disputed this. For instance, Delattre (1969: 298) argues that duration merely correlates with reduction and should be considered secondary, with stress and speech tempo being the main determinants. Crosswhite (2004: 217) also takes a contrary position to Lindblom's claims and maintains that a pressure to avoid effortful articulations leads to a change in quality, which in turn shortens the vowel's duration. Although researchers differ in their views of what causes a decrease in duration, the shortening of length is nevertheless one of the defining features of a reduced vowel.

Vowel reduction in English can be divided into two types. When the reduced vowels move towards a central region in the vowel space, such as schwa, it is termed a 'centripetal' reduction (Kuznetsova and Verkhodanova 2019: 203). Alternatively, 'centrifugal' reduction occurs when reduced vowels move towards the edges of a vowel space, the three corner vowels:

/a i u/ (Kuznetsova and Verkhodanova 2019: 203). Harris (2005: 122) asserts that the two systems may co-occur since it is uncommon for a language to only exhibit centripetal reduction. Moreover, Harris (2005: 120) argues that both centripetal and centrifugal reduction share the effect of “diminishing the amount of phonetic information in the speech signal.” The way a particular phoneme is pronounced holds valuable information that can manifest as sentence structure through various linguistic units, informational cues, and interactional features because the information influences pragmatics as well (Hawkins 2011: 559). Hawkins (2011: 559) exemplifies this with /t d ɪd/ signifying the English past tense (e.g., *looked*) and /s z ɪz/ indicating plurals (e.g., *cats*), demonstrating how phonetic information is reflected in morphological units. Harris (2005: 127) maintains that with centralization, the entire informational content is lost. He (2005: 125) explains that while the /ɑ/ vowel creates a peak in the middle of the vowel spectrum by converging the F1 and F2 measures, the schwa vowel is regarded as unfocalized due to evenly spaced formants. Hence, centripetal reduction may be seen as lack of phonetic information because it suppresses energy peaks (Harris 2005: 125).

Vowel reduction to schwa in English is mainly associated with monophthongs. These are vowels that do not involve a glide to or from another vowel during production and are written with one vowel symbol (Carley et al 2018: 139). Monophthongs in Received Pronunciation (RP)⁴ are divided into two based on length: short [ɪ ɛ æ ə ʌ ɒ ʊ] and long [i: ɑ: ɔ: u: ɜ:] (Jones 2011: vii). In General American (GA)⁵, there is no length distinction. Instead, vowels are distributed as lax [ɪ ɛ æ ʊ ʌ ə] and tense [i ɑ ɔ u] (Rogers 2000: 75) (see Figure 1). The vowel quadrilaterals of RP and GA are represented in Figure 1⁶. In both varieties, the schwa

⁴ Received Pronunciation (RP) is a prestige accent selected as a model for British English since it is thoroughly described in terms of phonetics and phonology (Setter and Makino 2022: 531).

⁵ General American (GA) is an amalgam of educated northern American English (Collins et al 2019: 53).

⁶ The quadrilaterals are based on the figures in Carley et al (2025: 64–68). They transcribed vowels uniformly in both varieties, hence the use of the sign ‘:’ that indicates a lengthened vowel in GA.

vowel is positioned centrally and has the same quality as the NURSE /ɜ:/ vowel. Their only difference lies in length.

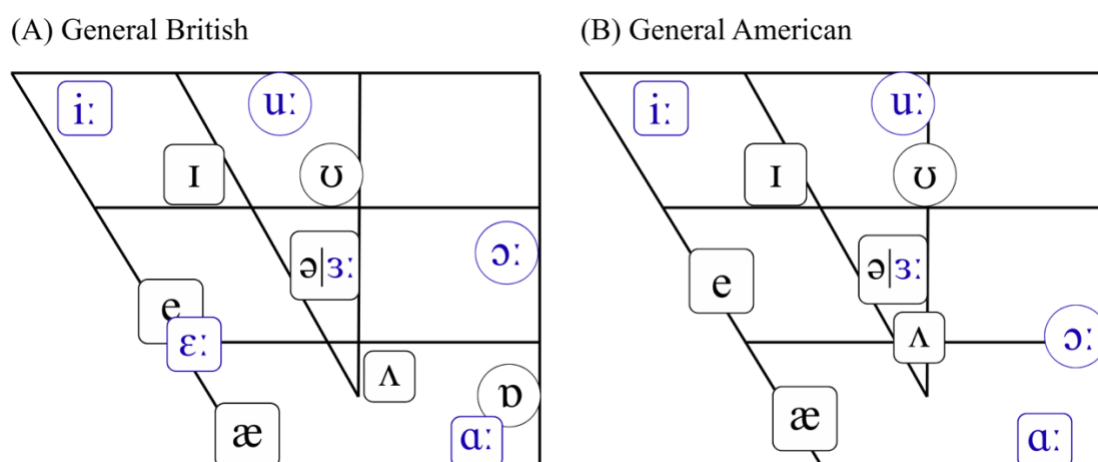


Figure 1. Vowels in RP (panel A) and vowels in General American (panel B) based on Carley et al (2025). Short vowels are written in black and long vowels are in blue. Rounded vowels are represented with a circle surrounding the phoneme.

According to Dauer (1993: 62), in unstressed syllables, front vowels are commonly reduced to weak KIT /ɪ/ and the low and back vowels to schwa /ə/. Flemming and Johnson (2007) similarly found that in American English, nearly all non-final reduced vowels are acoustically closer to [ɪ], with [ə] being more appropriate for word-final positions. In contrast, Fabricius (2002: 213) observed that in RP, as a result of language variation and change, the KIT vowel has been drifting into the schwa vowel. Carley et al (2025: 65) have identified this as the “weak vowel merger”. For instance, the word *animal*, previously pronounced as /'ænɪml/, has become /'ænəm/ in both RP and GA as a result of the merger (Carley et al 2025: 65). As found by Beal (1999: 159), this uncertainty—whether an unstressed vowel should be transcribed as schwa or KIT—has been present since the 14th century and continues, to some extent, today. Nevertheless, within the context of centripetal vowel reduction, the primary focus is on reduction to schwa.

One of the defining properties of schwa is its lack of a clearly specified articulatory position. Ogden (2017: 64) has proposed describing mid-central schwa as a ‘neutral’ vowel.

However, Priva and Strand (2023: 1) consider this characterization problematic, as there are no clear properties for describing schwa's position and therefore poses the question whether using the word 'neutral' would thus be the most accurate way of defining schwa. Crosswhite (2004: 192) has boldly assumed that schwa is not specified for any vowel features and is considered 'targetless'. This means that the schwa vowel does not have an articulatory target (Harris 2005: 128). However, Harris (2005: 129–130) argues that schwa may be as suitable for specified formant values as any other vowel. Also, Napoli and Clopper's comprehensive study (2024: 16) reveals that both word-initial and phrase-initial schwas are targeted. Consequently, research has shown that schwa has an acoustic target that can be measured in formants.

For many native speakers, the stressed counterpart of the typically unstressed /ə/ is the STRUT vowel /ʌ/ (Collins et al 2019: 218). Although this view is broadly accepted, Roach (2009: 113) challenges it by proposing that schwa is an allophone of several different vowel phonemes rather than only the STRUT vowel. In contrast, Szigetvári (2018: 83) remains unconvinced that a contrast can be established between the schwa vowel and the STRUT vowel. While Szigetvári (2018: 85) concurs that the schwa vowel may be regarded as an allophone of any short vowel, he excludes the KIT vowel since the two may contrast. However, Minkova (1991: 104) maintains that word-final schwas reject the allophonic treatment of schwa. Since the word-final schwa only alternates with itself or nothing (i.e., elision) within its morpheme's boundaries and never with other vowels, it does not meet the requirements to be regarded as an allophone (Minkova 1991: 104). Although the latter example only accounts for word-final schwas, it is still customary to treat schwa as a separate phoneme.

Carley et al (2018: 137) claim that schwa is the only British English weak vowel that is exclusively used in unstressed syllables and therefore may never occur in stressed syllables. Szigetvári (2018) argues against this conviction. Based on Szigetvári's analysis of RP (2018: 89–90), schwa may occur in stressed syllables but once it does, it is transcribed as STRUT /ʌ/ or

NURSE /ɜ:/, resulting in a “stressed schwa avoidance”. Both Wells (1982: 303) and (Giegerich 1991: 131) have also identified the NURSE vowel /ɜ:/ as a stressed schwa in London English⁷ and in RP. Cruttenden (2008: 95) likewise states that schwa and the NURSE vowel differ only in length, not in quality. In addition, Carley and Mees (2020: 128) discuss stressed schwa in GA, claiming that it is more open than an unstressed schwa. In contrast, Heselwood (2007: 153) argues that the schwa vowel cannot occur in stressed syllables. Rogers (2000: 76) supports this by claiming that in GA, schwa may occur in stressed syllables only as *schwar* /ɔ/ (e.g., *fear*). Among the known languages that have a schwa vowel in their phonetic inventory, the majority of times it is unstressed (Stolz and Levkovich 2023: 160). Therefore, regarding schwa as an unstressed vowel is more common and typologically more precise.

Moreover, Dudek (2015: 54) further investigated the relationship between schwa and STRUT in English and concluded that they are two stress-dependent phonetic objects that phonologically behave as one object. This means that in some cases, for example, in syllables bearing secondary stress, the STRUT vowel, as a slightly “stronger” vowel, replaces the schwa vowel (Dudek 2015: 54). Rogers (2000: 76) has also concluded that in terms of quality, the STRUT and the schwa vowel are the same for many GA speakers. The preference or use depends on the individual and thus, varies across speakers (Rogers 2000: 79). Similarly, Carley et al (2025: 65) have identified a STRUT-schwa merger in GA. As a result, they are realizations of the same phoneme, and the STRUT vowel is slightly more open since it occurs in stressed syllables (Carley et al 2025: 65). For the purpose of clarity and displaying the contrast of stress and rhythm, using STRUT to transcribe the respective vowel in stressed syllables and schwa in unstressed syllables appears to be the established tradition.

The schwa vowel has more functions in speech compared to any other use of verbal communication (Gósy 2004: 16). For instance, Brown (1990: 1158) maintains that the schwa

⁷ Not a single coherent variety but a range from Cockney to RP, depending on which borough of London the speaker is from (Hickey 2014: 183).

vowel strongly influences the rhythm of speech and may therefore either cause or result from an uneven syllable pattern of English. Carr (2013: 83) exemplifies this by showing that a shift in stress from the first syllable to the second (e.g., '*photograph*' and *pho'tography*) results in the vowel in the initial syllable changing from the 'full' vowel to 'reduced'. Although vowel quality is essential for identifying stress in English, its relative scope of influence compared to other parameters—duration, intensity, and F0⁸—remains uncertain (Zhang and Francis 2010: 261). Also, syllables can help signal and identify word boundaries (Gósy 2004: 17). On the one hand, Kim et al (2012: 4) emphasize that schwa vowels in word-initial position are most frequently the reason for ambiguous word boundaries because schwa is often highly reduced in connected speech. On the other hand, Dauer (1993: 85) holds that non-native speakers often fail to reduce enough, which may hinder the listener's ability to identify where words begin and end. Hence, vowels must be reduced enough to create word boundaries, but not to the extent that excessive reduction will create ambiguity. Consequently, vowel reduction or a change on the segmental level contributes to a change on the suprasegmental level, realized as stress.

Although the duration of an unstressed vowel is inherently short, the position of schwa in a word definitively determines its duration. For example, Weijer et al (2019) studied vowel reduction in English *-man* compounds, such as *policeman* and *space man*. In their study (2019: 678), they based a hypothesis on the premise that syllables in longer words are gradually allotted less time, meaning that the final syllables are more sensitive to reduction from a lack of time. Moreover, if the schwa vowel is located in a word-medial position, its duration is shorter than any other vowel's, illustrating that it is highly susceptible to coarticulatory pressure (Ogden 2017: 65; Napoli and Clopper 2024: 2). Based on these examples, the duration of schwa seems shortest in word-medial and word-final positions due to limited time for development and considerable influence of adjacent sounds.

⁸ Fundamental frequency.

As discussed, depending on the vowel's position in a word, stress, and the variety of the speaker, the pronunciation of schwa is highly variable. Usually, altering or omitting a stressed vowel may cause changes in the meaning of words (e.g., *bet* and *bat*). However, using schwa for an unstressed vowel rarely alters the meaning of a word (Brown 1990: 1158). Heselwood (2007: 154) exemplifies this with words such as *opera*, *reasoning*, and *marvellous*, all having the option of including or excluding the schwa vowel without it affecting the meaning of the words. This shows that variations in the pronunciation of schwa are limited to the phonological level and do not impact semantics. In addition, Ogden (2017: 77) proposes that the schwa vowel can be related to a type of vowel harmony, for instance, in the phrase *to the [tə ðə] park*, the schwa vowel is more back to agree with the back vowel in *park* whereas in the phrase *to the [tə ðə] hill*, the schwa vowel is fronted, being more harmonious with the front vowel in *hill*. This further demonstrates schwa's adaptability and variability in English.

To sum up, vowel reduction occurs in unstressed syllables. As a result, vowels in these syllables are neutralized and often realized as the schwa vowel. The English schwa vowel has a short duration and a central quality in most English varieties, including RP and GA. Although it has been compared to the STRUT and NURSE vowels, it is regarded as a separate phoneme for the most part. While the STRUT and NURSE vowels share a similar quality to schwa, they occur solely in stressed syllables. In addition, the NURSE vowel is lengthened and rhotic, opposing schwa [ə] in its length. Hence, in unstressed syllables, only schwa occurs. Moreover, schwa's duration can be influenced by its position in a word as syllables are gradually allotted less time.

1.3 Vowel Reduction in Estonian

There are nine vowels in Estonian, pronounced as [i y u e ø ɤ o æ ɑ] (Asu and Teras 2009: 368). Estonian vowels are divided into three based on tongue height: high [i y (u) u], high-mid [e ø ɤ o], and low [æ ɑ] (see Figure 2) (Asu et al 2016: 19). The front vowels are [i y e ø æ] and [u (u)/ɤ o ɑ] are considered back vowels (Asu et al 2016: 19). Rounded vowels are

[y ø u o] (Asu et al 2016: 19). Acoustically closest vowels to the English schwa vowel are the Estonian mid vowels [ø ɤ]. In a study by Leppik et al (2023)⁹, the results of ten Estonian native speakers were presented on a vowel chart (see Figure 2). The measurements place the [ɤ] vowel centrally and leaning more towards being a back vowel. The [ø] vowel is more front and slightly more open.

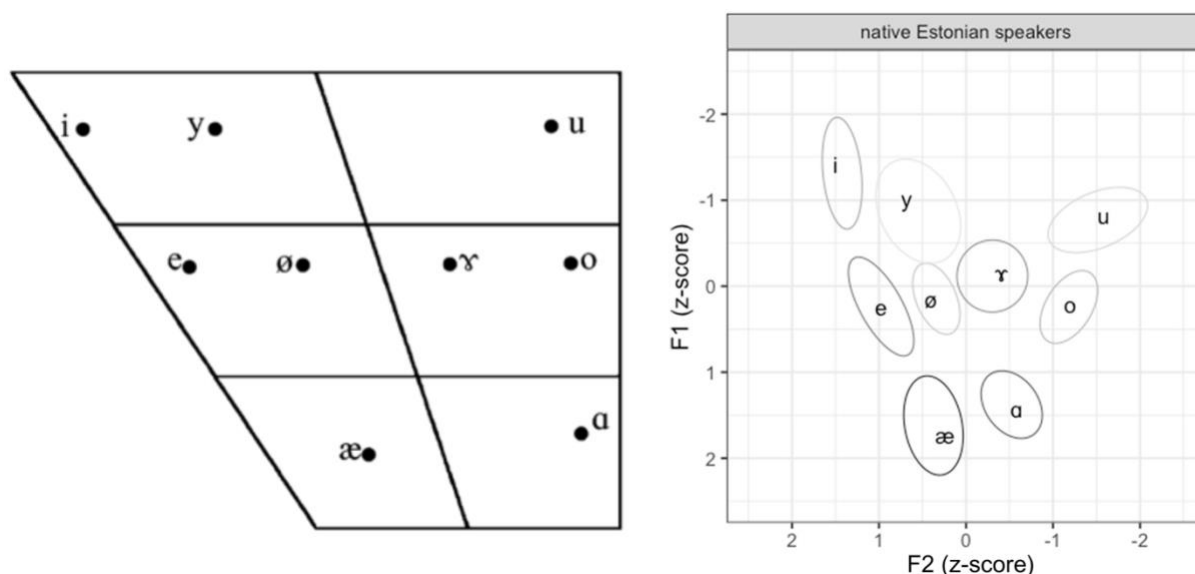


Figure 2. Estonian vowel diagram (left) (Asu and Teras 2009: 368) and acoustic measurements of Estonian vowels by ten native Estonian speakers (right) (Leppik et al 2023: 6).

Although vowel reduction occurs in Standard Estonian to some extent, it is markedly different from English both in scope and in frequency. All nine Estonian monophthongs /i y u e ø ɤ o æ ɑ/ may occur as a nucleus in syllables with primary stress (Asu and Teras 2009: 368–369). There is little variability in the quality of the vowels in syllables with primary stress, no matter the degree of quantity they are pronounced in (Metslang et al 2023: 51). This means that vowels in this position are rarely reduced. In noninitial syllables with no primary stress, only vowels /i u e o ɑ/ may occur (Asu et al 2016: 20). If these vowels are in noninitial syllables of words in the third degree of quantity, they may be reduced or shortened, and their quality is less distinct (Metslang et al 2023: 51–52). Consequently, Flemming (2005: 29) considers Estonian

⁹The measurements of Estonian vowels by Leppik et al (2023) were included to later compare the Estonian [ɤ] vowel to the Estonian participants' pronunciation of the English schwa vowel.

a language with “non-initial vowel reduction, not unstressed vowel reduction.” Metslang et al (2023: 52) discern that reduction in Standard Estonian mainly concerns back vowels, /u o ɑ/. In spontaneous speech, loss of sounds is common, for instance by pronouncing *üüles* [yt:les] as [yt:s] ‘said, 3rd person sg’ (Metslang et al 2023: 52).

In an effort to identify reduction in Standard Estonian, Eek and Meister (1999) hypothesized and proved that the vowels in Q1¹⁰ and Q2 feet in an unstressed position undergo Finnic-type reduction. This type of reduction involves little to no change in vowel quality (Eek and Meister 1999: 556). Moreover, Eek and Meister (1999: 551) emphasize that, as a rule, the quality and intensity of unstressed vowels in Q1 feet are not reduced. Instead, the unstressed vowels of words in Q1 and Q2 feet are phonetically half-long but maintain their quality, as seen in the non-initial vowels of *sada* ‘hundred, nom.’ and *saada* ‘send, 2nd person imp.’ (Eek and Meister 1999: 556). However, in case of the Q3 foot (e.g., *saada* ‘available, adv.’), the vowel undergoes the Germanic-type reduction, which involves a substantial change in vowel quality (Eek and Meister 1999: 556). This occurs mainly because the short duration of the vowel hinders a pronunciation with full vowel quality. In addition, in stressed syllables, Estonian vowels are never reduced (Asu and Teras 2009: 369), aligning with Recasens’ claim that a stressed position is an unnatural environment for schwa to occur (Recasens 2022: 60). Therefore, English-like reduction in Estonian occurs only in Q3 feet and only in an unstressed position. While in certain lexical items the vowel quality may change, there is no target reduced vowel like schwa in Standard Estonian.

Based on previous research (Mutt 1978; Kostabi 1993), Estonian learners of English may pronounce the English schwa vowel as either of the two Estonian vowels [ø] or [ɤ]. Kostabi (1993: 90) has also suggested that learners might retain the full vowel quality, i.e., fail to reduce vowels at all. In addition, Mutt (1978: 32), proposes that the reduced vowel may be pronounced

¹⁰ Q = Quantity

as any other vowel than schwa. Nevertheless, the possible impulse to replace the English schwa vowel with Estonian vowels [ø] or [ɤ] is understandable. When categorizing Estonian vowels by tongue height, the mid vowels are [e ø ɤ o] (Asu and Teras 2009: 368), out of which [ø ɤ] are central vowels. Thus, rather than acquiring or producing an unfamiliar sound—in this case, the English schwa—Estonian learners of English may transfer a similar and familiar L1 vowel ([ø] or [ɤ]) to substitute for the unfamiliar one.

While the position and transcription of the [ø] vowel are generally uncontroversial, the properties of [ɤ] are more complex. Similarly to the English schwa vowel, the exact articulatory position of the Estonian [ɤ] vowel is difficult to determine. Acoustically, [ɤ] is a close-mid vowel, yet it can also be classified as a central vowel (Asu et al 2016: 20). Perceptually, its realizations range from close-mid to close back (Asu et al 2016: 20). However, Asu et al (2016: 20) maintain that, phonologically, the [ɤ] vowel is a back vowel, a view they claim is supported by phonetic data. Hence, the possible phonetic variants of the [ɤ] vowel are “a mid-back vowel [ɤ], a close back vowel [u] or a mid-central vowel [ə]”, depending on the speaker (Asu and Teras 2009: 369). It is also important to note that, according to Eek and Meister (1999: 562), [ɤ] is not the most precise IPA symbol for describing the Estonian non-low back unrounded <õ>. Nevertheless, it is possibly the most accurate representation of a main variant of the phoneme (Eek and Meister 1999: 562).

The position of [ɤ] is complex across Estonia, not only in Standard Estonian. Lindström and Pajusalu (2003: 247) describe it as “the most problematic sound” to identify phonologically. In Standard Estonian and Mulgi, it is a close-mid vowel [ɤ], whereas in Seto and Võro it corresponds to [u] (Norvik et al 2021: 62). The vowel [ɤ] is most prominent in these latter dialect areas and their subdialects. Unlike Standard Estonian, the Võro dialect has two central vowels, neither of which have the same quality as the Standard Estonian [ɤ], illustrated by the data from its Vastseliina subdialect (Parve 2000: 241). Based on F2 measurements, Teras (2003:

2522) defines the [ɤ] vowel in Southern Estonian speech as central. The vowel is acoustically considered closer to front than back vowels, but phonologically, it tends to behave similarly to back vowels, e.g., in vowel harmony (Teras 2003: 2522). Nonetheless, the presence of back or central unrounded vowels such as [ɤ], [u] and [i] is a feature that links the Southern Finnic languages to Latgalian and Russian (Norvik et al 2021: 62).

While the [ɤ] vowel is considerably common in the Southern Estonian dialects, it is strikingly less common in the Coastal and Insular dialects, the latter being spoken on the largest Estonian island, Saaremaa. In fact, according to a 2003 study, the average occurrence of [ɤ] in speech is 10.1% in Seto and only 0.01% in the Insular dialect (Lindström and Pajusalu 2003: 250). A more recent study by Teras and Praakli (2024: 103) confirms that there is considerable variation in the pronunciation of [ɤ] in the Insular dialect. They (2024: 103) conclude that the fronting and labialization of the vowel [ɤ] may still be regarded as a characteristic of the Saaremaa accent. In addition, the vowels [ɤ] and [ø] have become closer not only because of [ɤ] being fronted, but also because [ø] has moved more backwards (Teras and Praakli 2024: 103). These studies suggest that the [ɤ] vowel is difficult to position in any of the Estonian dialects. However, it is clear that the vowel is much more common in Southern Estonian dialects as opposed to the Insular dialects.

1.4 The Revised Speech Learning Model and Linguistic Transfer

Learning a foreign language entails a distinction between the mother tongue (L1) and the language being acquired (L2). The revised Speech Learning Model (SLM-r) and its predecessor, the Speech Learning Model (SLM) are often applied when Second Language Acquisition (SLA) studies involve phonological and phonetic aspects, especially to research the production and perception of vowels and consonants (i.e., segments) (Flege and Bohn 2021: 64). The central idea of SLM-r is that the similarities between L1 and L2 can either help or hinder the process of learning L2 perception and production (Trofimovich et al 2015: 356). The

term L2 is used as an umbrella term in the context of SLA, a field of study that researches the interaction between L1 and L2 (Behney and Marsden 2020: 37). According to Behney and Marsden (2020: 37), L2 in the context of SLA can refer to both the second language a person acquires first in terms of chronology and any language that has been acquired after the first (the mother tongue).

Since the SLM-r is the reworked version of SLM, it is necessary to discuss the SLM before exploring the revised version. Flege (1995: 238) emphasizes that the SLM is a working model and it may be useful for planning research since it provides testable predictions and ways to organize and interpret empirical data of a wide range. In general, Flege's model aims to explain the reasons behind some L2 segments being more attainable and easier to acquire than others (Derwing and Munro 2015: 24). To accomplish this, Flege (1995: 239) established four postulates and seven hypotheses (H). For example, H2 claims that a new L2 phonetic category that differs from the closest L1 sound can only be established if learners notice at least some difference between the two sounds (Flege 1995: 239). In other words, it proposes that learners may find it difficult to differentiate between L1 and L2 sounds that are perceived very similarly (Derwing and Munro 2015: 68). Furthermore, H3 states that "The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that phonetic differences between the sounds will be discerned" (Flege 1995: 239). Hence, the sound must first be perceived as different before it can be pronounced as it is heard (Derwing and Munro 2015: 68).

Among other models, Derwing and Munro (2015: 69) argue that the SLM is more of a process-oriented model that focuses on learners and the mechanisms that are connected to perception and production. Thus, they do not consider language as simply "a thing" (Derwing and Munro 2015: 69). According to Strange (2007: 36–37), SLM posits that L2 sounds are perceived through or influenced by the filter of L1 sounds, i.e., all new sounds are recognized

through the already familiar L1 phonological categories. This may result in L1 interference for adult learners of a foreign language (Strange 2007: 37). This is possible due to Flege's proposed "common phonetic space" where both L1 and L2 sounds exist in the brain (Flege and Bohn 2021: 21). According to Flege and Bohn (2021: 19), the L1 and L2 sounds are perceptually linked, and these links are disrupted with the intent of forming new phonetic categories only if and when the learner discovers differences between the sounds.

Many core aspects remained unchanged in the revised version, such as the principles behind forming new L2 phonetic categories and the suggested existence of the common phonetic space (Flege and Bohn 2021: 40, 42). While the main focus of the SLM was on between-group differences, the SLM-r aims to explain the reorganization of phonetic systems over a learner's life span, taking into account the age of first exposure to L2 and the input received during learning (Flege and Bohn 2021: 58, 64). In a comparison of the two models, Amengual (2023: 84) maintained that the SLM focuses more on between-group differences whereas the SLM-r's attention is on individual learners acquiring L2 sounds. The SLM-r claims that L2 phonetic input and creation of new phonetic categories is available for L2 learners of all ages because learners acquire L2 sounds the same way and with same mechanisms they acquired L1 sounds (Amengual 2023: 84).

In short, the SLM and SLM-r recognize that L1 and L2 sounds exist in a common phonetic space, new L2 phonetic categories may emerge if the learner perceives the two as different, and similar sounds are hypothesized to be the most difficult to differentiate for the learners. Major (2008: 72) argues that if the differences are minimal, transfer persists and thus, the L2 sound is not learned at all. Hence, he (2008: 73) maintains that the SLM implicitly entails that "transfer persists more for similar sounds than for dissimilar sounds." The languages and phonetic categories influencing each other in the brains of bilingual or multilingual speakers is an expected outcome. Amengual (2023: 74) has defined this influence as 'cross-lingual

influence (CLI)’ whereas Odlin (1989: 27) suggests that the similarities and differences of L1 and L2 influencing each other result in what is known as ‘transfer’. Both are correct as Odlin (2022: 1) explains that ‘transfer’ and ‘CLI’ have been used interchangeably across the works on SLA.

Assuming that all acquired vowels exist in a common phonetic space, it may be possible that Estonian learners of English will not create a new phonetic category for the English schwa vowel because the Estonian [ɤ] vowel is acoustically close to it. Hence, they may perceive these vowels as similar upon hearing them, may find them difficult to discern, and thus transfer the pronunciation of [ɤ] to the pronunciation of schwa. However, Major (2008: 74) points out that it is not always clearly outlined what constitutes as similar. Phonetic similarity is defined differently across models and is usually not well-specified (Strange and Shafer 2008: 172). Nevertheless, Chang (2015: 205) asserts that predicting perceptual assimilation on the basis of phonetic (acoustic or articulatory) similarity is reasonable. In fact, studies have shown that over the course of L2 learning, learners seem to calculate crosslinguistic phonological similarity through phonemic correspondence rather than acoustic proximity (Chang 2015: 206). Thus, the SLM-r provides a general framework to research possible similarities or differences between the acoustic features of the Estonian [ɤ] vowel and the English schwa vowel.

1.5 Vowel Reduction in the Speech of EFL Learners

Although the wish to sound like a native speaker is a personal preference, Bang et al (2014: 935) argue that mastering the pronunciation of reduced vowels is one way for learners to approximate native-like English. Carley et al (2018: 1) maintain that the primary goal should be intelligible pronunciation, as this makes communication easier and more comfortable for the listener. One may not want their speech to be misperceived, especially as an off-target pronunciation expands “articulatory effort in an ineffective manner” (Crosswhite 2004: 193). Also, producing an off-target pronunciation may distract the listener, obscure the intended

message, or even lead to the speaker being treated differently (Carley et al 2018: 1). Such experiences may even result in the learner avoiding or fearing to speak in L2 English. Research on vowel reduction in the speech of EFL learners has identified the importance of reduced vowels for a native-like speech as well as aspects that can affect the acquisition of vowel reduction, such as L1 influence, learning environment, and proficiency level.

One frequently foregrounded issue is the quality of the input available for EFL learners. Verbeke et al (2025: 2) and Dommelen (2018: 74) suggest that non-native English listeners and learners may encounter reduced forms less frequently when learning English in a foreign language classroom and as a consequence, mainly encounter canonical word forms. For natives, however, the situation is reversed: they encounter reduced forms more frequently than canonical realizations (Dommelen 2018: 74). Brown (1990: 1161) also notes that native speakers are often even unaware of the schwa vowel in their own speech as reduction occurs automatically for them. In the context of EFL learners, Verbeke et al (2025: 2) highlight that recognizing and processing reduced forms is challenging even when learners are in a naturalistic environment. Ghazali and Bouchhina (2003: 964) conclude that, in their experience, overcoming the prosodic impact of a learner's L1 is only possible through exposure to native English in a natural setting. As a result, learners of English may be at a disadvantage to learn proper vowel reduction as learning it directly from a native speaker in a native environment is not realistic for EFL learners.

However, these previous studies have not taken into account the influence of English as a *lingua franca* or the amount of input from informal learning. People are not only exposed to English in classroom settings but also through activities where language learning happens unintentionally (De Wilde et al 2020: 171). De Wilde et al (2020) researched the influence of variables, such as using social media in English, listening to English music, and speaking English in gaming contexts among others, and how much these variables explain the overall

proficiency of a learner. Their study (2020: 178) concluded that 22% of the children's overall proficiency scores were explained by exposure to the target language outside the classroom setting. Although learners may encounter mainly canonical forms in the classroom, they are highly exposed to native speech through various informal settings. Thus, they are likely to come across reduced forms even if it is not taught to them in foreign language classrooms.

The influence of a learner's L1 is another relevant aspect regarding vowel reduction. Research suggests that some L1s will benefit the learner while other L1s may hinder the learner's progress in reducing vowels. Verbeke et al (2025: 3) summarize previous findings, showing that non-native listeners can "compensate for phonetically reduced segments in L2 speech when similar phonetic processes occur in their L1". For example, Fragozo (2015) researched how L1 Brazilian Portuguese (BP) acquire English unstressed vowels. Since vowel reduction occurs in BP, the learners' success rate was above 80% with identifying the perceived schwa vowels and shortened durations (Fragozo 2015: 124–125). An example of the opposite effect comes from a study on Czech learners of English. Words that have near-equivalents in Czech were transferred and pronounced more Czech-like because the schwa phoneme does not exist in Czech (Poesová and Weingartová 2018: 111). Implementing the SLM-r, it appears that the L1 Czech learners were able to override the target L2 English pronunciation due to a lack of a same or a similar sound in their common phonetic space. Based on these findings, the influence of L1 may help some learners reduce English vowels if reduction or the schwa vowel are already part of their L1 systems.

The influence of L1 is not exclusively related to pronunciation but also spelling. Historical changes of elisions and vowel shifts have affected the English spelling-to-sound correspondences. Venezky (1999: 62) has identified schwa as the source of problems with reading and spelling in English. In addition, Wheelock (2016: 45) describes English phonemic orthography as inconsistent and finds that it makes English pronunciation challenging. Brown

(1990: 1158) suggests that even native speakers of English often misspell words in the written language because the use of schwa is not particularly restricted in the oral language. For instance, Poesová and Weingartová (2018: 98) acknowledge that Czech speakers of English are significantly sensitive to written words due to a “highly regular letter-to-sound correspondence” in Czech. This means that Czech learners are used to vowel sounds corresponding with graphemes (Poesová and Weingartová 2018: 99). Their results revealed that orthography enables more full vowel realizations as graphemic representations are used to deduce a vowels quality and quantity (Poesová and Weingartová 2018: 110, 99). These findings suggest that learners whose L1 letter-to-sound correspondence is more regular may encounter issues with reducing vowels in English because reduced vowels are not marked orthographically. While the sound-to-print correspondence is highly irregular in English, it is highly regular in Estonian (Viise et al 2011: 425). Therefore, the strong influence of letters matching sounds in Estonian may hinder learners’ acquisition and pronunciation of the English schwa.

As mentioned above, the connection between vowel reduction and stress or rhythm has long been recognized. Hence, difficulties with grasping the English stress patterns may prevent learners’ ability of reducing vowels. According to Poesová and Weingartová (2018: 97), the distinctive rhythm created through contrasts involving schwa is essential for “the natural flow of English rhythm”. In fact, insufficient vowel reduction may cause rhythmical distortions, resulting in delayed word recognition, and consequently, hinder comprehension (Poesová and Weingartová 2018: 97). Duckinoska (2021: 279) argues that difficulties in acquiring English vowel reduction presumably lies in learners failing to differentiate between stressed and unstressed syllables. Zhang and Francis (2010: 260) have proposed that an L1 stress pattern may interfere with learning the stress system of another language. However, their study (2010: 261) produced unexpected results when native Mandarin learners of English used vowel quality as a prosodic cue for stress, despite vowel quality not functioning as a stress cue in their L1.

Ghazali and Bouchhioua (2003) also studied the acquisition of English prosodic elements by speakers of Tunisian Arabic. They (2003: 963) found that unstressed function words were pronounced prominently or as stressed in 92.5% of cases. Moreover, when native English speakers heard these pronunciations, they misinterpreted them in 94.38% of the cases (Ghazali and Bouchhioua 2003: 963). For example, the native speakers failed to distinguish between sentences like *she's going too fast—she's going to fast*, where the only difference lies in the reduction of the vowel in the function word *to* (Ghazali and Bouchhioua 2003: 963). A preference for strong forms, i.e., not reducing vowels in function words, has likewise been observed in the speech of Czech EFL learners (Poesová and Weingartová 2018: 112).

Another factor that seems to affect successful vowel reduction is learners' level of proficiency in English. Ghazali and Boucchioua (2003: 963) emphasize that correct stress placement correlates with proficiency level, i.e., higher proficiency corresponds to a more precise stress placement. The first experiment conducted by Verbeke et al (2025: 6), in which participants transcribed 120 sentences, revealed that learners with a higher proficiency in English produced more accurate transcriptions of target words, regardless of their L1 backgrounds. Duckinoska's (2021: 288) findings also support this trend: learners at the B1 level produced weak forms correctly in 15.83% of cases, whereas learners at the C2 level did so in 23.37% of cases. These results suggest a positive correlation between higher proficiency and more accurate vowel reduction. Contrary to these findings, Brzezicha and Kul (2014: 4) claim that an advanced level of proficiency does not necessarily lead to correct vowel reduction. Interestingly, their study on Polish learners of English revealed that the group without phonetic training reduced vowels more frequently and to a greater degree than those with phonetic training (Brzezicha and Kul 2014: 13). However, since all the participants in the present study have received phonetic training at some point, it is reasonable to group the Estonian participants according to their English proficiency levels to determine whether any differences emerge.

Many researchers emphasize the importance of vowel reduction in learning English as a foreign language. Poseová and Weingartová (2018: 97) strongly suggest that although vowel reduction is often overlooked when deciding which English-specific phenomena should be taught to L2 students, it should be fundamental for learners whose linguistic background is schwa-less. Roach (2009: 76) also maintains that learners of English must learn the appropriate environments where schwa can occur. In addition, Duckinoska (2021: 296) highlights the need for pronunciation, especially reduced forms, to take a central role in EFL classrooms. Poesová and Weingartová (2018: 113) suggest that mastering vowel reduction is necessary for creating the specific English sound and boosting the confidence of non-natives speaking in English. The main concern of researchers, then, lies in the learner's intelligibility in the target language. Lepage and Busà (2013: 3) aimed to figure out whether misplaced word stress or incorrect vowel reduction causes intelligibility in L2 English. Their study revealed that while both affect intelligibility, not reducing vowels correctly has an even larger impact (Lepage and Busà 2013: 11). They conclude that both word stress and vowel reduction must be taught to learners of English (Lepage and Busà 2013: 11). Thus, to boost learners' confidence in spoken English, it is necessary to increase their knowledge about reduction if their L1 is schwa-less.

Vowel reduction and the quality of schwa have not been studied in the speech of Estonian learners of English. In fact, the influence of L1 Estonian on L2 English pronunciation has not been extensively studied. In addition to the aforementioned Mutt (1978) and Kostabi (1993), Ader and Miljan (2015) have evaluated the interference of L1 Estonian on L2 English pronunciation. However, their study observed the pronunciation of numerous consonants and four vowels: FLEECE, KIT, GOOSE, and THOUGHT (Ader and Miljan 2015: 27). Instead, there are many studies focusing on the influence of a foreign language on L1 Estonian (Meister 2011, Meister and Meister 2019, Leppik et al 2023). Thus, the pronunciation of Estonian EFL learners is an understudied field.

Previous research has shown that reducing vowels and the use of schwa are essential for intelligible speech in English since they are directly linked to stress and rhythm. While certain lexical items are reduced in Standard Estonian (Eek and Meister 1999: 556), there is no specific vowel like schwa that occurs in unstressed syllables. In addition, vowel reduction and the pronunciation of schwa have not been researched in the speech of Estonian learners of English. Based on the premise of the SLM-r and the shared phonetic space (Flege and Bohn 2021), I hypothesize that Estonian EFL learners will not create a new phonetic category for schwa in English but use the familiar and acoustically similar Estonian central vowel [ɤ] in its stead.

2 VOWEL REDUCTION TO SCHWA IN THE SPEECH OF ESTONIAN EFL LEARNERS

The thesis aims to examine how Estonian learners of English reduce vowels and, consequently, realize the schwa vowel. Since the schwa vowel only occurs in unstressed syllables, the focus of the study is on researching the quantity and quality of vowels in unstressed syllables. Both native speakers of English and Estonian EFL learners were included in the sample. The chapter begins with a description of the participants and their linguistic background. A two-part pronunciation test—a reading task and a storytelling task—was created to gather empirical data. Acoustic analysis was applied to observe whether the schwa vowel is the most common target reduced vowel and to evaluate the quality and quantity of schwa by L1 Estonians. The chapter ends with an overview of the results and a comprehensive discussion of what was found.

2.1 Participants

The sample includes two groups of participants: native speakers of English and native speakers of Estonian, each assigned a code at the outset to ensure their anonymization. The first group—the control group—consists of ten adult native speakers (NS) of English from the United Kingdom. The participants were assigned the code N (for native speakers), followed by a sequence number from 01 to 10. They were recorded by Professor Claire Nance at Lancaster University over several weeks in February and March 2026. The mean age of the control group was 31.8, with ages ranging from 24 to 44. They were asked to fill in a consent form and a questionnaire (see Appendix 2) before taking part in the pronunciation test. The NS were recorded with the help of the aforementioned professor to ensure that the sample of NS was sufficient in size and included native speakers living in a native environment.

The second group—the test group—consists of twenty adult Estonian learners of English. As a group, they are referred to as non-native speakers of English (NNS). Each participant was given a code number (01–20) beginning with the letter S. The participants were recruited by advertising the experiment in seminars and by posting informational flyers at the message boards in two university buildings. All participants of the test group were native speakers of Estonian. Two participants (S03 and S07) were also speakers of the Insular dialect, and two participants (S04 and S08) were speakers of the Southern Estonian dialects, Võro and Seto respectively. The mean age of the test group was 22.95, with ages ranging from 19 to 48.

Prior to participation, all member of the test group completed the LexTale test¹¹ to determine their level of L2 English proficiency. The LexTale test results were used to check whether participants had assessed their own proficiency levels accurately and thus avoid people's over- or underestimation of their abilities. Based on the calculations of the correlations between LexTale results and CEFR levels by Lemhöfer and Broersma (2012: 341) (see Table 1) participants' self-evaluated proficiency levels were adjusted where necessary. For instance, if a participant had evaluated themselves at a B1 level, but scored above 60% in the LexTale test, their proficiency level was adjusted to B2 level.

¹¹ The abbreviation stands for *Lexical Test for Advanced Learners of English*. The test was created for the purpose of researchers having a quick and feasible proficiency test that meets the needs of cognitive researchers (Lemhöfer and Broersma 2012).

Table 1. Correlation between CEFR, QPT¹² and LexTALE scores (Lemhöfer and Broersma 2012: 341).

CEF Level	CEF Description	QPT Score	LexTALE Score ^a
C1 & C2	Upper & lower advanced/ proficient user	80%–100%	80%–100%
B2	Upper intermediate	67%–79%	60%–80%
B1 and lower	Lower intermediate and lower	below 66%	below 59%

^a Prediction based on Dutch group

The test group was divided into four proficiency levels, ranging from B1 to C2 on the basis of CEFR¹³ levels (see Table 2). Within the test group, two participants were identified at the B1 level, five participants at the B2 level, and three at the C2 level. The largest subgroup consists of C1 level learners, who make up half of the participants. The maximum number of years of English study was 16, and the minimum was 3. Overall, both the mean and median length of English study in the test group was 11.5 years.

Table 2. Mean years of learning English according to proficiency levels across the twenty participants.

Proficiency	Participants	Mean	Median	St.deviation
B1	2	14.5	14.5	2.1
B2	5	11.0	10.0	2.3
C1	10	11.0	11.5	3.5
C2	3	12.0	12.0	1.0

All the participants had studied English pronunciation at some point in their life. The most frequently reported context of learning English pronunciation was ‘university’ (n = 16), followed by ‘middle school’ (n = 10), ‘high school’ (n = 7), and ‘elementary school’ (n = 5).

¹² QPT = Quick Placement Test. It is a commercial placement test used to assign adult learners to English course levels or to evaluate their proficiency for academic programs (Lemhöfer and Broersma 2012: 328).

¹³ CEFR levels = Common European Framework of Reference levels (A1, A2, B1, B2, C1, C2) are used to define proficiency “in a number of scales of illustrative descriptors” (North 2014: 9).

However, the combinations of learning contexts vary across individuals (see Figure 3). Six participants reported having learned English pronunciation exclusively at university, and two participants exclusively in middle school. All remaining participants had received pronunciation instruction at a minimum of two levels of education.

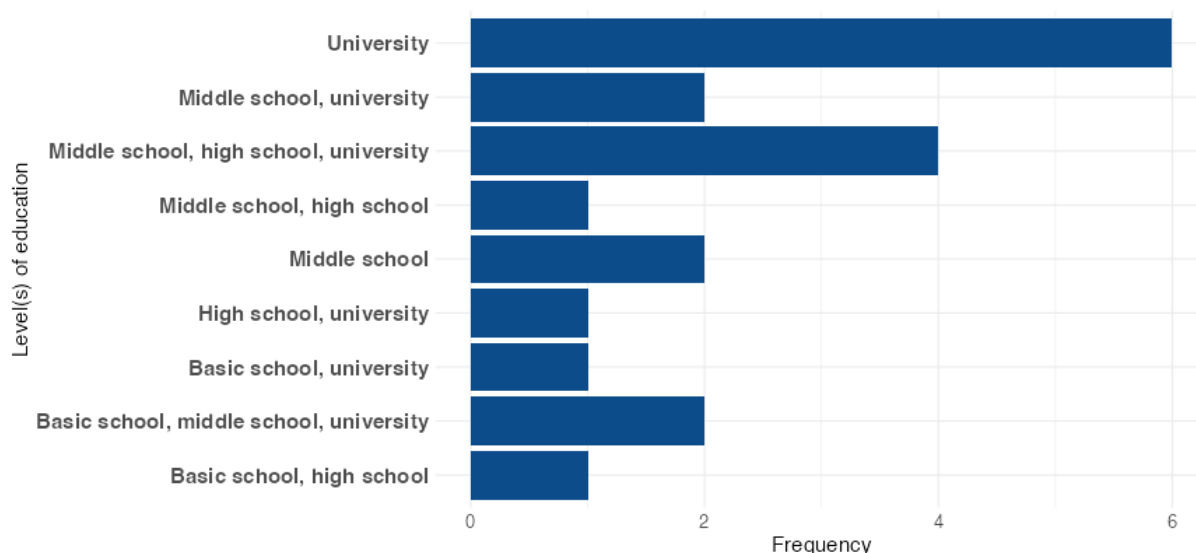


Figure 3. Level(s) of education at which participants have been taught English pronunciation.

All but one participant were aware of the spoken varieties of English they use. The most common choice was a mix of ‘British/American’ ($n = 15$), followed by two who selected ‘only British’ (S02, S19) and two who selected ‘only American’ (S01, S16). When asked about the contexts in which they use English, nearly all participants ($n = 18$) selected all the given options—reading, listening, writing, and speaking. Two participants (S07 and S15), however, did not include the ‘speaking’ option. Out of the twenty participants, four had spent a considerable amount of time in an English-speaking country. Participant S01 had lived ten months in Australia, S08 three years in England, and S13 and S18 a year and a half and ten months, respectively, in the United States.

2.2 Pronunciation Test

The pronunciation test is divided into two parts: reading task and a storytelling task. While many studies have employed reading tasks to observe vowel reduction (Flemming and

Johnson 2007; Kim et al 2012; Poesová and Weingartová 2018), it has also been regarded as a methodological weakness (Sönning 2014: 170). For instance, Sönning (2014: 170–171) has posed that reading may not be representative of learner speech and draws attention to the influence of orthography in reading tasks. Hence, the pronunciation test of this thesis includes two parts to see whether there is a difference between a controlled setting (reading task) and a spontaneous setting (storytelling task). This way, both settings are tested and compared in case one setting heavily influences the results of participants.

For the reading task, ten random lexical words and ten function words were selected (see Table 3). The function words were chosen based on what Collins et al (2019) considered as the most common function words in weak forms. Previous research has shown that centralization towards schwa is especially apparent in grammatical words because they are not information carriers (Brzezicha and Kul 2014: 3; Duckinoska 2021: 279). The lexical words for the reading task were selected to ensure coverage of all possible schwa positions in a word. Kuznetsova and Verkhodanova (2019: 203) emphasize that vowel qualities are not affected equally across words or phrases by reduction, which is why it was important to include a range of schwa positions. Lexical words 1–3 in Table 3 exemplify word-initial schwas, words 4–6 illustrate word-final schwas, and the last four words demonstrate word-medial schwas.

Table 3. Words used in the reading task.

	Lexical words	Function words
1.	alive /ə'laɪv/	a /ə/
2.	attention /ə'tenʃn/	as /əz/
3.	astonishing /ə'stɒnɪʃɪŋ/ (BrE), /ə'stɑːnɪʃɪŋ/ (AmE)	the /ðə/
4.	panda /'pændə/	and /ænd, ən/
5.	soda /'səʊdə/ (BrE), /'soʊdə/ (AmE)	but /bət/
6.	America /ə'merɪkə/	than /ðən/
7.	astronaut /'æstrɒnɔ:t/ (BrE), /'æstrɒnɑ:t/ (AmE)	at /ət/
8.	horrible /'hɒrəbl̩/ (BrE), /'hɔːrəbl̩/ (AmE)	of /əv, ə/
9.	helmet /'helmət/	to /tə/
10.	virus /'vaɪərəs/ (BrE), /'vaɪrəs/ (AmE)	was /wəz/

In the selected words, schwas are represented with various vowel letters, not only <a>, which appears to be the most frequent. All selected words have two or three syllables to avoid excessive variability. In addition, the schwa vowel was checked to occur in the same position in both British and American English varieties. The lexical words provide ten tokens and function words ten tokens, totaling at twenty tokens of schwas in the reading task. In addition to schwas, several “full” vowels were also annotated to illustrate potential centralization from full vowels towards the schwa vowel. These include the TRAP /æ/, KIT /ɪ/, DRESS /e/, FOOT /ʊ/, STRUT /ʌ/, THOUGHT /ɔ:/, PALM /ɑ:/, and LOT /ɒ/ vowels.

All of the selected words were used to create sentences (see Appendix 1). Each sentence contained two target items for analysis: one lexical word and one function word. In total, twenty sentences were created so that each word appears twice. Care was taken to ensure that the same words would not occur in the same position across its two appearances; for instance, if a word appeared sentence-finally in the first sentence, it occurred sentence-initially or sentence-medially in the second. In addition, words were arranged so that the word-final schwas would be followed by plosives to facilitate more reliable acoustic analysis. The schwar sound (schwa + /r/ or [ə]) was avoided both in the selection of test words and in sentence construction, as English varieties differ in rhoticity and because Poesová and Weingartová (2018: 103) have shown that F2 and F3 measurements are strongly affected by rhoticity. Interrogative and imperative sentences were also avoided in order to elicit neutral intonation and stress placements. Each sentence was read three times in a random order, totaling 120 tokens of schwa per participant. Across the twenty participants in the test group, 2400 tokens of schwa were annotated from the reading task in addition to the 1200 tokens of schwa produced by the test group.

In the second part of the test, the participants were asked to spontaneously create and narrate a story based on a sequence of four pictures (see Figure 4). The task was based on an

illustration of a panda whose problem is unexpectedly resolved. The sequence was created by the author specifically for this thesis, using copyright-free elements in the online graphic design tool Canva. The aim of this task was to elicit spontaneous speech by allowing the participants to speak freely on a controlled topic. Words such as *panda*, *astronaut*, and *soda* were foregrounded as they also appeared in the reading task, thereby providing comparable material.



Figure 4. Pictures for the elicitation task.

Before recording the actual participants, two pilot tests were conducted. The purpose of these pilots was to identify any overlooked issues in the test design, to estimate the overall duration of the test, and gather valuable feedback from people who were not in the two test groups. Both the pilot participants and the Estonian participants (the test group) were recorded at the University of Tartu Phonetics Lab. The pronunciation test was created in the SpeechRecorder BAS program¹⁴, which is the primary program used for such recordings at the lab. Recordings were made using an AKG C414 microphone and were transferred to a personal

¹⁴ An audio recording software customized for recording speech developed at the Bavarian Archive for Speech Signals (BAS) (Ludwig Maximilian University of Munich 2025).

hard drive. After all the recordings had been collected, they were compressed using a MacOS system utility ‘Disk Utility’ into a disk image and encrypted with 256-bit AES encryption. Only the author of the thesis had access to the password protected disk image.

The pronunciation tests with Estonian learners of English were recorded from December 2025 to the end of January 2026. Upon arriving at the lab, the participants were first asked to read and sign an informed consent form (see Appendix 3). The consent form explained the anonymization procedure and how their recordings would be handled for the purposes of this thesis. Participants then filled out the linguistic background questionnaire (see Appendix 3) and completed the LexTale test. After that they were guided to the recording booth, where they were explained the structure of the test and instructed to wait for a green light before reading out the sentence on the screen. First, there were three trial sentences for the participants to practice waiting for the green light. Next, the reading task followed. After the reading task, the participants were offered a short break if needed. Then, they were prepared for the storytelling task, with instructions to describe the panda’s issue and how it got resolved in their own words. The entire experiment lasted approximately thirty minutes.

2.3 Analysis Method

The results of the reading and storytelling tasks were acoustically analyzed with Praat version 6.4.43. All the subsequent analyses were carried out using R Statistical Software (v4.5.1; R Core Team 2024), the *tidyverse* package (Wickham et al 2019), and the *flextable* package (Gohel and Skintzos 2026). To prepare the data of the reading task, it was first necessary to create .txt files corresponding to the .wav sound files. This was done by using an R script (Malmi and Lippus 2025) that looped through all the rows of a composite file containing the 60 sentences and generated 60 separate text files with the correct filenames, matching the filenames to the sound files. Once these files were created, an autosegmentation R script (Lippus 2024a) was run. This script automatically created .TextGrid files, which is a

Praat-specific text file, and paired each .TextGrid file with its corresponding .wav sound file. It also created two tiers, ‘words’ and ‘phones’. The script by Lippus (2024a) makes use of a speech recognition system created by Alumäe, Tilk, and Asadullah (2018). When their system malfunctioned, WebMAUS (Schiel 1999) was used instead for autosegmentation. The procedure was repeated with the data from the storytelling task once the narrations had been manually transcribed by the author of this thesis and saved as .txt files.

After the preparatory steps were completed, the author manually checked the segmentation of each word chosen for analysis and adjusted the phoneme boundaries where necessary. The identification of phoneme boundaries followed the guidelines provided in Lippus (2026). For example, for locating the schwa vowel in the word ‘helmet’, the vowel begins where the nasalized bilabial sound /m/ ends. Nasals can be identified by their lighter spectrogram background, as can be seen in the middle horizontal panel in Figure 5. The vowel itself is easier to spot with the derived formants activated, illustrated automatically by the program as red dotted lines. Formants are counted from the bottom up, with the lowest dotted line the first formant (F1). The vowel ends with the glide to the voiceless alveolar plosive /t/. Since a plosive begins with a complete closure, the closure is included in the annotation. The dotted formant lines indicating energy at the beginning of a closure indicate pre-aspiration, which in turn marks the end of the preceding vowel and the onset of the following plosive in the word ‘helmet’.

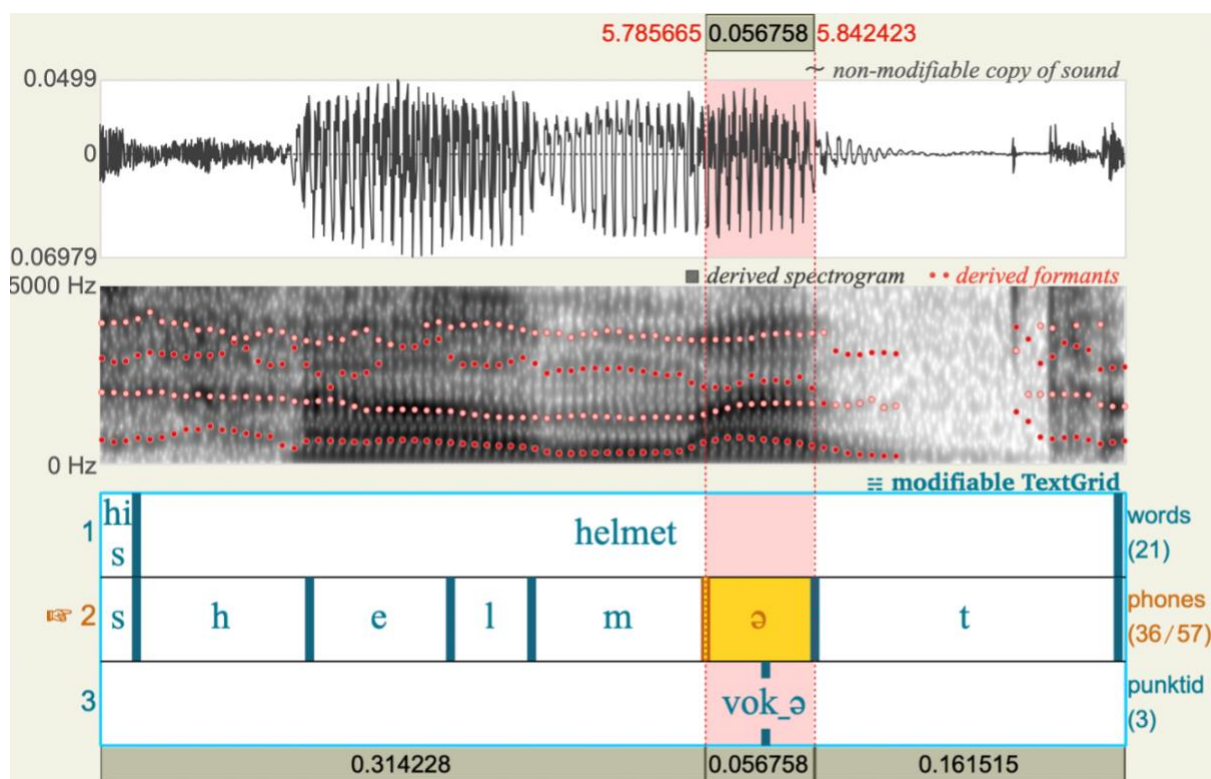


Figure 5. Segmentation of the word 'helmet' in Praat.

The type of an analysis illustrated above was manually carried out for each word chosen for analysis. Once the segmentation was satisfactory, a point tier (labelled 'punktid') was created to mark the occurrences of schwa. On the point tier, schwas and full vowels were labelled in the form of 'vok_x' ('vowel_x'), such as 'vok_ə'. This can also be seen in Figure 5. Since each sentence contained two tokens of schwa, each point tier had two points signifying a schwa. In the sentences from which full vowels were extracted, additional points were added to the point tiers to mark those vowels. After all the relevant vowels were added to the point tiers, a Praat script (Lippus 2024b) was used to pull vowel durations and formant values and to write the collected results into a table saved as a .txt file. The script measured vowel formats at the midpoint to maximize the accuracy of formants, as vowel boundaries are often unclear because of glides from or to an adjacent sound. Finally, the data in the table in a .txt file were used to visualize the results by creating F1-F2 vowel plots and boxplots with R.

To enable comparison across individuals with different physiological features, the collected data of vowel quality must be normalized. Normalization or scaling of data is essential for measuring speakers of different ages and sexes since these factors cause anatomical differences to their vocal tracts. Yang (2022: 271) emphasizes that since formant frequencies are directly related to a speaker's vocal tract, women usually have higher formant frequencies as opposed to men, whose vocal tracts are generally longer. One widely used method of normalization is the Lobanov scaling, proposed by Lobanov in 1971 (Yang 2022: 272). This method of normalization was used on the data of this thesis, provided in a script by Lippus (2025). It is a “statistical method for a parallel shift and linear compression” where the normalized formant value corresponds to the z-value (Yang 2022: 272). This z-value is calculated by “dividing the distance of the given formant of a vowel from the average value by the standard deviation” (Yang 2022: 272). According to Yang (2022: 272), it is most common for the z-values to stay between -3 and +3, i.e., the standard deviations are either three above or below the average. The durations were also normalized and, thus, presented on a logarithmic scale because participants' speech rates also vary. Converting the durations to an equal scale enables comparison. Otherwise, the results of participants with a significantly slower or a faster speaking rate may interfere with the final results. The durations were converted using the ‘log()’ function in R, which computes natural logarithms by default (The R Core Team 2026: 335). The scale used in this thesis ranges from 1–5.5 which is realized as 2.71 ms to 244.69 ms.

2.4 Results of the Case Study

For a comparison of the results, the Estonian learners of English are divided into two groups based on their proficiency levels. Participants with the proficiency levels B1 and B2 were grouped under B ($n = 7$) and participants with the proficiency levels C1 and C2 were grouped under C ($n = 13$). Collectively they are referred to as non-native speakers (NSS). Native speakers are represented as NS ($n = 10$).

2.4.1 Results of the Reading Task

The results are based on 2386 tokens of schwa by Estonian learners of English. There was total deletion of 14 tokens of schwa. This deletion was also apparent in the speech of native speakers of English since instead of 1200 tokens, there are 1171 tokens available for comparison (see Table 4). The elision of schwa often manifested as coarticulation, most commonly when surrounded by stops and fricatives. The coarticulation resulted in noise in the waveforms and the spectrogram in positions where schwa was expected to occur. For example, instead of *to see* [tə si:], participants occasionally deleted the schwa and pronounced it as [tsi:].

Table 4. Expected tokens of schwa vs. final number of tokens of schwa due to deletion in the speech of native speakers of English (NS) and non-native speakers of English (NNS) in the reading task.

	Expected	Final
Native speakers (NS)	1200	1171
Non-native speakers (NNS)	2400	2386

2.4.1.1 Quality of Schwa

Figure 6 illustrates the overall English vowel space of Estonian learners of English. The mean qualities of the schwa vowel are represented as a darkened jumble in the middle of the chart, marked with a red circle. The schwa vowel is isolated from other vowels. There is significant overlap with the FOOT vowel and slight overlap with the KIT vowel. All other vowels stand separately from the schwa vowel, indicating that in stressed syllables, Estonian EFL learners pronounce full vowels whereas in unstressed syllables, they pronounce reduced vowels.

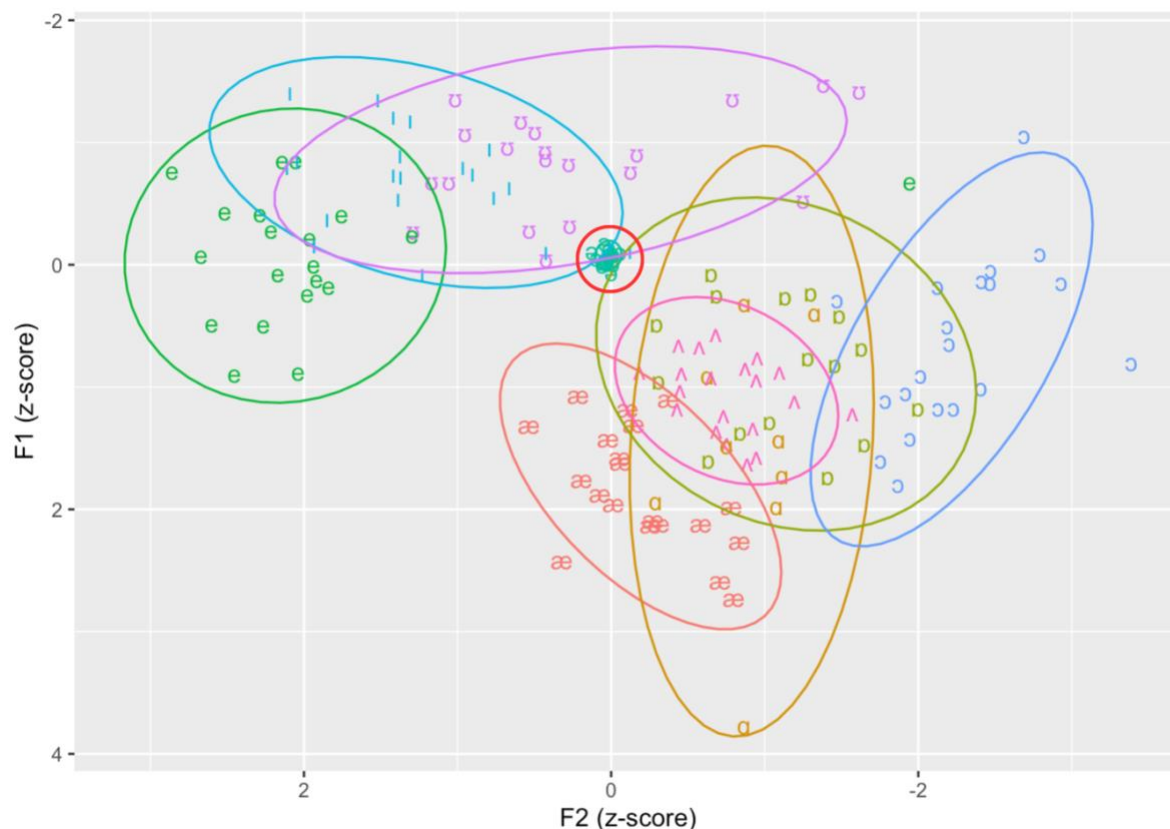


Figure 6. Normalized English F1-F2 vowel space by Estonian learners of English (reading task).

The measurements of the Estonian [ɤ] vowel obtained by Leppik et al (2023: 6) and repeated here for comparison next to the pronunciation of English schwa in the reading task by L1 Estonians are displayed in Figure 7. Taking the green dot or the crossing of the zero lines as the point of reference, the ellipse of the [ɤ] vowel skims over the central point. However, the symbol (ɤ) represents the mean measurement, showing that the [ɤ] vowel leans more towards back vowels.

In contrast, the schwa vowel produced by Estonian learners of English is tilted more towards being a front and high vowel. Since the ellipses of both vowels include the central point of the vowel space to some extent, there may be some overlap between the two pronunciations. Regardless, the two vowels are facing apart. The schwa vowel is more front whereas the [ɤ] vowel is more back. It appears that the measurements of schwa would situate it right between the three Estonian vowels [y ɤ ø] without any significant overlap with any of them.

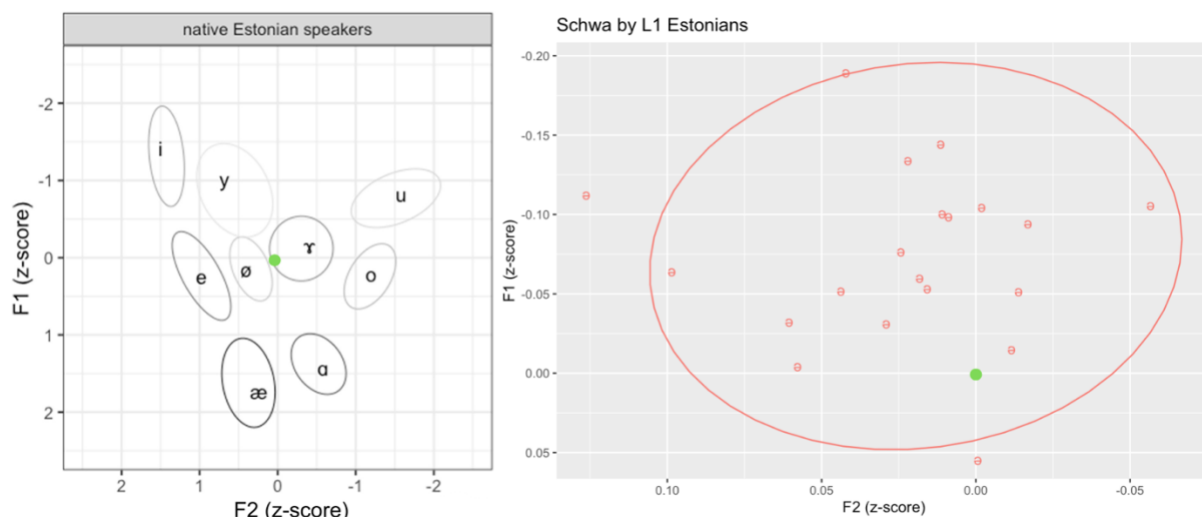


Figure 7. Acoustic measurements of Estonian vowels by ten native Estonian speakers, obtained by Leppik et al (2023: 6) (left) and the English schwa produced by Estonian learners of English in the reading task (right). The green dot marks the central spot of the z-score space.

While comparing the overall vowel space of Estonian learners of English to the vowel space of native speakers of English, there are many differences (see Figure 8). However, focusing on the schwa vowel, it is positioned nearly identically for all three groups. The quality of schwa by Estonian learners of English is slightly more central than the schwa produced by native speakers. Furthermore, there is no significant difference between the two Estonian groups, revealing that in terms of schwa's quality, the proficiency level is not an important variable.

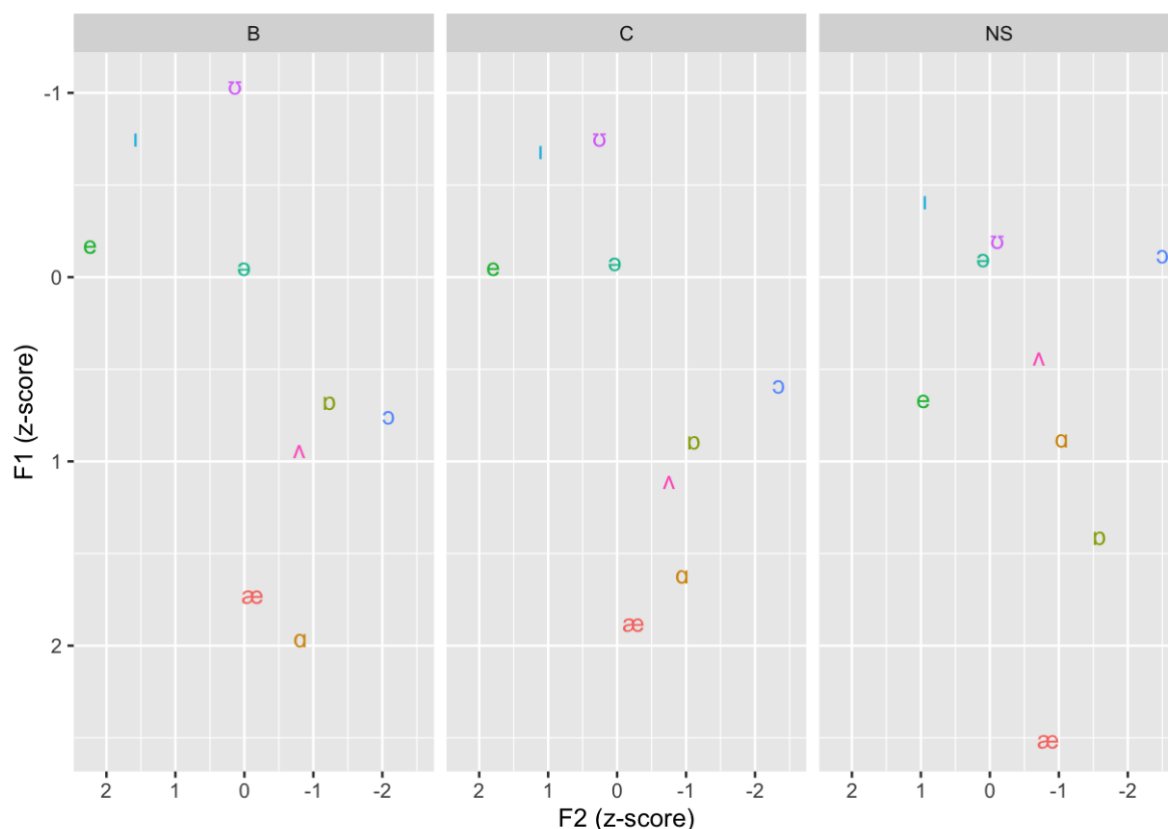


Figure 8. Positions of vowels in a normalized F1-F2 space according to proficiency levels (B and C) and native speakers (NS) (reading task).

Figure 9 illustrates the position of schwa in lexical and function words. The mean quality of schwas in lexical words is represented with a triangle and the mean quality of schwas in function words is represented with a dot. For the native speakers of English, the schwa vowel is situated centrally in lexical words, near the intersection of the graph. The results of Estonian learners of English are similar, regardless of proficiency level. The schwa in lexical words produced by Estonian EFL learners is slightly higher and shifted towards negative F2 z-scores whereas NS schwa is more on the positive side of the scale. However, the difference is small and hardly noticeable.

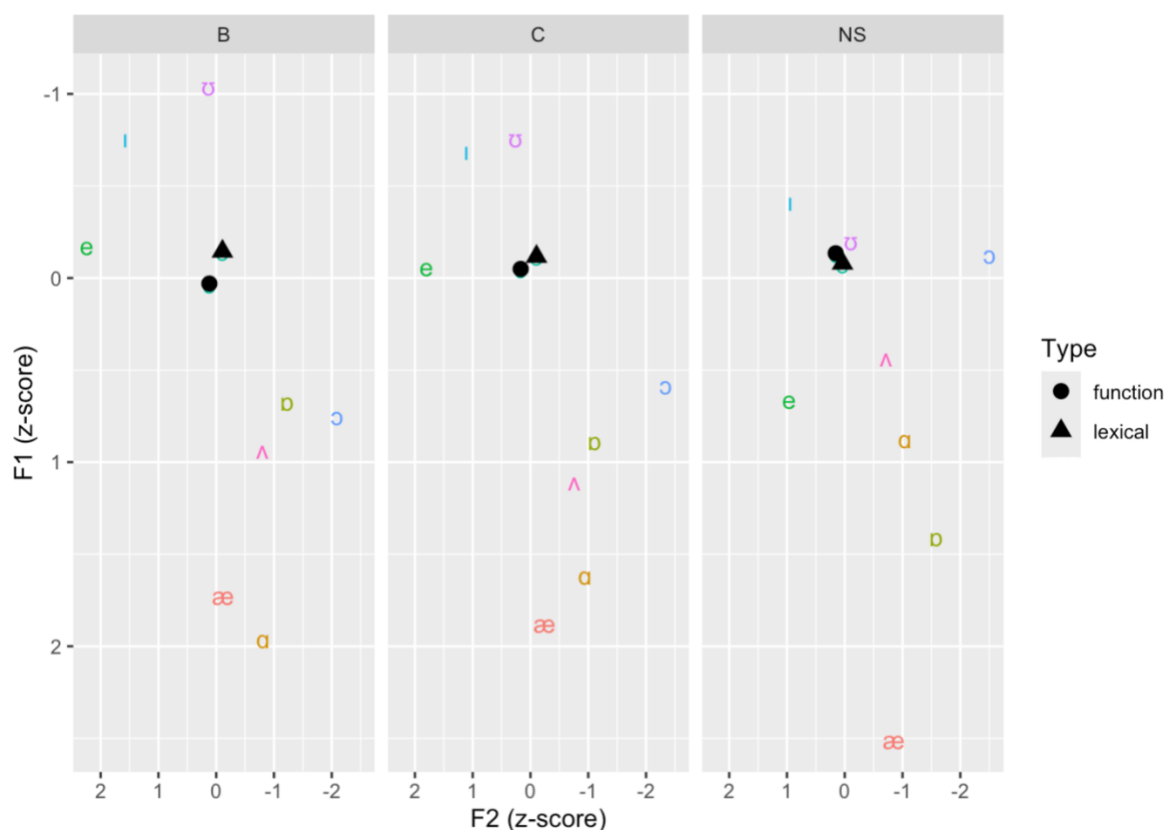


Figure 9. Position of the schwa vowel in lexical (triangle) and function words (dot) in the speech of Estonian learners of English based on proficiency levels (B and C) and native speakers of English (NS) in the reading task.

The position of schwa in function words is somewhat more distinct across the three groups. Overall, schwa is still the most central vowel as opposed to full vowels. Compared to the schwa in lexical words, it is slightly more front and higher in the speech of native speakers. The schwa in function words produced by Estonian learners of English with the proficiency level C is similar to their schwa in lexical words. It is situated a bit more front and lower in function words. The schwa in function words produced by Estonian learners of English with the proficiency level B has moved diagonally compared to their schwa in lexical words. Hence, in function words, it is more front and lower.

To evaluate whether the position of schwa in a word influences the quality of schwa, the test words were divided into three: word-initial, word-medial, and word-final. The results of the schwas in different positions can be seen in Figure 10. In the speech of native speakers, word-initial schwa, represented with a triangle, is higher than its usual central position and

highest out of the three positions. For both groups of Estonian learners of English, word-initial schwa is similarly positioned as the results of NS.

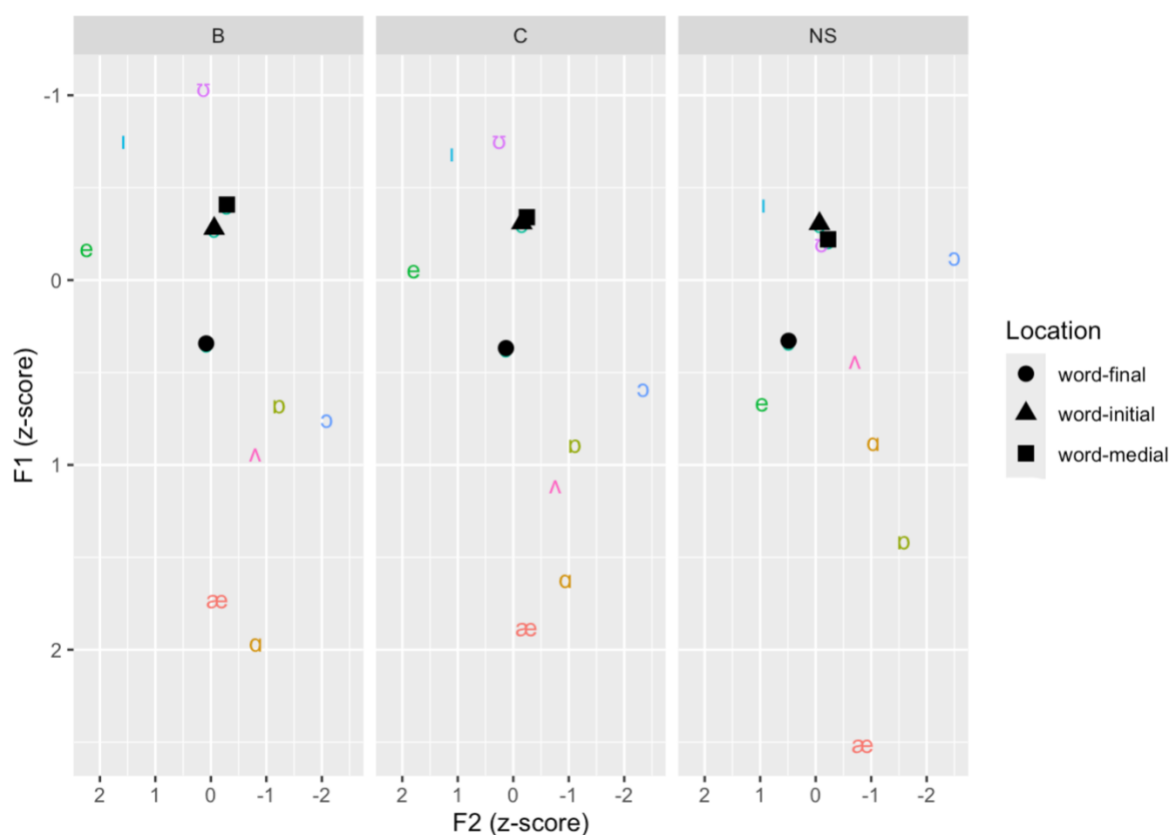


Figure 10. Quality of schwa in word-final (dot), word-initial (triangle), and word-medial (square) positions in the speech of Estonian learners of English based on proficiency levels (B and C) and native speakers of English (NS) in the reading task.

For the Estonian participants, however, the highest schwas are word-medial schwas, indicated with the square symbol. The word-medial quality of schwa in the speech of NS falls slightly below the quality of the word-initial schwa. Comparing these across the groups, the word-medial schwa is highest in the speech of B-level learners and lowest in the speech of NS. Both word-initial and word-medial schwas are pronounced with a rather closed jaw, indicated by the higher positions on the plot. In contrast to other full vowels, these are still the most central vowels. Interestingly, in the speech of NS, the FOOT vowel is entwined with the word-initial and word-medial schwas. This may suggest that the schwa vowel can be used

interchangeably with the FOOT vowel. In other words, in contexts where you would expect to find the FOOT vowel, native speakers may pronounce the schwa vowel.

Visually, there is a stark difference between word-final schwas (illustrated with a dot) compared to word-initial and word-medial schwas. For all three groups, word-final schwas are significantly lower and for the NS group, more front than the quality of schwas in the other two locations. The word-final schwas of B-level and C-level Estonians seem identical. Compared to the NS, the NNS word-final schwa is a little more central as it is right next to the vertical zero line. These results reveal that the word-final schwa is the most open schwa for all three groups as it is the lowest.

2.4.1.2 Duration of Schwa

Since duration or quantity of the schwa vowel as a result of vowel reduction is as telling as its quality, it was checked in comparison to other full vowels. The results are presented using box plots, where the full range of data is divided into four: the box represents 50% of the data and the vertical lines above and below the box show the top 25% and bottom 25% of the data, respectively (Nuzzo 2016: 268–269). The bold horizontal lines in the boxes serve as median lengths and extreme data values are marked with dots and considered outliers (Nuzzo 2016: 269).

Out of all the vowels, the schwa vowel is the shortest in the speech of Estonian learners of English because its horizontal bold line (the median) is the lowest. This can be seen in Figure 11. The schwa's median logarithmic duration is slightly above 3.5. Regardless, it also has largest variation, indicated by the wider box and more extensive whiskers. While the KIT and FOOT vowels are also the shortest (below 4), the medians of all other vowels are significantly higher with TRAP and THOUGHT being the longest ones.

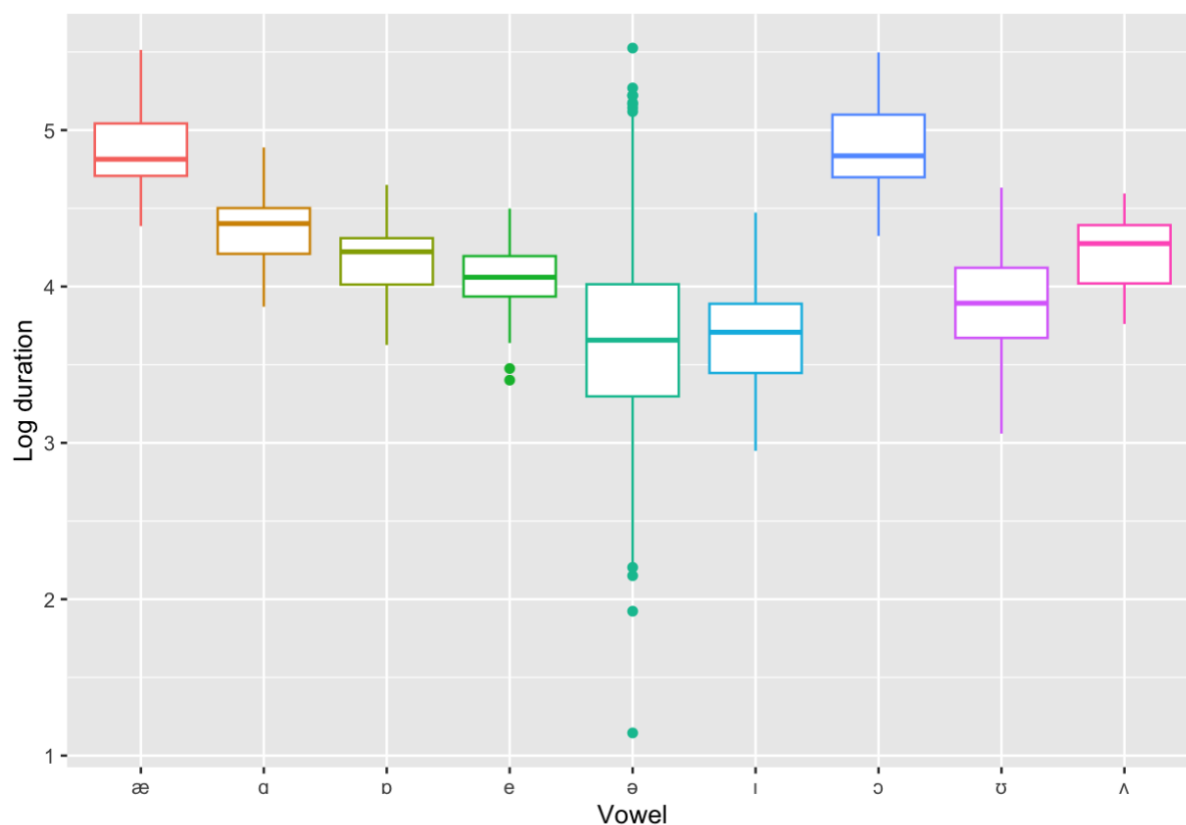


Figure 11. Vowel durations by Estonian learners of English (reading task).

The logarithmic vowel durations by native speakers of English are demonstrated in Figure 12. The median logarithmic length of the schwa vowel falls considerably under 3.5. Consequently, it is the shortest vowel produced by native speakers of English. Their schwa likewise varies in length, as seen by the wider box and broader whisker span. Similarly to Estonian speakers of English, the next two shortest vowels are FOOT and KIT and the longest are THOUGHT and TRAP.

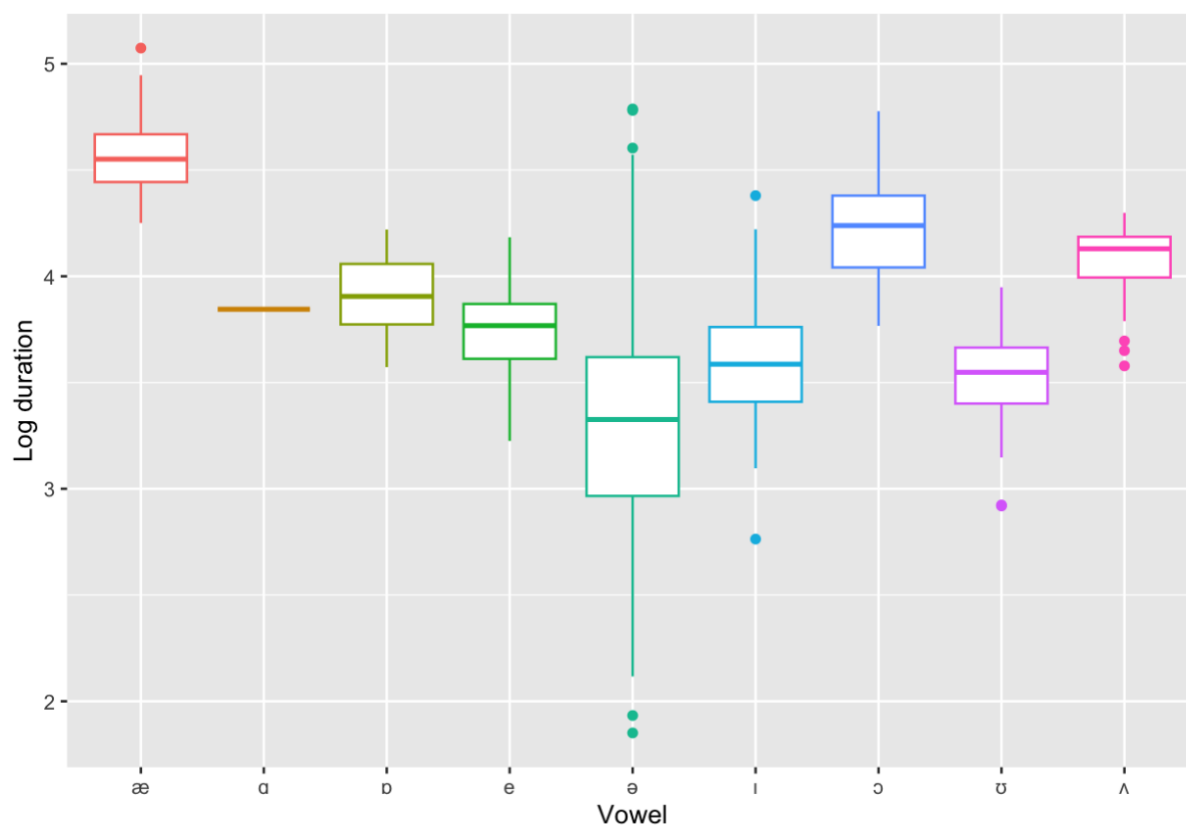


Figure 12. Vowel durations by native speakers of English (reading task).

According to the medians in Figure 13, indicated by bold horizontal lines in the boxes, the schwa duration is shorter in function words and slightly longer in lexical words by native speakers of English. Both median lengths are around 3.25. The box of lexical words ranges from a bit below 3 to around 3.75, indicating the range of schwa's length. In function words, this range is from 3 to around 3.5. In the speech of Estonian learners of English whose proficiency level is C1 or C2, there is no difference between the median durations of schwa in function and lexical words. Both medians are positioned above the 3.5 mark. The length of schwa in lexical words varies from 3.25 to 4 and it is around the same for schwa in function words.

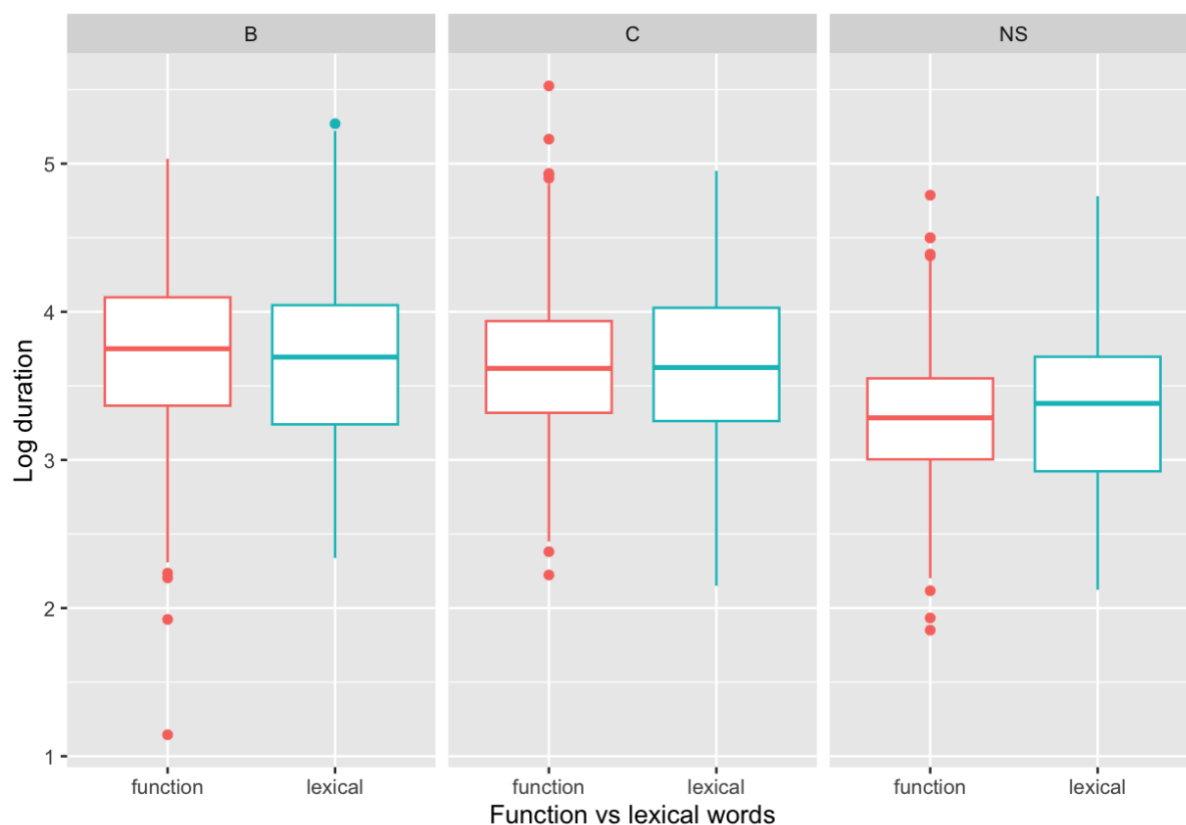


Figure 13. Duration of schwa in function and lexical words by proficiency levels of Estonian learners of English (B and C) and native speakers of English (NS) in the reading task.

Although the median of schwa in function words pronounced by Estonian learners of English with a B level of proficiency is slightly above the median length of schwa in lexical words, the difference is minuscule. Both medians are near the 3.75 mark. Hence, the median length increases by 0.25 with each group. The difference in medians between the NS and B groups is 0.5. Hence, the schwa in both function and lexical words is longer and lengthened by Estonian learners of English, especially those within the proficiency level B group.

The logarithmic durations of schwa are divided according to schwa's position in a word in Figure 14. The results of native speakers of English reveal that schwa is shortest in a word-medial position, followed by word-initial position, and longest in a word-final position. The order is the same for both groups of Estonian learners of English. The median length of word-medial schwas in the speech of NS is around 2.75. There is considerable variation, signified by the box, the difference in length being around 1 logarithmic duration. The median length of

schwas in a word-initial position is slightly below 3.5. Word-final schwas are the longest, with the median at around 3.75.

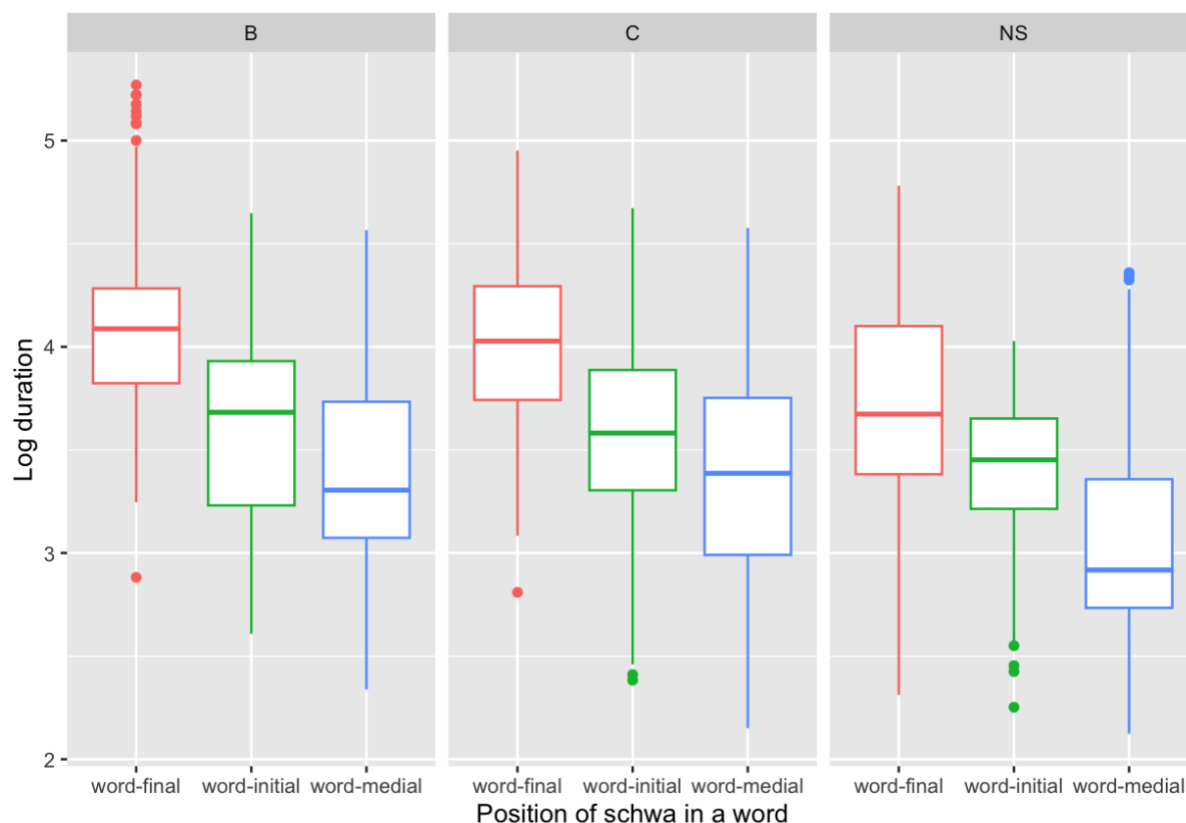


Figure 14. Duration of schwa according to its position in a word by Estonian learners of English (proficiency levels B and C) and native speakers of English (NS) in the reading task.

Estonian participants with a proficiency level C in English pronounce the word-medial schwa with a longer duration than participants with a proficiency level B. While the median length of schwa in word-medial position is a bit below 3.5 for C-level participants, it is around 3.25 for B-level participants. In contrast, those with a proficiency level C pronounce the word-initial schwa for a shorter duration than B-level participants. The medians are around 3.5 and 3.75, respectively. The word-final schwa is lengthened similarly in both groups with the median standing slightly above 4.

Compared to the results of native speakers, the overall lengths of schwas are longer for Estonian learners of English. However, there is a clear contrast between the three positions in the speech of both native speakers and Estonian learners of English. Also, the contrast is the

same for all three groups: the shortest are schwas in word-medial positions and the longest schwas are in word-final positions.

2.4.2 Results of the Storytelling Task

The results of the storytelling task are based on 200 tokens of schwa for Estonian learners of English. From each participant, five schwas from function words and five schwas from lexical words were obtained, totaling at 100 schwas from function words and 100 schwas from lexical words (see Table 5). In addition, eight full vowels: TRAP, KIT, DRESS, THOUGHT, LOT, PALM, STRUT, and FOOT were annotated for comparison from the recordings of each participant. The same procedure was repeated with the recordings of the native speakers, totaling at 50 schwas from function words and 50 schwas from lexical words. The obtained words and their quantity vary because of the nature of the material. The lengths of the narrations differed greatly, ranging from less than thirty seconds to more than two minutes.

Table 5. Number of each lexical and function word obtained from the storytelling task recordings from native speakers of English (NS) and Estonian learners of English (NNS).

	Word	NS	NNS	Total
Lexical	American	5	3	8
	astronaut	11	26	37
	helmet	1	0	1
	panda	17	35	52
	soda	16	36	52
Total				150
Function	a	10	18	28
	and	10	14	24
	as	0	3	3
	at	4	6	10
	but	1	3	4
	of	7	16	23
	the	12	15	27
	to	6	16	22
	was	1	8	9
Total				150

2.4.2.1 Quality of schwa

Figure 15 illustrates the overall F1-F2 vowel space of Estonian learners of English based on the material obtained from the storytelling recordings. There is a significant overlap between most of the vowels. The full vowels have quite large ellipses, signifying considerable standard deviations, i.e., variation. However, it may also be caused by the small number of measurements for the full vowels. Focusing on the schwa vowel, the only vowels that the schwa does not overlap with are the KIT, THOUGHT, TRAP and PALM vowels. This shows that the DRESS, FOOT, STRUT, and LOT vowels can be quite central at times. Regarding the schwa vowel, it is positioned rather centrally and more front and high than back and low.

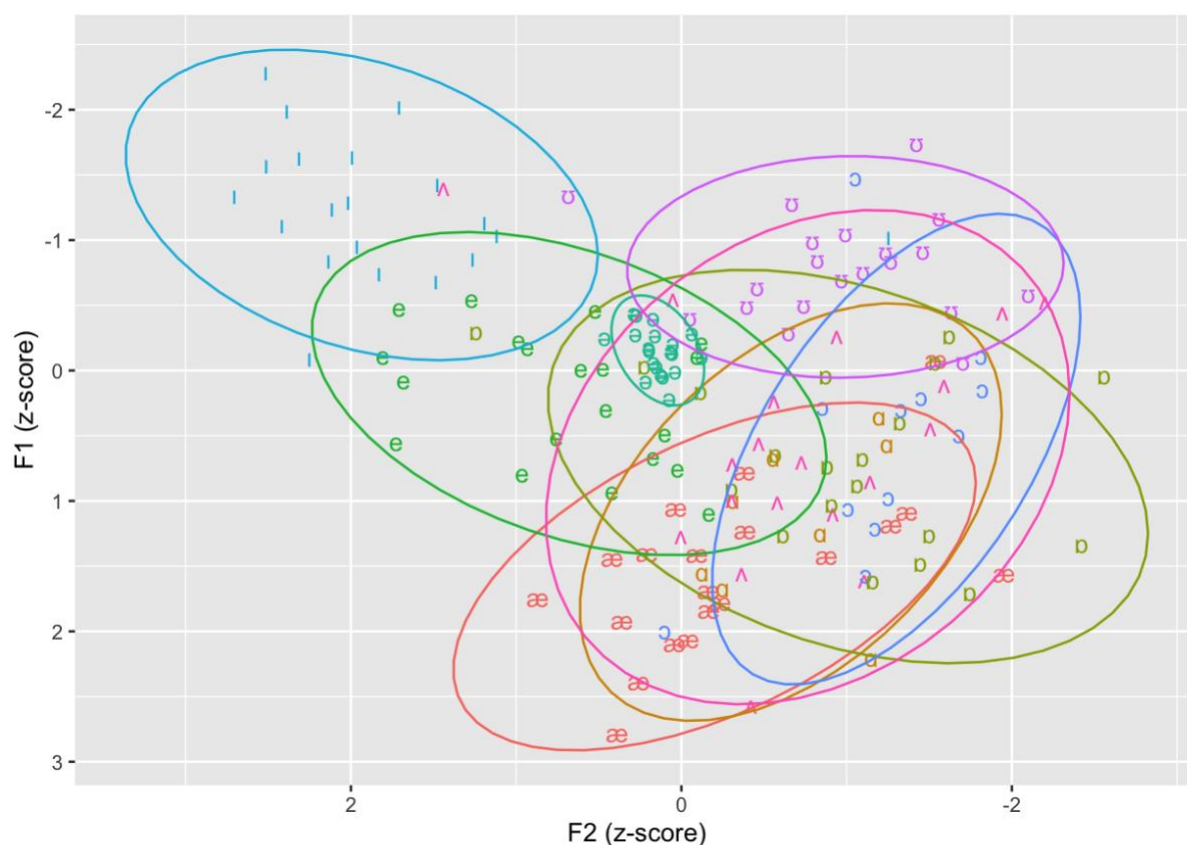


Figure 15. Normalized English F1-F2 vowel space by Estonian learners of English (storytelling task).

Comparison of the Estonian [ɤ] vowel to the pronunciation of English schwa in the storytelling task by L1 Estonians can be seen in Figure 16. The point of reference is the green dot or the crossing of the zero lines. While the [ɤ] vowel in the speech of native Estonians is

positioned more to the right from the central point, the schwa vowel is leaned towards the left. This means that while the Estonian [ɤ] vowel is more of a back vowel, the vowel Estonian learners of English pronounce in unstressed syllables is more of a front vowel. Although there is little overlap around the midpoint of the z-score space as the ellipses of both vowels include the intersection, the two vowels do not match otherwise. In fact, since it is more front and angled towards the front of the mouth, it rather resembles the Estonian [ø] vowel based on the first two formants.

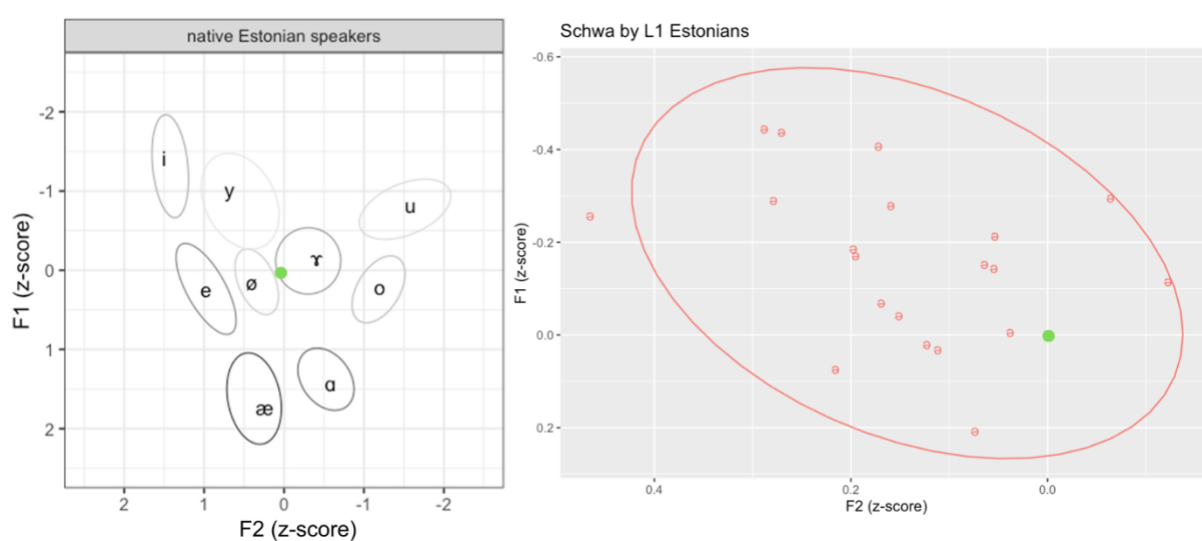


Figure 16. Acoustic measurements of Estonian vowels by ten native Estonian speakers, obtained by Leppik et al (2023: 6) (left) and the English schwa produced by Estonian learners of English in the storytelling task (right). The green dot marks the central spot of the z-score space.

The storytelling results of Estonian participants divided based on proficiency levels B and C are compared to the results of native speakers in Figure 17. The schwas are positioned similarly across the three groups. For native speakers of English, the schwa vowel is central compared to other vowels. It is slightly high and front. The schwa produced by C-level Estonian learners of English is situated in a nearly identical position to the native speakers' schwa. Compared to the other two groups, the schwa pronounced by B-level Estonian learners of English is a bit lower but nevertheless, the most central vowel in the vowel space.

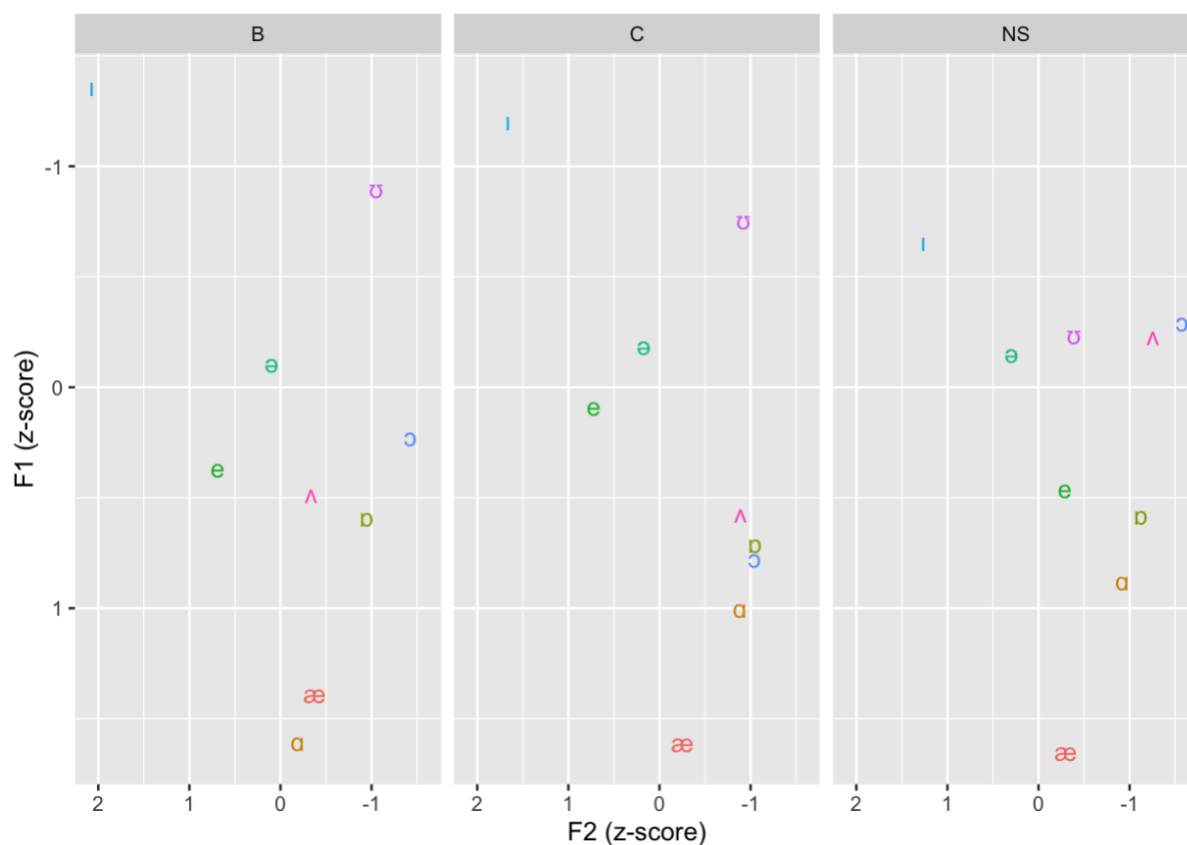


Figure 17. Positions of vowels in a normalized F1-F2 space according to proficiency levels (B and C) and native speakers (NS) (storytelling task).

The schwa position in lexical words in spontaneous speech, represented with a triangle, varies across the three groups as seen in Figure 18. The schwa position in this setting in the speech of native speakers is quite standard, above and in front of the zero lines. However, both Estonian groups pronounced lower schwas in lexical words. Estonian learners of English with the proficiency level C have a more front schwa in this setting than Estonian learners of English with the proficiency level B.

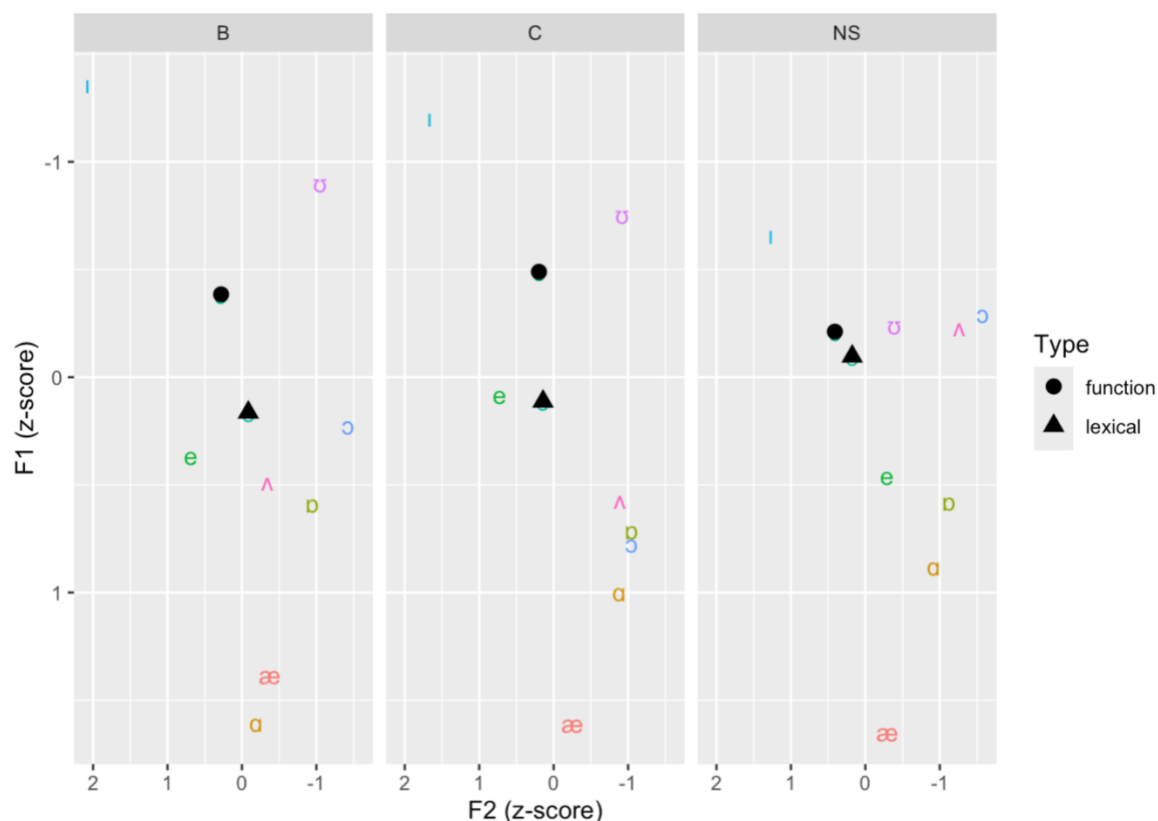


Figure 18. Position of the schwa vowel in lexical (triangle) and function (dot) words in the speech of Estonian learners of English based on proficiency levels (B and C) and native speakers of English (NS) in the storytelling task.

Compared to lexical words, schwa in function words by native speakers is similarly situated, if only a little bit higher. In contrast, both groups of Estonian EFL learners produced a much higher schwa in function words. While it is fronted alike according to the F2 score, it is nearly on the -0.5 mark for C-level Estonian participants and slightly below it in the speech of B-level Estonian participants. Consequently, they are the highest schwas produced in the contexts of this thesis. Regardless, compared to other full vowels, they can still be considered rather central.

2.4.2.2 Duration of Schwa

The durations of vowels on a logarithmic scale produced by Estonian learners of English in a spontaneous speech environment are displayed on Figure 19. The median logarithmic length of schwa is above 3.5, indicated by a thick horizontal line inside the box. The box is expansive, showing that its duration can vary from around 3.25 to 4.25. Furthermore, it has the

widest whiskers, which signifies a larger variation in length. Nevertheless, it is the shortest vowel compared to the other vowels. The two other shortest vowels based on median lengths are KIT and FOOT and the longest vowels are TRAP and LOT.

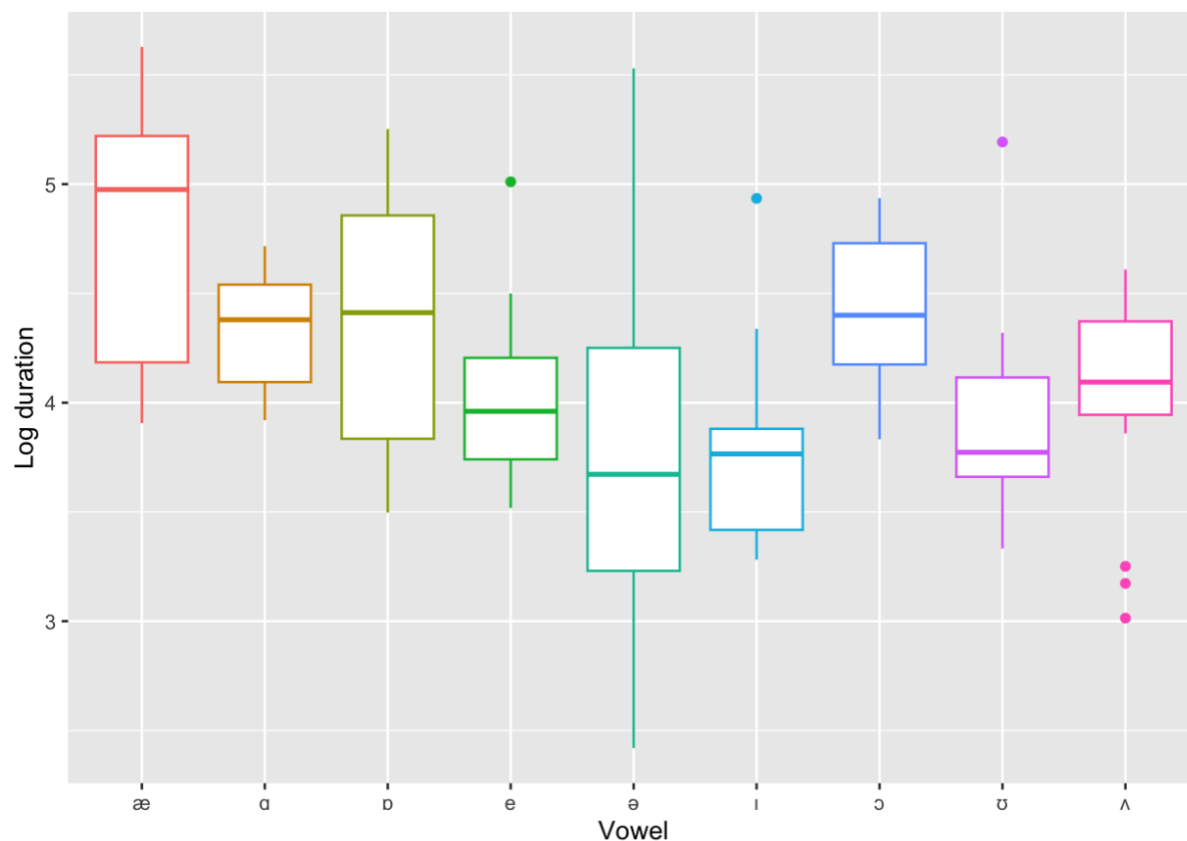


Figure 19. Vowel durations by Estonian learners of English (storytelling task).

Figure 20 illustrates the durations of full vowels and the schwa vowel in the speech of native speakers of English in a spontaneous speech environment. The median length of the schwa vowel falls in line with the 3.5 mark. Its length varies from slightly above 3 to 4 and it has the largest variation, demonstrated by its wide whiskers. The schwa vowel is the shortest vowel out of all the vowels. Its median length is almost identical to the median length of the FOOT vowel, the next shortest vowel. The two longest vowels in the speech of native speakers in this environment are LOT and THOUGHT.

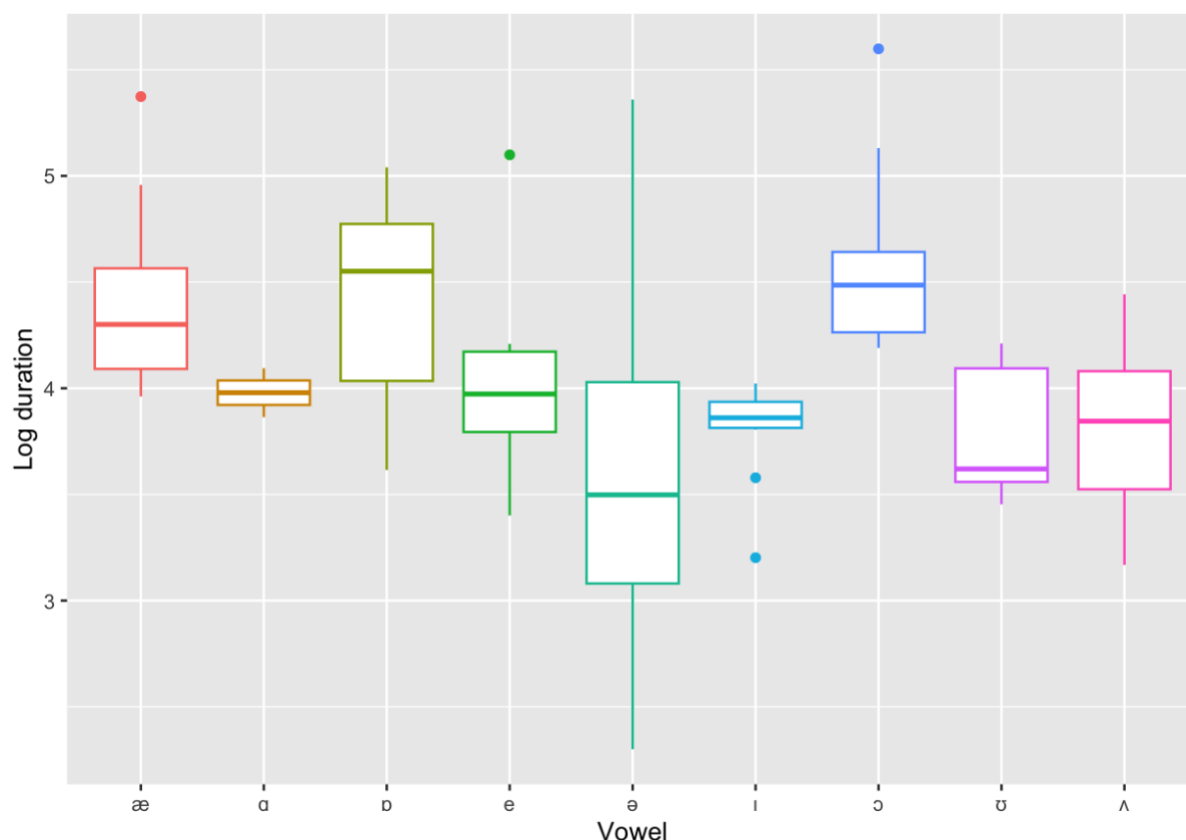


Figure 20. Vowel durations by native speakers of English (storytelling task).

The length difference between schwa in lexical and function words can be seen in Figure 21. The difference is smallest between the two word classes in the speech of native speakers of English. The median logarithmic length of schwa in lexical words is slightly above 3.5. However, it exhibits great variation as its length can vary from 3 to 4.5. In function words, the median length falls below 3.5 and the variation is not as extensive, ranging from slightly above 3 to slightly above 3.5.

There is a larger difference between the lengths in the speech of Estonian learners of English, especially in the speech of B-level Estonian participants. The median length of schwa in lexical words by C-level Estonian participants falls just below 4 whereas it is above 4 for B-level Estonian participants. In addition, while the length may vary from 3.25 to 4.5 for C-level Estonian participants, it can be as long as 4.75 for B-level Estonian participants.

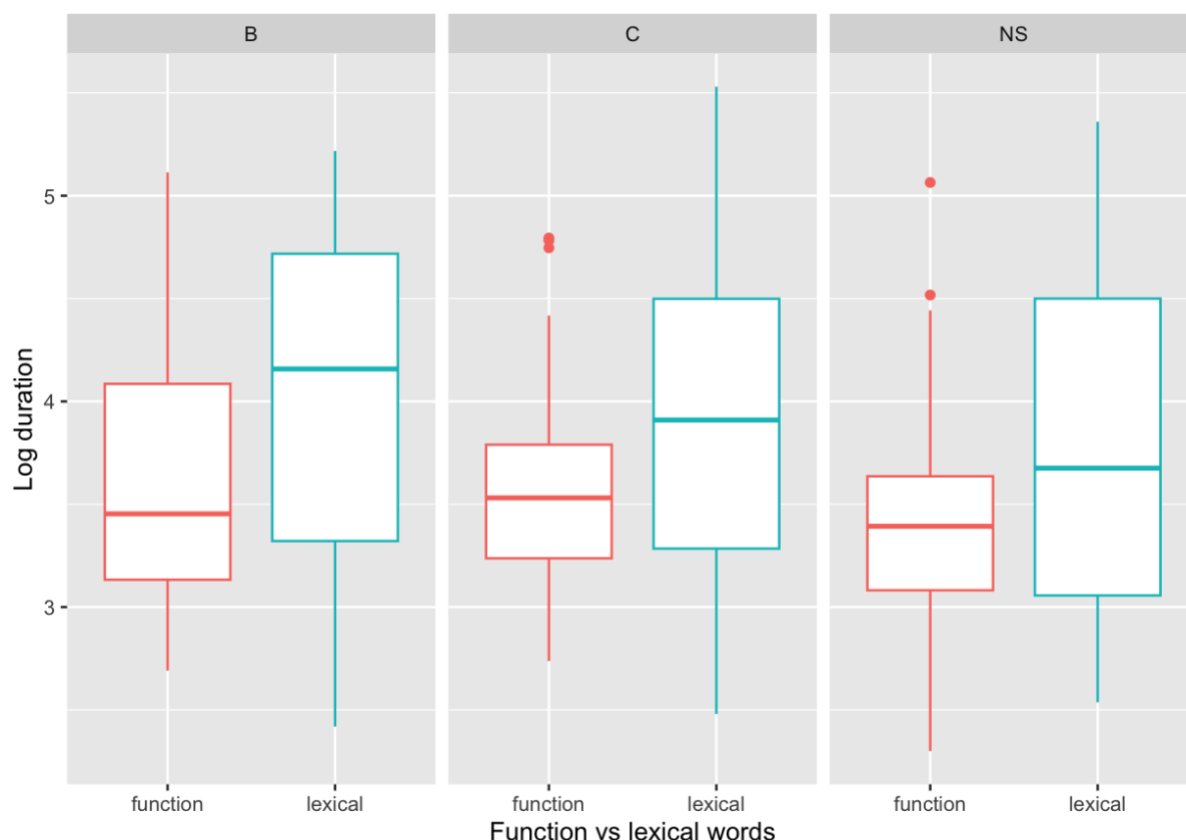


Figure 21. Duration of schwa in function and lexical words by proficiency levels of Estonian learners of English (B and C) and native speakers of English (NS) in the storytelling task.

In function words, the median length is 3.5 in the speech of Estonians with C-level proficiency, and its length may vary from 3.25 to 3.75. While the median is lower for Estonian students with a B-level proficiency, standing slightly below 3.5, its length ranges from 3.25 to slightly above 4 in function words. Compared to the results of native speakers, the length of schwa in both lexical and function words was produced similarly by C-level Estonian participants while the medians and variation differed most for B-level Estonian participants.

The estimated logarithmic median durations of schwas in both the reading task and the storytelling task are presented in Table 6. The schwas produced by native speakers were the shortest, both in comparison to full vowels and in all of the contexts, even falling below 3.0 in the word-medial position. The schwa was shorter in the reading task and slightly longer in the storytelling task for NS. The overall length of schwa in the reading and storytelling tasks differed by 0.1 for Estonian learners of English. In the reading task, the lengths of schwas in

function and lexical words were nearly identical and differed minimally between groups. However, the contrast was larger between schwas in function and lexical words in the storytelling task. While the median lengths differed by 0.4 in the C group, the median length difference was 0.7 for the B group. Regarding the location of schwa in a word, the main difference between the B and C groups concerns the word-medial schwas, where the B group shortened the schwas more, creating a stronger contrast between the three locations.

Table 6. Summary of the logarithmic median durations in the reading and storytelling tasks by native speakers (NS) and Estonian learners of English (NNS) overall and according to proficiency levels B and C.

Type of duration	NS	NNS	
Overall (reading)	3.25	3.6	
Overall (storytelling)	3.5	3.7	
		B	C
Function lexical (reading)	3.25 3.4	3.75 3.75	3.6 3.6
Function lexical (storytelling)	3.4 3.7	3.5 4.2	3.5 3.9
Final initial medial (reading)	3.75 3.5 2.9	4.1 3.75 3.25	4 3.6 3.4

2.5 Discussion

The first research question was posed to observe how unstressed vowels are pronounced by Estonian EFL learners. The results of the reading task reveal that the schwa is positioned centrally compared to full vowels in the speech of both native speakers and Estonian learners of English. While there is a slight overlap in the speech of L1 Estonians with the KIT, FOOT, and schwa vowels, it is not unexpected, as these three vowels are the main targets for vowel reduction (cf. Duckinowska 2021: 279). Hence, it may be the case that in some unstressed syllables, the FOOT or KIT vowels are used instead of the schwa vowel. In the vowel chart of the storytelling task (see Figure 15), there is considerable overlap between most of the vowels, revealing that some full vowels in spontaneous speech of L1 Estonian learners, such as STRUT and LOT, may be quite ambiguous at times. However, the schwa vowel is nevertheless the most central and is positioned similarly to the pronunciation of the native speakers. In fact, in both

the reading task and the storytelling task, the schwa's produced by Estonian EFL learners were slightly more central than those by NS. While it may suggest L1 influence of the more back [ɤ] vowel, it can also be illustrating the ambiguity of central vowels.

The second research question was posited to identify whether the schwa vowel is the most common target reduced vowel. The quality of schwa in the reading and storytelling tasks confirms that in unstressed syllables, where native speakers would pronounce the schwa vowel, the target reduced vowel for Estonian participants is also schwa. Since Standard Estonian is schwa-less, it was hypothesized that Estonian learners of English might transfer the familiar [ɤ] vowel from their L1 in place of the English schwa (cf. Flege and Bohn 2021). Based on the results of this study, Estonian learners of English have created a separate phonetic category for the English schwa vowel instead of transferring the familiar L1 central vowel [ɤ] (see Figure 7 and Figure 16). While there is some overlap between the two vowels, the similarities are minimal. In the reading, the schwa pronounced by Estonian learners of English leans more towards being a front vowel whereas the [ɤ] vowel is positioned more backward. Interestingly, the schwa vowel in the storytelling is more front and tilted more sharply towards the front of the mouth. In that sense, it resembles the [ø] vowel, one of the vowels that Kostabi (1993: 90) suggested might be transferred by Estonians. Since there is only a slight overlap with the surrounding vowels and the [ɤ] vowel is facing apart from the English schwa vowel in the F1-F2 vowel space, it is reasonable to assume that there are two different vowel categories representing the Estonian [ɤ] vowel and the English schwa vowel in L1 Estonian speech.

It may be the case that the two vowels are not acoustically and perceptually as similar as they might have seemed. As it was pointed out by Major (2008: 74) and Winifred and Strange (2008: 172), it is not always clear what constitutes as similar since similarity is often not well-specified. In addition, since the Estonian participants were intermediate (B) and advanced (C) speakers of English, their perception and distinction abilities may have improved over time of

acquiring English. Thus, like Chang (2015: 206) highlighted, L2 learners might not rely on acoustic proximity to use similar phonemes as the learning progress advances. Accordingly, Estonian learners of English have successfully created a new phonetic category for the English schwa vowel instead of transferring their familiar [ɤ] vowel from their L1.

The influence of English in Estonia has been gradually growing since Mutt (1978) and Kostabi (1993) suggested that Estonians may replace the schwa vowel with familiar sounds from Estonian. It is likely that Estonian learners of English have encountered enough reduced forms to become accustomed to them. Notably, the study by De Wilde et al (2020: 178) found that 22% of proficiency scores were explained through informal learning settings, such as use of social media, gaming, etc. When asked about the contexts in which they use English, the participants of this study selected all—reading, listening, writing, and speaking. Only two participants excluded the ‘speaking’ option. Hence, Estonian EFL learners are relatively exposed to English in various ways and probably not only in classroom settings. However, as a recommendation for further research, it would perhaps be helpful to let the participants evaluate the types of English input and output they are exposed to. Also, it would help to ask the participants to estimate the time spent using English or receiving English input to get a clearer idea of when and how much learners encounter English pronunciation.

Overall, the quality of schwa is overwhelmingly similar between the two Estonian groups and the native speakers. The only context in which both Estonian groups significantly differ from the native speaker group is between the quality of schwas in lexical and function words in the storytelling task (see Figure 18). The schwas pronounced by Estonian participants in lexical words are much lower than the schwas in function words whereas there is a small difference between the two types in the NS group. In the reading task (see Figure 9), the quality distinction between schwas in lexical and function words can be deemed insignificant for all three groups. Thus, in a spontaneous speech environment, Estonian learners of English

pronounce a much more close and high schwa in function words and a lower schwa in lexical words. In other words, Estonian learners of English open their jaw less for schwas in function words and more for schwas in lexical words.

The durations measured in the reading task revealed that the vowels in unstressed syllables, annotated with the symbol [ə] were indeed the shortest vowels compared to all other vowels. In an effort to see whether Estonian learners of English have a preference of strong forms, drawing from the findings of Ghazali and Bouchhioua (2003) and Poesová and Weingartová (2018), the quality and duration of schwas in function and lexical words were extracted and presented for comparison. In the reading task, the quality of schwas was nearly identical in both contexts and the median durations matched for both function and lexical words. Based on these results, Estonian learners of English may potentially prefer strong forms over weak forms in a reading environment since a lack of a distinction in length and quality was detected. However, this may also mean that the schwa vowel is unnecessarily elongated in function words, yet the quality distinction remains. For listeners who are more sensitive to vowel quality instead of vowel length distinctions, such as native English speakers (McAllister et al 2002: 231), they could still understand the message intelligibly. For instance, in the example *she's going too fast—she's going to fast* (Ghazali and Bouchhioua 2003: 963), Estonian EFL learners may lengthen the function word *to* but keep the quality of schwa. Hence, their pronunciation would rather resemble /ə:/ instead of /u:/. Yet, for more conclusive results, further research is necessary, perhaps through minimal pairs, such as *too* and *to*.

In the storytelling task, however, the distinction between schwas in function and lexical words was sharper. To recall, the schwas in function words were pronounced with more closed jaws than the schwas in lexical words. The schwa in function words pronounced in a spontaneous setting by NS was more central than the schwa by L1 Estonian participants. However, the schwa in lexical words was closer to the central position than in function words.

Thus, the assumption that centralization is more evident in grammatical words (Brzezicha and Kul 2014: 3; Duckinoska 2021: 279) did not hold true for this thesis, even in the speech of NS. Although the schwa in function words was more central in the speech of NS than NNS, the schwa in lexical words was more central in the spontaneous speech setting.

In addition, the difference in median lengths between function and lexical words is much more substantial in the storytelling task. Schwas in function words are significantly shorter than schwas in lexical words, especially by B-level Estonian learners of English. Based on these findings, the more closed jaw and a shorter duration for schwas in function words indicates that speakers allot less time for schwas in these types of words. Thus, in contrast to the findings in the reading task, function words in the spontaneous speech of Estonian EFL learners are accurately pronounced as weak forms. This accurate use of weak forms in turn determines the correct rhythm of speech which is characteristic of English pronunciation (Carley and Mees 2020: 1). It may be the case that the participants used more hyperspeech in the reading task and hypospeech (cf. H&H theory by Lindblom 1990) in the spontaneous speech environment. Perhaps the participants felt the need to be more precise in their pronunciations in the reading task since it is not as natural as spontaneous speech, as mentioned by Sönning (2014: 170).

The schwas in lexical words were also checked for the in-word positions they were in (see Figure 10). This was possible solely in the reading task as it was a controlled environment. In terms of quality, the word-final schwas were much lower for all three groups, indicating a more open jaw. The word-initial vowels were highest for NS while word-medial vowels were highest for NNS. Perhaps NNS were affected more by coarticulation, which resulted in higher schwas, because the sounds following word-medial schwas were /n b t s/, all of which are pronounced in the front of the mouth. Regardless, the qualities of the word-medial and word-initial vowels were barely distinct. The durations, however, revealed a clear hierarchy. For all three groups, the shortest schwas were in word-medial positions and the longest in word-final

positions, leaving word-initial between the two. According to the claims of Napoli and Clopper (2024), word-medial schwas are shortest due to coarticulatory pressure. Thus, the position of word-medial schwas in the hierarchy of durations was to be expected.

In contrast, the word-final schwas being the longest was unforeseeable because Weijer et al (2019) hypothesized that word-final schwas would be more sensitive to reduction due to a lack of time. It may be that the final syllables were longest since it is common for people to lengthen word- and phrase endings. Syllable prolongations, including utterance-final syllable prolongations are aspects of prosodic temporal phenomena which are features of human speech (Zellner 1994: 41). Therefore, the word-final schwas may be longest due to a common characteristic of human speech, prolonging syllables. This might also explain the lower quality of word-final schwas. The jaw relaxes with the prolonged syllable and gradually opens more, resulting in a lower quality.

The expected influences from the learners' L1 and proficiency levels failed to manifest in the results. Even though the schwa vowel does not exist in Standard Estonian, learners were able to produce native-like schwa qualities in both the reading task as well as the storytelling task. Hence, the acoustically close Estonian central vowels [ø ɤ] did not interfere with their English pronunciation. Also, the ability to pronounce schwa vowels shorter than any other vowel may be an indication of L1 positively influencing Estonian EFL learners, due to the complex quantity system of Estonian. As a possibility, Estonians must perceive length distinctions in the speech of native speakers of English and therefore, accurately produce the distinctions themselves. Therefore, this sensitivity to durational contrasts may have aided Estonian EFL learners with vowel reduction by regarding duration as a cue to reduce.

As mentioned, Estonian has a highly regular sound-to-print correspondence (Viise et al 2011: 425) which might hinder Estonians' quality of schwa by retaining full vowels in unstressed syllables. In fact, Poesová and Weingartová (2018: 98) noticed the strong influence

of orthography in Czech speakers of English. However, the results of the reading task, where spelling could affect results, and the storytelling task, with only one written cue, were similar in terms of schwa's quality. The possible influence of orthography could have manifested in the lower F1 quality of word-final schwa's as they were all written with <a>. Yet, had this been the case, it should have likewise influenced the word-initial schwa's as they were also written with <a>'s but did not. Since all the vowels in the F1-F2 plots were quite ambiguous and they often overlapped, it is possible that orthography influences other vowels produced by Estonian EFL learners. However, this should be further researched to draw definite conclusions. Regardless, orthographic influence was not noted in the quality of schwa in the speech of Estonian EFL learners.

Finally, many studies (Ghazali and Boucchioua 2003; Duckinoska 2021; Verbeke et al 2025) maintained that there is a positive correlation between higher proficiency and more accurate vowel reduction. To test this, the Estonian learners of English were divided into two (B and C) based on respective proficiency levels. In general, however, the Estonian learners of English performed similarly despite their proficiency levels. The differences in quality were always minimal and even if there were variations between the NS and NNS groups, the Estonian B- and C-level participants always behaved similarly except for some differences in the length distinctions. The B-level participants produced shorter word-medial schwas in the reading task and shorter schwas in function words in the storytelling task, creating a larger contrast between schwas in function words and schwas in lexical words. In all other contexts, the schwas by B-level learners were longer than those by C-level learners. Nevertheless, the differences were rather insignificant.

What should be kept in mind is that the two groups were not balanced. There were seven people in the B-level groups and thirteen in the C-level groups. It is possible that a more balanced comparison could have facilitated different results. The division to groups based on

the LexTale test (Lemhöfer and Broersma 2012) might be a limitation of this thesis since the LexTale test categorizes learners based on a lexical decision task. While learners may recognize a word and know its spelling, it does not necessarily reflect the learners' knowledge of pronunciation. Furthermore, out of the twenty participants, sixteen had had phonetic training at university in addition to previous education levels (see Figure 3). Hence, their previous knowledge might have aided in the native-like results. In future research of the topic, A-level learners and learners who have not been taught English phonetics should be included to definitively conclude whether there are differences based on proficiency levels in Estonian EFL learners.

A possible explanation for the notable success of reducing vowels and pronouncing a native-like schwa by Estonian learners of English could also be merited to word frequency. For instance, Poesová and Weingartová (2018: 111) acknowledged the likelihood of word frequency accounting for successful pronunciations of some words, such as articles, by Czech English learners. The chosen words for this thesis were not checked for frequency. Instead, they were selected with the goal of being familiar for all learners regardless of proficiency levels. A way to check the influence of word frequency would be by creating pseudo words or selecting infrequent words for pronunciation. It would then be possible to see whether learners would alternate between stressed and unstressed syllables in a native-like manner. Consequently, it would be possible to observe whether the vowels in unstressed syllables of such words would resemble the schwa vowel.

All in all, Estonian learners of English were successful in reducing vowels in unstressed syllables based on quality and duration. The unstressed vowel claimed the central region of the F1-F2 vowel space, represented as the vowel schwa. Accordingly, the schwa vowel was the target reduced vowel. The results suggest that Estonian learners of English have distinguished the schwa vowel from the Estonian [ʏ] vowel and by doing so, have created a new phonetic

category for the English schwa vowel. The assumed influences of the high sound-to-print correspondence of Estonian and level of English proficiency did not deter Estonian EFL learners' pronunciation of schwa. Instead, the complex quantity distinction of Estonian might have aided the L2 learners' perception of unstressed vowels as they are considerably shorter than stressed vowels.

CONCLUSION

The aim of this study was to observe the pronunciation of the vowel schwa as a result of vowel reduction in the speech of Estonian learners of English. The hypothetical observations of Mutt (1978) and limited findings by Kostabi (1993) gave incentive to research this topic empirically since reduction to schwa had not been previously studied. The first research question was posed to identify how English vowels in unstressed syllables are positioned in an F1-F2 vowel space in the speech of Estonian learners of English. The objective of the second research question was to evaluate whether Estonian learners of English use the schwa vowel as a target reduced vowel in unstressed syllables where schwa was expected to occur. Flege and Bohn's (2021) revised Speech Learning Model provided the theoretical framework of phonetic categories existing in the shared phonetic space in the bi- or multilingual brain. According to the SLM-r, this causes learners to filter L2 sounds through already familiar L1 sounds, facilitating L1 influence or interference. Thus, it was hypothesized that learners might not create a new phonetic category for schwa in English but transfer a perceptually similar L1 vowel [ʏ] in its stead.

A pronunciation test was conducted to fulfill the aim of the thesis and test the hypothesis. Ten native speakers of British English made up the control group and the test group consisted of twenty Estonian learners of English. The test group was divided into two based on their proficiency levels. There were seven participants in the B-level group and thirteen in the C-level group. The pronunciation test was divided into two: a reading task and a storytelling task. The purpose was to assess whether results would differ in a controlled and a spontaneous speech setting. In the reading task, participants were asked to read twenty sentences thrice, containing 60 schwas for analysis. The chosen sentences included both lexical and function words with schwas. Lexical words were further divided into three based on the position of schwa in the word: word-initial, word-medial, and word-final. In total, 2386 tokens of schwa by Estonian

EFL learners were gathered for analysis. In addition, 200 tokens of schwa were gathered from the storytelling task. For comparison, 1171 and 100 tokens of schwa were collected from the recordings of English native speakers. Furthermore, full vowels were also annotated and extracted from both groups in both tasks.

Previous research on vowel reduction has studied the phenomenon in the speech of many L2 English learners, such as Czech, Brazilian Portuguese, and Mandarin. However, it had not been studied in the speech of L1 Estonian learners. The current study aims to contribute to the slowly growing pronunciation studies of Estonian EFL learners. The existing research revealed possible aspects that may affect the acquisition of vowel reduction for non-native speakers of English. These included the L1 sound system interference, orthography, and level of proficiency. As a result, these findings were taken into account when analyzing the results of the study. The analysis was carried out in Praat where the phoneme boundaries were manually checked before using a script (Lippus 2024b) to extract the formant values and vowel durations. The data were normalized using the Lobanov scaling to prevent speakers' differences in their vocal tracts influencing the results. The durations were also presented on a logarithmic scale since the differences in speech tempo would not have enabled an equal comparison.

Both the results of the reading task and the storytelling task revealed that, overall, the schwa vowel is in a central position compared to full vowels in the speech of Estonian learners of English. The quality of the schwa vowel is nearly identical to the results of the native speakers. Thus, in unstressed syllables, Estonian learners of English reduce vowels, and the target reduced vowel is schwa. The median duration of schwa compared to full vowels was shortest, also illustrating the L1 Estonians' ability of vowel reduction. Although it was hypothesized that Estonians may transfer the familiar [ʏ] vowel to their English pronunciation, the results demonstrated that Estonians have created a new phonetic category for the English

schwa vowel. It is acoustically more front than the [ɤ] vowel. Hence, instead of the two sounds matching, they are opposite of each other in an F1-F2 vowel space.

Vowel reduction and the acoustic properties of unstressed vowels in the speech of Estonian learners could be further researched in a broader scope considering the limitations of this study. Since this research was conducted on twenty L1 Estonians, a larger sample size would facilitate larger-scale conclusions. Moreover, it would be beneficial to include A-level learners and learners who have not had phonetic training in the future. In addition, since the SLM-r claims that production and perception coevolve, a way to research this further would be by measuring the perceptual boundaries of central vowels. Thus, instead of observing the pronunciation of L2 learners through acoustic measurements, a perceptual test would uncover whether Estonian learners of English hear and perceive the schwa vowel as acoustically close to L1 central vowels [ø ɤ] or not.

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APPENDICES

Appendix 1 – Sentences created for the reading task

1. Fortunately, Robert's dad is **alive** and well after **a** skiing accident.
2. She comes across **as** someone who seeks **attention**.
3. My family keeps assuring me that **the** cake I made is **astonishing**.
4. I was sad about not seeing any giraffes at the zoo **but** at least we got to see a **panda**.
5. I wonder if **soda** could be better in France **than** in Estonia.
6. Rosa is finishing her degree **at** a university somewhere in **America**.
7. You would think that an **astronaut** would have sufficient knowledge **of** space.
8. I could not imagine how **horrible** that must have been **to** see.
9. I had to make sure that Jimmy took his **helmet and** his bike to the park.
10. The outbreak of the **virus was** sudden and uncontrollable.
11. We received **a** call from the hospital that confirmed he is **alive**.
12. **As astonishing** as it sounds, I don't think this event is for me.
13. My puppy craves **attention but** only if you approach with treats.
14. Having a **panda** costume **was** surprisingly popular this Halloween.
15. I jumped **at** the piercing sound, but it was only a **soda** can being crushed.
16. Life in **America** can seem more fun **than** life in Europe.
17. I hope I never have **to** take that class again because that exam was **horrible**.
18. **The** biggest dream among some kids is becoming an **astronaut**.
19. Wearing a **helmet** should not feel embarrassing **and** restricting.
20. Hundreds **of** people were downplaying the effects caused by the **virus**.

Appendix 2 – Informed consent form and questionnaire for the native speakers

Informed consent form for native English speakers taking part in the study

Hello!

My name is K  rolin Veerpalu. I am conducting this study for the purpose of analyzing the speech of Estonian learners of English. Your participation is valuable as it will give me the means to compare the learners' speech to the speech of a native.

I will need a recording of your speech based on a production test. I will also ask you to fill out a questionnaire about your linguistic background. The collected data will be anonymized from the beginning by assigning every participant with a code. Upon receiving the data, I will be the only one working with the data and it will not be accessed by any third parties. Only the aspects relevant for my study will be analyzed by using a speech analysis program by me. I will publish the significant results in my thesis, referencing you only through your code name.

Participation is voluntary and you can withdraw from the study without any negative consequences. To do so, do not hesitate to contact me via e-mail before April 2026: karolin.veerpalu@ut.ee.

The informed consent forms will be destroyed at the end of this year, 2026. The anonymized data will be preserved on a hard drive in an encrypted folder. The probability of reconstructing your identity based on the anonymized data is low.

If you have read the consent form and agree with the conditions, please sign here:

signature: _____

date: _____

Thank you!

K  rolin Veerpalu

karolin.veerpalu@ut.ee

Questionnaire for native English speakers taking part in the study

1. Please state your age.

2. What language is your mother tongue? If you have more than one, please write them all.

3. Which variety (-ies) of English do you speak? (for example, British English, American English, Australian English, Irish/Hiberno English...) **you may choose multiple varieties*

4. If valid, please write down other languages that you can speak. Please assess your level of proficiency in your foreign languages (*beginner – advanced – proficient*).

Appendix 3 – Informed consent form and questionnaire for the non-native speakers

Informeeritud nõusoleku vorm eesti keelt emakeelena kõnelevatele katseisikutele

Tere!

Olen Kärölin Veerpalu ning viin enda magistritöö raames läbi katset, kus lindistan eesti keelt emakeelena kõnelejate inglise keele kõne, et uurida võõrkeele hääldusega seotud aspekte. Hindan Teie panust kõrgelt, sest see materjal moodustab minu magistritöös olulise osa.

Katses lindistan Teie kõne ning palun täita küsimustiku, et mõista Teie keelelist tausta. Esimesest hetkest saate koodi, mis tagab Teie anonüümsuse. Ainult mina pääsen ligi kõne lindistustele ja küsimustikele ning neid ei jagata kolmandate isikutega. Analüüsin kõneanalüüsi programmiga vaid magistritööga seotud aspekte ning asjakohased tulemused avaldan enda töös anonümiseeritud kujul.

Katses osalemine on vabatahtlik ja Teil on võimalik katses osalemisest taganeda ilma ühegi negatiivse tagajärjeta. Selleks palun Teil võtta minuga ühendust e-maili teel: karolin.veerpalu@ut.ee.

Nõusolekuvorme säilitatakse 2026. aasta detsembrini. Anonümiseeritud andmeid säilitatakse tähtajatult salasõnaga kaitstud välisel kõvakettal. Võimalus, et Teie identiteeti on hiljem võimalik rekonstrueerida pseudonümiseeritud andmete põhjal on väga väike.

Kui olete lugenud nõusoleku vormi läbi ning nõustute tingimustega, palun Teil allkirjastada vorm:

Mina, _____, olen lugenud läbi informeeritud nõusoleku vormi ja nõustun vormis mainitud tingimustel katses osalema.

Katseisiku allkiri:

Kuupäev:

Katse läbiviija allkiri:

Kuupäev:

Aitäh!

Kärölin Veerpalu

karolin.veerpalu@ut.ee

Küsimustik eesti keelt emakeelena kõnelevatele katseisikutele

2. Mis on Teie vanus?

3. Mis on Teie emakeel?

4. Kas kasutate mõnda eesti murdekeelt? Kui jah, siis millist?

5. Kas olete õppinud inglise keelt? Kui jah, siis kui kaua (*kuudes/aastates*)?

6. Millisele tasemele hindate enda inglise keele oskuse?

- A1 → mõistab ja kasutab igapäevaseid fraase, oskab end ja teisi tutvustada, suhtleb lihtsas keeles, kui vestlus toimub aeglaselt ja selgelt
- A2 → mõistab ja kasutab spetsiifilise valdkonna [nt kodukoht, töö] väljendeid ja lauseid, suhtleb endale tuttavatel teemadel, oskab kirjeldada enda ja teiste elutingimusi, väljendada enda vajadusi
- B1 → mõistab ja suhtleb endale olulistel teemadel [nt hobid], saab seda keelt kõnelevas välisriigis hakkama, oskab endale huvitaval teemal koostada teksti, kirjeldab sündmusi jms ja suudab oma seisukohti lühidalt põhjendada

- d. B2 → mõistab keerukamate teemade tuuma, vestleb spontaanselt ja ladusalt, oskab luua ühtset teksti ja selgitada enda vaatenurki, kaalub seisukohtade tugevaid ja nõrku külgi
 - e. C1 → tabab tekstides varjatud tähendusi, suhtleb spontaanselt ja ladusalt, kasutab keelt paindlikult ning erinevates kontekstides, loob sidusa teksti ka keerukatel teemadel.
 - f. C2 → suudab sünteesida ja ümber jutustada eri teavet ja sõnastada nendes esinevaid põhjendusi ja arutelusid, eristades ka peenemaid tähendusvarjundeid, väljendab end ladusalt ja täpselt.
7. Kas teile on kunagi õpetatud inglise keele hääldust? Kui jah, siis millises kooliastmes? **võib ka mitu*
- a. Ei ole õpetatud
 - b. Lasteaias
 - c. Algkoolis (1.-4. klass)
 - d. Põhikoolis (5.-9. klass)
 - e. Gümnaasiumis/kutsekoolis (10.-12. klass)
 - f. Ülikoolis
8. Kas teate, millist inglise keele varianti (briti inglise keel, ameerika inglise keel, austraalia inglise keel, iiri inglise keel...) kõnelete? Kui jah, siis millist? **võib ka mitu*
-
9. Millistes kontekstides kasutate inglise keelt? **võib ka mitu valida*
- ☐ Luges (nt raamatud, uudised, artiklid...)
 - ☐ Rääkides (nt sõpradega, loengutes, tööalaselt...)
 - ☐ Kuulates (nt taskuhäälingud, videod, raadiosaated, filmid, muusika...)
 - ☐ Kirjutades (nt koolitööd, looming, tööalaselt, meilid...)
 - ☐ Muu: _____
10. Kas olete elu jooksul veetnud rohkem kui 3 kuud ingliskeelses keskkonnas? Kui jah, siis kus ja kui kaua?
-
-
11. Kas oskate rääkida teisi võõrkeeli? Kui jah, siis milliseid ning mis tasemel?
-
-
-

RESÜMEE

TARTU ÜLIKOOL
ANGLISTIKA OSAKOND

Kärolin Veerpalu

Vowel Reduction to Schwa by Estonian Learners of English: A Case Study

Vokaalide reduktsioon ja inglise keele täishäälik švaa eesti emakeelega keeleõppijatel: juhtumiuuring

Magistritöö

2026

Lehekülgede arv: 84

Annotatsioon:

Magistritöö vaatlleb inglise keskvokaali švaa hääldust eesti emakeelega keeleõppijate kõnes vokaalide reduktsiooni tagajärjel. Varem on eestlaste inglise vokaalide hääldust käsitlenud Mutt (1978) ja Kostabi (1993), kes jõudsid järeldusele, et eestlased võivad asendada inglise švaa vokaali eesti keele keskvokaalidega [ø ʏ]. Magistritöö eesmärk oli välja selgitada eestlaste inglise švaa asukoht vokaalidiagrammil ning uurida, kas rõhututes silpides redutseeritakse rõhutus positsioonis asuv vokaal švaaks. Selleks viis autor läbi kaheosalise kõnekatses ja akustilise analüüsi.

Magistritöö algab sissejuhatusega, kus on sõnastatud uurimisküsimused, püstitatud hüpotees ja defineeritud peamised mõisted. Töö on jaotatud kaheks peatükiks. Esimene peatükk annab ülevaate foneetilisest reduktsioonist, pannes rõhku vokaalide reduktsioonile nii inglise kui eesti keeles. Samuti kirjeldatakse inglise švaa vokaali, eesti keele keskvokaale ja keeleõppe mudelit SLM-r, mis annab tööle teoreetilise raamistiku. Viimaks arutletakse varasemate uurimuste üle. Teine peatükk keskendub osalejate, kõnekatses ja analüüsi tutvustamisele. Sellele järgneb tulemuste arutelu ning kogu töö kokkuvõte.

Magistritöösse kaasati kakskümmend eesti emakeelega inglise keele õppijat ning kümme inglise keelt emakeelena kõnelejat, kellel paluti osaleda kõnekatses. Esimene katse pool oli lugemiskatses, kus osalejad lugesid kokku 60 lauset. Teises pooles paluti osalejatel kirjeldada nelja pildi jada, et kutsuda esile spontaanset kõne. Osalejad täitsid küsimustiku ja informeeritud nõusoleku vormi enne katses osalemist. Metoodika alapeatükk annab ülevaate sõnade valikust ja töös rakendatavate akustilise analüüsi põhimõtetest. Tulemuste analüüsis kõrvutatakse inglise keelt emakeelena kõnelejate tulemused eesti keeleõppijate tulemustega nii, et eesti õppijad on jaotatud keeletasemete järgi kaheks: B ja C tasemega õppijad. Arutelus põhjendatakse saadud tulemusi vastavalt varasematele teadmistele ja tulemustele.

Peale lugemiskatses märgendamist saadi analüüsitavaks materjaliks 2386 švaad eesti keeleõppijate kõnest ja 1171 švaad inglise keelt emakeelena kõnelejatelt. Jutustamiskatses koguti analüüsiks vastavalt 200 ja 100 švaad. Tulemused kinnitasid, et eesti keeleõppijad redutseerivad rõhututes silpides vokaale švaa kvaliteediga sarnaselt inglise emakeelekõnelejatega nii grammatilistes kui ka leksikaalsetes sõnades. Švaa vokaal oli lühim ka eestlaste kõnes, viidates samuti reduktsioonile. Viimaks, tulemused viitasid sellele, et eestlased on loonud inglise keele švaa vokaali jaoks ajus uue foneetilise kategooria, mis ei kattu täielikult kumbagi eesti keskvokaaliga.

Märksõnad: inglise keele hääldus, foneetika, vokaalide reduktsioon, švaa, akustiline analüüs, kestus, vokaali kvaliteet, inglise keel, eesti emakeelega keeleõppijad

Lihtlitsents lõputöö reprodutseerimiseks ja lõputöö üldsusele kättesaadavaks tegemiseks

Mina, Kärölin Veerpalu,

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Vowel Reduction to Schwa by Estonian Learners of English: A Case Study,

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/allkirjastatud digitaalselt/
Kärölin Veerpalu

Tartus, 12.05.2026.

Autorsuse kinnitus

Kinnitan, et olen koostanud käesoleva magistritöö ise ning toonud korrektselt välja teiste autorite panuse. Töö on koostatud lähtudes Tartu Ülikooli maailma keelte ja kultuuride instituudi anglistika osakonna oma õppekava magistritöö juhendist ning on kooskõlas heade akadeemiliste tavadega.

/allkirjastatud digitaalselt/
Kärolin Veerpalu

Tartus, 12.05.2026

Lõputöö on lubatud kaitsmisele.

Reeli Torn-Leesik.

Tartus, 12.05.2026.