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Stress Interaction in English Loanwords Used in Kusaal

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Dissertação realizada no âmbito do Mestrado em Linguística, orientada pela Professora Doutora Juliana Novo Gomes e pelo Doutor Carlos Rogério Sousa e Silva.

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To Enrico, Laura and Flavio

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Declaration of Honour

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I hereby declare that this dissertation is of my authorship and has not been used previously in another course, degree, curricular unit or subject, at this or any other institution. References to other authors (statements, ideas, thoughts) scrupulously respect the rules of attribution and are duly indicated in the text and bibliographical references, in accordance with the rules of referencing. I am aware that the practice of plagiarism and self-plagiarism is an academic offence.

I further declare that I have not used generative artificial intelligence tools (chatbots based on large language models) to carry out part(s) of this dissertation, and that all interactions (prompts and responses) have been transcribed in the annex.

[Porto, 2025]

[Guendalina Gianfranchi]

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Abstract

The British colonial legacy has led to widespread borrowing and phonological adaptation of English words into many African languages, including Kusaal, a Mabia (Gur) language spoken in northeastern Ghana, Burkina Faso, and Togo (Eddyshaw 2024). This study investigates how native Kusaal speakers perceive stress in English loanwords and explores whether stress perception correlates with L2 English proficiency, word frequency, syllable count and phoneme length. It also addresses the phenomenon of stress “deafness“, previously observed in fixed-stress language speakers such as French (Dupoux et al. 1997, 2001), and examines its relevance in a tonal language context, where literature remains sparse.

An auditory lexical decision task was administered to four native Kusaal speakers using 40 English loanwords sourced from Sandow (2021), along with stress-altered pseudo-word counterparts (e.g., [ˈɛnd͡ʒɪn] vs. [ɛnˈd͡ʒɪn]) and 20 phoneme-based control pairs (e.g., [bɪˈtwiːn] vs. [bɪˈpwiːn]). Stimuli were recorded by three native British English speakers and presented via the PCIbex platform (Zehr & Schwarz 2018). Participants judged lexicality via keypress and completed both a self-assessed proficiency questionnaire and the LexTALE proficiency test (Lemhöfer & Broersma 2012).

Results indicate that participants performed well in identifying real words, especially in the stress condition, likely due to tonal-prosodic alignment between English stress and Kusaal tone. However, pseudo-words with incorrect stress were frequently misidentified as real, suggesting reduced sensitivity to stress contrasts. On the other hand, phonemic mismatches were more reliably detected. Proficiency significantly predicted faster reaction times, though it did not impact accuracy. Word frequency, syllable count and phoneme length had no significant effects.

These findings highlight the influence of prosodic transfer in L2 perception and underscore a reduced salience of stress cues among Kusaal speakers. This study contributes a new perspective to the typologically diverse landscape of African phonological systems.

Keywords: phonology, psycholinguistics, Kusaal, loanword adaptation, stress perception.

Portuguese abstract [Resumo]

O impacto do período colonial britânico resultou numa grande quantidade de empréstimos e adaptação fonológica de palavras do inglês em várias línguas africanas, incluindo o kusaal, uma língua Mabia (Gur) falada no nordeste de Gana, Burkina Faso e Togo (Eddyshaw 2024). Este estudo investiga como falantes nativos de kusaal percebem o acento em empréstimos do inglês e explora se essa percepção está correlacionada com a proficiência em inglês como L2, frequência lexical, número de sílabas e número de fonemas. Também aborda o fenómeno de "surdez" acentual, anteriormente observado em falantes de línguas com acento fixo, como o francês (Dupoux et al. 1997, 2001), e examina sua relevância em línguas tonais, contexto ainda pouco explorado na literatura.

Foi aplicada uma tarefa de decisão lexical auditiva a quatro falantes nativos de kusaal, utilizando 40 empréstimos do inglês extraídos de Sandow (2021), juntamente com pseudopalavras alteradas por acento (por exemplo, [ˈɛnd͡ʒɪn] vs. [ɛnˈd͡ʒɪn]) e 20 pares de controle com contraste fonémico (por exemplo, [bɪˈtwiːn] vs. [bɪˈpwiːn]). Os estímulos foram gravados por três falantes nativos de inglês britânico e apresentados por meio da plataforma PCIbex (Zehr & Schwarz 2018). Os participantes julgaram a lexicalidade e responderam a um questionário de autoavaliação de proficiência e ao teste LexTALE (Lemhöfer & Broersma 2012).

Os resultados indicam que os participantes tiveram um bom desempenho na identificação de palavras reais, especialmente na condição de acento, possivelmente devido ao alinhamento prosódico-tonal entre o acento do inglês e os tons do kusaal. No entanto, pseudopalavras com acento incorreto foram frequentemente identificadas como palavras reais, sugerindo uma sensibilidade reduzida a contrastes acentuais. Por outro lado, os contrastes fonémicos foram detetados com mais correção. A proficiência influenciou significativamente o tempo de reação, embora não tenha afetado a precisão. Frequência lexical, número de sílabas e número de fonemas não tiveram efeitos significativos.

Esses resultados destacam a influência da transferência prosódica na percepção de L2 e indicam uma menor saliência dos acentos entre falantes de kusaal. Este estudo contribui com uma nova perspectiva para o panorama tipologicamente diverso dos sistemas fonológicos africanos.

Palavras-chave: fonologia, psicolinguística, kusaal, adaptação de empréstimos, percepção de acento.

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1 Introduction

Lexical borrowing is a common language contact phenomenon (Beyogle 2015: 1). Loanword adaptations, the transformations that foreign language words undergo when they are borrowed into a language, have been of particular interest to phonologists and psycholinguists alike (Peperkamp 2005: 341). The influence of the English language has led to lexical borrowing and adaptation in native languages in Africa, many countries, such as, Cameroon, Gambia, Ghana, Kenya, Nigeria, Tanzania, and Uganda, among many others, having been marked by the arrival of the British (Sheini 2022: 1). This study focuses on English loanwords that have been adapted into Kusaal, a Mabia (Gur) language spoken in northeastern Ghana, as well as in Burkina Faso and Togo (Eberhard 2024). When languages borrow words from other languages, those words are often adjusted to fit the sound system of the borrowing language. This involves changes at the segmental level, where sounds from the original language are matched with similar native phonemes, and at the suprasegmental level, where the borrowed words are modified to align with the borrowing language's rules for syllable structure, phonotactics and patterns of stress or tone (Uffmann 2013: 2). Suprasegmental adaptation is a fairly understudied field, in comparison to segmental or phonotactic adaptation (Kang 2010:: 2295); as such, this study aims to contribute to this growing field of research by focusing on lexical stress in English loanwords adapted into Kusaal.

Kusaal is a tonal language, while English is a non-tonal language that has contrastive lexical stress. As is common when tonal languages borrow from stress-marking languages (Uffmann 2013: 8), Kusaal too maps English stressed syllables as high tones and unstressed syllables as low tones (Eddyshaw 2024: 28). From a psycholinguistic perspective, research has demonstrated that our first language influences how we pronounce, remember and interpret sounds from other languages (Dupoux & Pepperkamp 2003: 367). This influence can lead to a reduced ability, or even an inability, to detect certain sound differences in a foreign language. This phenomenon is known as phonological "deafness". This affects both individual sounds and broader features like intonation or rhythm, as well as distinctions based on whether a particular sound is present or absent (Dupoux & Pepperkamp 2003: 367). This phenomenon has been examined in the context of lexical stress, particularly among native speakers of French, a language with fixed word-final stress (Dupoux et al. 1997, 2001). Findings from these studies indicate that French speakers tend to struggle with distinguishing between pseudo-words that differ solely in where the stress falls, coining the term stress "deafness" (Dupoux et al. 2001: 1606). Further studies have adapted the experimentation used to explore this phenomenon to other languages, (Peperkamp & Dupoux 2002b; Altmann 2006; Dupoux et al. 2008; Peperkamp et al. 2010; Lin et al. 2014; Rahmani et al. 2015), including tonal languages, in the case of Rahmani et al. (2015), who focused on Dutch, Japanese, French, Indonesian and Persian. Peperkamp & Dupoux (2002b); Dupoux et al. (2008, 2010) and Lin et al. (2014) focused their research on the perception of stress by participants in languages other than their native tongues, with Lin et al. (2014) studying the phenomenon in native speakers of a tonal language (Korean). However, to our knowledge, no study on stress perception, be it in native language (L1) or second language (L2), has focused on a tonal Mabia (Gur) language. As a pioneer study in this realm, then, this study sets out to contribute to a better understanding of how lexical stress is perceived by native speakers of Kusaal. To this end, the present study aims to explore some of the phonological dynamics of lexical stress and of loanword adaptations, to better understand how it impacts its perception in native Kusaal speakers when interacting with their L2, English. To best examine this phenomenon, the present study culminates with an experiment, conducted on native speakers of Kusaal, consisting of an auditory lexical decision task, based on previous studies on stress "deafness" (Peperkamp & Dupoux 2002b; Dupoux et al. 2008; Peperkamp et al. 2010; Lin et al. 2014). The web-based experiment, run on the PCIbex platform (Zehr & Schwarz 2018), involved English loanwords used in Kusaal, recorded by three native speakers of British English, with correct and incorrect stress placement. Controls were also used, in which words were recorded with correct stress, but with one differing phoneme, to ensure that participants would not rely on stress-specific mechanisms for processing (Lin et al. 2014: 325). Participants were asked to determine whether these words were or were not real words in English, in order to observe if participants had difficulty in perceiving the difference in stress placement in these words.

This investigation, therefore, aims to further contribute to the relatively limited research on loanwords and their adaptations in Mabia (Gur) languages, as well as on the perception of lexical stress in English loanwords in native speakers of Kusaal. In order to do so, the present study aims to fulfil the following objectives:

(i) Provide a descriptive overview of some of the processes that English loanwords go through when adapted into Kusaal;

(ii) Determine how L1 Kusaal speakers perceive lexical stress in L2 English loanwords;

(iii) Establish whether there is interaction between stress perception and L2 English proficiency, word frequency, number of syllables and number of phonemes.

Based on existing literature on stress “deafness“ and, more specifically, on results obtained by Lin et al. (2014), investigating this phenomenon in a tone language, the expected results of the present study are for native Kusaal speakers to present difficulty in discerning stress placement, but little to no difficulty in discerning phonemic contrasts. Furthermore, it is expected that higher English proficiency levels and high word frequency will facilitate stress perception and that a higher number of both syllables and phonemes in the stimuli would affect participants’ perceptions of stress, making longer words more challenging. However, statistical results of Altmann’s Altmann (2006: 80) cross-linguistic study on stress perception and production show that the weaker performance by speakers of languages with predictable stress, and the stronger performance by speakers of other languages, was not linked to word length. Instead, this pattern held true across all word types, regardless of syllable count. This suggests that the most important factor affecting how participants perceived stress was whether or not their native language has predictable stress patterns (Altmann 2006: 80-81).

Through these objectives, the present study aims at enriching the current knowledge on the stress systems, and, consequently, tonal and syllabic patterns, of Kusaal through their interaction with English loanwords. This knowledge aims to help expand our understanding of lesser studied languages, whose richness is of indubitable cultural importance.

1.1 Cultural and Linguistic Background

Ghana, officially the Republic of Ghana, is a country located in West Africa, on the coast of the Gulf of Guinea. Its neighbouring countries are Côte d'Ivoire to the west, Burkina Faso to the north and Togo to the east. Although relatively small in size, covering 238,533 square kilometres, and in population, with 26,908,262 inhabitants (Bendor-Samuel 2000), Ghana is one of the leading countries in Africa, both due to its natural wealth and to having been the first Black African sub-Saharan country to gain independence from colonial rule (Maier 2024). Previous to its independence, Ghana was known as the Gold Coast, due to its land's natural abundance in the mineral, and was under the rule of the United Kingdom until 1957 (Fage 2024). English has remained the official language and lingua franca of Ghana, being the language used in education, governmental activities and business (Appiah 2021: 441). Ghanaian Pidgin English is also commonly spoken, with 5 million first language (L1) speakers (U.S.A.I.D. 2020: 4). There are also 11 government-sponsored languages, namely: Akuapem Twi, Asante Twi, Mfantse, Ewe, Ga, Dangme and Nzema, Dagbani, Dagaare, Gonja and Kasem (Languages-BGL 2006). Ghana's language policy mandates the use of a student's L1 as the language of instruction from kindergarten until age nine, with English as the L1 thereafter; education in L1 is limited to the 11 government-sponsored languages mentioned above (U.S.A.I.D. 2020). Further highlighting the linguistic richness and heterogeneity of the country, Ethnologue attests the existence of 73 living indigenous languages and ten non-indigenous languages, as well as one now extinct indigenous language, all of which correspond to various ethnic groups (Eberhard 2024). Figure 1 highlights the languages spoken in Ghana.

All of the languages in existence in Ghana pertain to the Niger-Congo phylum and, more specifically, to two main branches, Mabia (Gur) and Kwa (Anyidoho 2008: 143). Within the Kwa group, Akan is the most spoken (8.1 million L1 speakers) (U.S.A.I.D. 2020), of which Akuapem Twi, Asante Twi and Mfantse (or Fante) are dialects of Akan and are mutually intelligible (Maier 2024). Both Kwa and Gur languages are branches of the Volta-Congo phylum, pertaining, respectively to the Kwa Volta-Congo and North Volta-Congo families (Eberhard 2024).

Figure 1: Language map of Ghana. (Eberhard 2013)

1.1.1 Mabia (Gur) Languages

The Mabia, also known as Gur, group of languages is typically divided into Central Gur, spoken in northern Ghana, eastern Burkina Faso, northern Togo and northern Benin, and Senufu, spoken in northern Ivory Coast, southwest Burkina Faso and southeast Mali, although a few languages do not belong to either of these groups (Gutman & Avanzati 2013). This group of languages is composed of around 85 languages, spoken by approximately 20 million people (Bendor-Samuel 2014). Of these, 26 are spoken in Ghana by varying amounts of native speakers, as shown in Table 1.

Language	Speakers	ISO	Glottocode
Dagara (Dàgáárè)	1 million	dga	sout2789
Gurenɛ (Farefare/Farefari/Frafra)	900,000	gur	fare1241
Dagbani	850,000	dag	dag1246
Konkomba	600,000	xon	konk1269
Kusaal	450,000	kus	kusa1250
Tem (Kotokoli)	420,000	kdh	temm1241
Birifor	300,000	biv	sout2790
Kasem	300,000	xsm	kase1253
Mampruli	250,000	maw	mamp1244
Ntcham	200,000	bud	ntch1241
Kulango	200,000	nku	kula1277
Waali	150,000	wlx	wali1263
Buli	150,000	bwu	buli1254
Tumulung Sisaala	110,000	tum	sisa1248
Nafaanra	65,000	nfr	nafa1258
Sisaala	50,000	sld	sisa1248
Paasaal	40,000	sig	sisa1248
Deg	30,000	mzw	degg1238
Delo (Ntrubo)	18,000	ntr	delo1240
Tampulma	18,000	tpm	tamp1252
Vagla	15,000	vag	vagl1239
Hanga	7,000	hag	hang1258
Chakali	6,000	cli	chak1271
Safaliba	4,000	saf	safa 1243
Kɔnni	4,000	kma	konn1242
Kamara	3,000	jmr	kama1357
Chala	3,000	cll	chal1269
Kantosi	2,300	xkt	kant1249

Table 1: Gur Languages spoken in Ghana. (Gutman & Avanzati 2013)

Ghanaian national censuses group together four ethnic groups who speak Gur languages, namely the Dagomba, the Nanumba, the Mamprusi and the Maore, which is spoken mainly in Burkina Faso (Hudu 2010: 3). The language group these are a part of is called

Mole-Dagbani. The Ghana Statistical Service, in publishing the 2000 Population Census, indicated that the Mole-Dagbani language group constitutes 16.5 per cent of the population of Ghana (Hudu 2010: 4).

1.1.2 Kusaal

Kusaal is spoken in the north-east of Ghana and its speakers are called Kusaas, or Kusaasi, (or Kusaa in singular form), while the land is called Kusaug. In geographical terms, the language is spoken in the following six districts of the Upper East region: Bawku Municipal, Pusiga, Garu, Tempane, Binduri and Bawku–West (Sandow 2021: 5). The Kusaa group border to the west with Burkina Faso and to the east with the Republic of Togo, where Kusaal is also spoken. Kusaal is part of the Western subgroup within the Oti-Volta branch of the Volta-Congo language family (Eddyshaw 2024: 3). The languages that neighbour Kusaal are: Farefari/Gurenɛ, Nabt and Taln to the west; Mampruli to the south; and Bimoba, Moore and Bisa to the east (Sandow 2021: 5). Its closest linguistic relatives are Nabit and Taln, followed by a tightly related subgroup that uncludes Mampruli, Dagbani, Hanga, Kamara and Yare (Eddyshaw 2024: 3). Languages such as Mooré, the Farefare and Dagaare dialect continua, Safaliba and Nõotre are somewhat less closely related (Eddyshaw 2024: 3). The Western Oti-Volta group as a whole is roughly as internally diverse as Romance languages, according to Eddyshaw (2024: 3). Within the broader Oti-Volta family, Kusaal also shows notable similarities with Buli and Konni and Yom and Nawdm, including shared sound changes, comparable verb morphology and overlapping vocabulary (Eddyshaw 2024: 3). More distantly related are the Gurma languages, such as Gulmancema, Moba, Konkomba, Akaselem, Gangam and Ncam, as well as the highly diverse Eastern group, which includes Ditammari, Nateni, Mbelime, Byali and Waama (Eddyshaw 2024: 3).

Kusaal has two dialects, Agole (or Agolle), or the Eastern dialect, and Toende, or the Western dialect, which present variation at both lexical and phonological levels (Sandow 2021: 5). The Toende dialect of Kusaal is spoken north of the border in Burkina Faso, while the Agole dialect is found to the east and in parts of Togo (Musah 2018: 32). A clear dialectal split exists between Agole and Toende Kusaal, likely due to the population decline near the White Volta River as a result of river blindness, (Eddyshaw 2024: 2). Agole has a significantly larger speaker base, approximately 350,000 speakers compared to about 87,000 for Toende, across all regions where Kusaal is spoken (Eberhard 2024). The Agole dialect, spoken by a larger population, serves as the basis for the written form of the language in Ghana, while written materials in Burkina Faso use the Toende dialect (Eddyshaw 2024: 2). Eddyshaw (2024: 2) attests that his Agole-speaking language consultants had little trouble understanding Toende speakers; however, Agole Kusaal tends to be more accessible to Toende speakers than the reverse. Agole has also received more attention in written form and serves as the standard dialect for most major publications in the language, including the official orthography and Bible translations (Musah 2018: 33). Additionally, Agole is used as a medium of instruction in schools and can be studied as a subject at the University of Education, Winneba, in Ghana (Sandow 2021: 52).

A more detailed analysis of Kusaal's phonological properties is presented in Section 3.2.

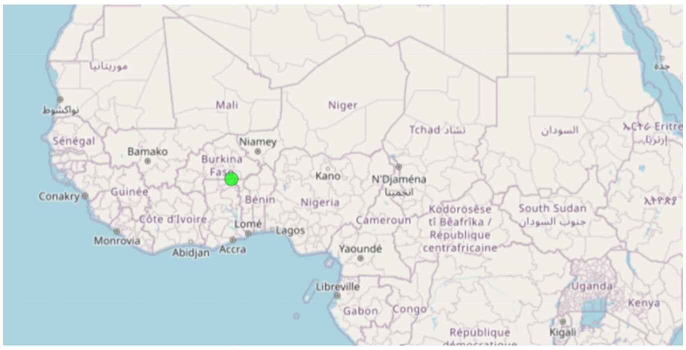

Figure 2: Kusaal language map. (Glottolog5.0 2024)

2 Theoretical Framework

In this section, relevant research and frameworks will be highlighted and discussed, giving an overview of different studies that have influenced the areas of interest of the present study. As such, Section 2.1 will offer an outline of loanword phonology and some of the processes that occur when loanwords are adapted into languages, sharing insight from both a phonological perspective, focused on production, and a psycholinguistic view point, focused, more so, on perception. Section 2.2 opens the discussion, more specifically, on lexical stress, on the different ways it presents and interacts with other elements in different languages, if at all, and on some theoretical approaches that have helped shape the way that stress is studied and analysed today. Finally, in Section 2.3, previous studies on the phenomenon known as stress “deafness“ are discussed, in order to better understand the framework behind the experiment conducted and the research that has allowed for this experiment to be expanded to a tone language like Kusaal. Particular attention will be paid to studies by Dupoux et al. (1997, 2001); Peperkamp & Dupoux (2002a); Peperkamp (2004a); Dupoux et al. (2008, 2010); Lin et al. (2014) to denote the progression on research on stress “deafness“ and its expansion towards languages other than French, upon which early studies were based (Dupoux et al. 1997, 2001; Peperkamp & Dupoux 2002a).

2.1 Loanword Adaptation

Loanword phonology examines how foreign words are modified to align with the segmental, suprasegmental and morphophonological rules of the borrowing language (Hsieh 2017: 624-625). Situations that involve language contact can result in various linguistic phenomena, including code-switching, code-mixing, borrowing and, over time, even the effect of language loss (Yeboah & Ansah 2022: 281). In code-switching and code-mixing, speakers are generally aware that they are switching between two or more languages - or at least that two or more languages are involved in their speech. On the other hand, in the use of loanwords, acquired through borrowing, speakers may utilise elements of a different language with no awareness that these words do not pertain to the same language. As such, loanword usage does not require speakers to be bilingual (Apeteng & Amfo 2014: 220).

Loanword adaptations are changes that apply to words when they are borrowed into a different language; words from a source language that are not well-formed in the borrowing language thus become well-formed words (Dupoux & Pepperkamp 2003: 367). In phonology, borrowing is generally categorised into two main types. The first is what Paradis (1996) calls adaptation, also referred to as on-line adaptations by Kenstowicz & Sohn (2001). The second type is referred to as loanwords (Paradis 1996; Kenstowicz 2003; Peperkamp 2004b) or historical loanwords (Dupoux & Pepperkamp 2001). Peperkamp

(2004b: 342) uses the term ”integrated loanwords” for this second category, defining them as borrowed words that have become part of the core vocabulary of the borrowing language. These are the most frequently studied types of borrowings (Peperkamp 2004b: 342). Because these forms are so thoroughly absorbed into the native lexicon, Peperkamp (2004a: 342) notes, monolingual speakers often have no awareness of their foreign origins. As a result, there is no need to assume that the underlying form of such words differs from their surface form in the grammar of these speakers (Peperkamp 2004a: 342). This type of borrowing is often referred to as nativisation or indigenisation, among other terms (Adomako 2018: 42). On-line adaptations, on the other hand, are foreign words that are borrowed in the moment, during real-time language use; these words are in the initial stages of being incorporated into the borrowing language (Peperkamp 2004a: 342).

2.1.1 Phonological Perspective on Loanword Adaptation

When foreign words are introduced into a language, they are adapted to the phonological system of this language, both on a segmental level, in which native phoneme categories are identified to express the sounds of the original word, and on a suprasegmental level, in which the borrowings are made to conform to native phonotactics and syllable structure constraints, allowing, also, for them to adapt to the native stress and/or tone system (Uffmann 2013: 2).

In regard to segmental adaptations in borrowing from a foreign language (L2) to a native language (L1), two main approaches are generally followed. In one case, borrowers might consider the incoming phonetic signal and find an underlying representation in the L1 in which the output is as phonetically similar to the L2 form as possible. In another case, borrowers might analyse the phonemes of the L2, and their underlying contrasts, and map these categories onto their L1 categories. The former of these pertains to a perceptive, or phonetic, approach, while the second pertains to a phonological approach (Uffmann 2013: 3). From the phonological perspective, a borrower must establish which L1 phoneme counts as equivalent to an L2 phoneme. This task, according to Uffmann (2013: 3), is not trivial, as some sounds that we may class as phonologically equal in their IPA transcription often still differ in their phonetic realisation, making it less straight-forward than it may appear on the surface. In the case of sounds that exist in the L2 but not in the L1, like, for example, the English interdental fricatives /θ, ð/, which get adapted into /t, d/ in some languages or into /s, z/ in others, a phoneme category existent in the donor language is mapped onto an existing category in the borrowing language (Uffmann 2013: 3). In the case of this example and in many cases of borrowing, mergers are involved in the adaptation process, here with alveolar stops or fricatives. Mergers are inevitable when the L1 has less contrasts compared to the L2 (Uffmann 2013: 3). Another process that may occur is a shift in phoneme category, which happens in the case of a borrowing language not having an equivalent category and one perceived as similar is selected instead. In this process it appears that, in some languages, allophonic information is taken into account during the adaptation process, while in other languages segmental adaptations are mainly phonemic (Uffmann 2013: 4). Essentially, one can understand segmental adaptations as the mapping of an L2 phoneme system on existing categories of the L1, though allophonic information may affect the process (Uffmann 2013: 5).

In his detailed analysis of vowel epenthesis strategies, Uffmann (2006) notes that languages employ various methods to determine the quality of the inserted vowel. From a perceptual standpoint, this would suggest that different strategies carry varying degrees of perceptual salience across languages, for reasons that may not be entirely clear (Uffmann 2013: 15). However, the evidence points to multiple possible ways of minimising salience and the specific path a language takes is ultimately a phonological decision. Often, there is no single default perceptual repair; rather, languages make a phonologically motivated choice. (Uffmann 2013: 15).

Suprasegmental adaptations can be subdivided into syllable structure (or phonotactic) adaptations and adaptations that involve stress and tone. The former of these typically occurs when the borrowing language's syllable constraints are tighter than the donor language, the latter permitting segment sequences that the L1 does not (Uffmann 2013: 6). Some languages do not allow syllable codas or may have restrictions on licit coda segments. Languages might also not permit consonant clusters as complex onsets or codas, especially if they are within the same syllable (Uffmann 2013: 6). It is also possible for languages to have strict restrictions regarding sonority sequencing, where they might not allow, for example, sonority reversals in onsets and codas, [sC] clusters or they might impose a minimal sonority distance for clusters (Uffmann 2013: 6). In the case of languages with this kind of constraints borrowing words from languages that do not follow these restrictions, the form of these words must be changed in order for them to fit in with the borrowing language's restraints. There are two ways for these adaptations to take place: ill-formed segments can be deleted or material can be inserted into ill-formed segment sequences (Uffmann 2013: 6). For instance, in Kusaal consonant clusters are disallowed, so when borrowing from English, vowel epenthesis may occur, like, for example, in the name Stephen, which is adapted into [asɪtɪːbin] (Sandow 2021: 80).

2.1.2 Psycholinguistic Perspective on Loanword Adaptation

Looking at loanword adaptation processes from a perception-based approach, Dupoux & Pepperkamp (2003: 267), offer an analysis using the following examples.

1. (a) Korean: [rəntən] 'London'

   (b) French: [wɔkmán] 'Walkman'

   (c) Japanese: [sɯfiŋkɯsɯ] 'sphinx'

   (d) White Hmong: [pe.si] 'Pepsi'

These highlight some adaptation processes of English words in various languages, following segmental changes (a), suprasegmental changes (b), epenthesis (c) and deletion (d). According to the authors, loanword adaptations are often treated as part of the borrowing language's phonology and are, therefore, considered on level with other phonological occurrences in the borrowing language (Dupoux & Pepperkamp 2003: 367). Various studies attest that phonetic representations of words in a source language compose the input to loanword adaptations, generating an output that is computed by the borrowing language's phonological grammar (Hyman 1970; Silverman 1992; Yip 1993; Paradis & LaCharité 1997; Jacobs & Gussenhoven 2000; Golston & Yang 2001). From a word-processing perspective, this means that in perception, the phonetic form of the word from the source language is copied onto an abstract underlying form in the borrowing language, allowing for adaptations to form following phonological processes in production (Dupoux & Pepperkamp 2003: 368). The phonological analysis that loanwords may undergo highlights phonologically minimal pairs that render foreign words illegal relatively to the native phonology. However, it is often possible for there to be more than one minimal pair of this sort; a non-native segment can be changed into a native one with more than one single alteration or consonant clusters can be separated through vowel epenthesis or consonant deletion (Dupoux & Pepperkamp 2003: 368). Shifting the perspective away from a purely phonological grammar one, Dupoux & Pepperkamp (2003: 368) present the argument that the choice between two or more phonologically equivalent options may be defined by phonetic minimality. In so doing, the authors attribute a role to perception in the process of loanword adaptation, as opposed to production. Phenomena related to loanword adaptation have been investigated with a language-specific approach, starting from the concept that the human processing system seems to be tuned for native language. Our native tongue distorts the way in which we produce, memorise and perceive sounds from a different language (Dupoux & Pepperkamp 2003: 367). The eventual inability or extreme difficulty to discern certain non-native contrasts, known as phonological "deafness", involves both segmental and suprasegmental contrasts, as well as contrasts brought on by the presence versus the absence of a certain segment. The following examples, given by Dupoux & Pepperkamp (2003: 367), according to the authors, present "deafness" features that relate to the examples given in (1):

2. (a) Korean listeners: [liːd - riːd]

   (b) French listeners: [ˈvasuma - vaˈsuma]

   (c) Japanese listeners: [ebzo - ebuzo]

Example (2a), corresponding to the changes highlighted in (1a), exemplifies the difficulty that native Korean speakers have in discerning between [l] and [r]. French speakers typically have difficulty with the perception of stress contrasts, shown in the changes in (1b) and (2b), while Japanese speakers may have difficulty in distinguishing the difference between consonant clusters and clusters separated by [u], shown through the epenthesis in the English loanword in (1c) and the example in (2c) (Dupoux & Pepperkamp 2003: 367). To follow up on this proposition, the authors offer a speech perception-based experiment model in regards to loanword adaptation, in which they present two components: a phonetic decoding module, which maps an acoustic signal onto a discrete representation, known as the phonetic surface form; and a phonological decoding module, which maps these surface forms onto possible underlying forms (Dupoux & Pepperkamp 2003: 368). Following the decoding processes of these modules, the phonetic decoding module represents the source of phonological "deafnesses" at the segmental level, like in the examples in (2a) and is, thus, responsible for the transformation of ill-formed segments during loanword adaptation, shown in the examples in (1a), given by the authors (Dupoux & Pepperkamp 2003). They propose that phonetic decoding will also account for the suprasegmental "deafnesses" and those due to phonotactic constraints and their respective repairs, like those shown in (1b-c) and (2b-c). As such, the phonetic decoder considers the inventory of segments, suprasegments and syllables and would, according to the investigators, develop an alternative, perception-based perspective that is psychologically plausible and merges the areas of phonology, phonetics and psychology (Dupoux & Pepperkamp 2003: 370).

2.2 Stress

In the realm of phonological typology, the prosodic system of languages can be largely identified as stress accent (SA), tone (T) or pitch accent (PA) (Hyman 2006: 228). There is some ambiguity in this grouping as, for instance, some languages show prosodic patterns that can be interpreted in more than one way and some languages blend features from different prosodic types (Hyman 1985: 229). Furthermore, words exhibit a range of prosodic features that go beyond stress, tone and length. These include phenomena such as:

(a) vowel and consonant harmony;

(b) constraints on the number of syllables or moras (the basic unit of timing in a phonological structure) in a word;

(c) positional restrictions;

(d) systematic patterns in how vowels and consonants combine (Hyman 2006: 229).

Incorporating all of these properties would cause a classification to become significantly more complex (Hyman 2006: 229). The focus on stress, tone and length is, however, justified as they are traditionally recognised as suprasegmental features and share common phonetic dimensions, such as pitch (f0), duration and intensity. Moreover, they frequently interact with one another and are functionally similar in that they often display culminative properties (with only one prominent element per word) and contribute to rhythmic alternations in speech (Hyman 2006: 229).

While tone, for example, involves pitch-based features, stress is generally understood in terms of metrical prominence, that is, how strongly a syllable stands out within a word's rhythmic structure (Hyman 2006: 231). Hyman (2006: 231) characterises SA as a system in which word-level metrical structure is marked by two key properties. First is obligatoriness, meaning that every lexical word must have at least one syllable identified as having the highest level of prominence, which is what we call primary stress. Second is culminativity, which ensures that there is no more than one such syllable per word (i.e., a word cannot have multiple primary stresses) (Hyman 2006: 231). According to Hyman (2006: 231), this distinction is important, even though any accounts of stress accent simplify this by saying that each prosodic word has "one and only one" primary stress, typically located in a single head foot. To clarify, a foot can be described a rhythmic group of syllables, usually containing one stressed syllable (the head) and optional unstressed syllables. The head, furthermore, is the most prominent syllable within a foot. In frameworks like Optimality Theory, discussed in Section 2.2.2, this assumption of both existence and uniqueness of main stress is often treated not as optional or violable, but as a default built into the grammar (McCarthy 2003: 110).

Unlike tone, which functions at the level of features and contrasts across paradigms, stress is inherently structural and relates to the sequence of elements in a word. While tone typically distinguishes lexical meaning by using pitch, SA serves a contrastive function, helping differentiate words even when minimal pairs are involved (Hyman 2006: 232).

The term ”stress”, then, represents greater prominence in relation to specific syllables. This prominence may be exhibited through a variety of acoustic properties and their perceptual counterparts, such as:

(a) increased duration;

(b) higher fundamental frequency (f0), which can be described as the acoustic counterpart of the perceptual property of pitch;

(c) increased intensity, like, for example, greater perceived loudness (Gordon 2016: 175).

Within stressed syllables, consonants and vowels may be subjected to fortition processes. Within unstressed syllables, on the other hand, consonants and vowels may undergo lenition processes. Furthermore, stressed syllables may also receive intonational pitch accents when they pertain to larger prosodic constituents (Gordon 2016: 175). Most languages seem to have some form of stress system, though the function of stress and how it interacts with other prosodic features like tone and intonation varies widely across languages (Gordon 2016: 175). As noted by Goedemans (2010: 649), out of the 176 languages in the 200-language WALS sample that included prosodic data, approximately 141 (around 80%) use stress, some alongside tone, while only 28 rely solely on tone or pitch accent. A variety of phonological dimensions can be utilised to describe different stress patterns:

(a) stress location;

(b) the extent to which stress is contrastive or not;

(c) if primary stress and secondary stress are differentiated;

(d) whether stress is sensitive to syllable weight;

(e) the interactions between stress and other prosodic properties like tone and intonation (Gordon 2016: 175).

In some languages, stress solely indicates a word edge, signifying that the position the stressed syllable is within a word is predictable (Rietveld 1980). However, in some other languages stress serves a contrastive function, signifying that primary stress is not fixed to a specific placement and, as such, different stress positioning within a word may result in a change in the meaning of the word (Altmann 2006: 23). It is possible, therefore, to distinguish two initial categories based on these features:

(a) predictable stress languages, in which primary word stress is regular and the placement of stress in a word can be predicted solely based on phonological characteristics of the word;

(b) non-predictable stress languages, in which primary stress is not fixed to one specific placement within a word. French is an example of a language that pertains to the former category, while English belongs to the latter (Altmann 2006: 23).

Stress may surface on syllables in different positions of a certain word, depending on the word itself and on its meaning. Furthermore, this does not mean that these languages allow for random stress placement, but rather that the placement of the stressed syllable is not solely determined by the phonological shape of the word (Altmann 2006: 23).

There is, however, another category of languages in which stress does not present a demarcative or a contrastive behaviour on the word level. Instead, pitch demarcates contrast (Altmann 2006: 24). These languages can, generally, be divided into two subcategories:

(a) tone languages, such as Mandarin Chinese, in which lexical tone is attributed to syllables in a word (Gussenhoven 2004);

(b) pitch-accent languages, such as Tokyo Japanese, in which a pitch contour spans an entire word and the only factors for inferring prominence are frequency features (Beckman 1986).

Tone languages may further be subdivided into restricted tone languages and contour tone languages (Rahmani et al. 2015: 2); the former term describing languages in which contrastive tone is restricted to a particular position within a word (Worbs 2016: 1) and the latter describing languages in which tones display pitch movements within a syllable

(Zhang 2001: 1).

Both tone and pitch-accent languages present differences in meaning in contrasting word combinations (Altmann 2006: 24).

Furthermore, there are languages that do not use pitch, duration or intensity systematically on word level. These languages may still express prominence on words when they are produced, but such prominence is not assigned on a lexical or phonological word level (Altmann 2006: 24).

With regards to L2 learning later in life, the acquisition of a native word prosodic structure presents clear consequences. While infants seem to start from the concept that the pitch pattern of words is a component of their representation, infants acquiring a tone-less language discard this assumption around nine months of age (Liu & Kager 2016: 7). Adult learners of contrastive tone or stress languages whose L1 does not present lexical prosody will, then, initially be unable to store the prosodic pattern of words in an L2 that has lexical tone (Rahmani et al. 2015: 2).

In an attempt to further uncover the presence of word prosodic structures, Dupoux and colleagues developed a series of studies (Dupoux et al. 1997, 2001; Peperkamp & Dupoux 2002a; Dupoux & Pepperkamp 2003; Peperkamp 2005; Dupoux et al. 2008; Peperkamp et al. 2010) demonstrating that sensitivity to word prosodic contrasts varies noticeably based on the listener's language background (Rahmani et al. 2015: 2). This topic and these studies will be further explored in Section 2.3.

2.2.1 Metrical Theory

Several phonological theories have been developed to explain stress and intonation patterns in English. *The Sound Pattern of English* (Chomsky & Halle 1968) outlines rules for phrasal prominence and approaches stress in a manner similar to phonemes, representing it through binary features. This work laid the foundation for metrical theory, which emerged in the late 1970s as part of the broader framework of nonlinear phonology, alongside autosegmental phonology (Kager 1995: 368). Initially developed by Liberman (1975) and further expanded by Liberman & Prince (1977) and Halle & Vergnaud (1990), the metrical theory aimed to move away from the non-local mechanisms used in linear phonology, such as rule variables and short-hand notations. To achieve this, the theory introduced hierarchical structures that allowed interactions between non-adjacent elements to be expressed through local processes (Kager 1995: 368). Word stress has been the primary focus of metrical phonology since its inception, though the theory has also been applied to other areas, including vowel harmony and syllable structure (Kager 1995: 368).

The analysis of lexical stress focuses on identifying which syllables in a word are emphasised, along with examining the rhythmic, positional, quantitative and morphological influences that shape these stress patterns (Kager 1995: 367). According to Kager (1995: 367), there are five main factors in word stress:

(a) stress is culminative: in most stress-based languages, each content word typically contains at least one stressed syllable;

(b) stress is hierarchical, allowing for varying levels of prominence when multiple stressed syllables are present;

(c) stress can be delimitative in systems where it signals the boundaries of words;

(d) stress contributes to rhythm in languages where stressed and unstressed syllables alternate and where consecutive stresses are generally avoided - stress does not assimilate to nearby syllables for this reason;

(e) stress differences are often supported by segmental features. Stressed syllables may be strenghthened through vowel lengthening or gemination, while unstressed ones may be weakened through vowel reduction (Kager 1995: 367).

In order to describe the metrical theory framework as a starting point for the development of the Optimality Theory framework, Kager (1999: 143) elaborates on four cross-linguistically common properties, starting with the culminative property. Many languages apply a ”stressability requirement” specifically to content words, such as nouns, verbs, adjectives and adverbs, while function words, like articles, pronouns and prepositions, do not need to be stressed and instead rely on nearby content words for prosodic support (Kager 1999: 143). Related to this is the idea that content words often must meet a minimum size requirement, such as being at least two syllables long or containing one heavy syllable. To maintain this minimum, some languages may modify shorter words by adding a syllable or mora, effectively lengthening them to meet the requirement (Kager 1999: 144). To clarify, a heavy syllable is one that carries more than a single mora of weight. It typically either includes a long vowel or ends in a consonant. In the case of the latter, the syllable is known as a closed syllable. This minimum word size usually corresponds to a single foot, which is a rhythmic unit made up of two syllables or two moras (Glottopedia 2007-10-24).

The demarcative property delineates how stress often helps mark the boundaries of grammatical units like words or phrases. Stress is commonly found near the edges of words, such as on the first, penultimate or final syllable, depending on the language. Some languages highlight both word boundaries or even internal morphemes like roots and affixes (Kager 1999: 144). In addition, many stress-based languages exhibit a rhythmic property, according to which stress patterns tend to alternate regularly between strong and weak syllables. These patterns help avoid sequences of too many stressed syllables (clashes) or too many unstressed ones (lapses) and typically follow a specific direction, from the beginning or end of a word (Kager 1999: 145). Languages vary along a rhythmic spectrum, illustrated in Figure 3. At one end are highly rhythmic languages with regular stress patterns; at the other end are unbounded languages that allow long stretches of unstressed syllables with only one stress per word.

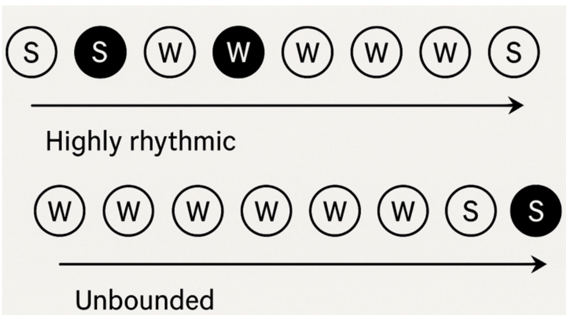

Figure 3: Rhythmic spectrum of stress-based languages

Lastly, according to Kager (1999: 145), stress often aligns with syllables that are naturally prominent, a feature called quantity-sensitivity. Stress is more likely to fall on heavier syllables (those with long vowels, diphthongs or closed syllables), as they carry more phonetic weight. This sensitivity to syllable weight reinforces the link between stress and perceived prominence in many languages (Kager 1999: 146).

Word stress systems have traditionally been classified along several dimensions:

Fixed vs. free systems:

- Fixed systems place stress in predictable, rule-governed positions.
- Free systems have unpredictable stress placement, often serving to distinguish between words (Kager 1995: 367).

Phonological vs. morphological determinants:

- Some systems determine stress placement based solely on phonological factors (e.g., syllable weight, rhythm, or proximity to word boundaries).
- Others are influenced by morphological structure, such as the roles of roots and affixes (Kager 1995: 367–368).

Bounded vs. unbounded systems:

- Bounded systems restrict stress to occur within a specific range relative to other stresses or word edges.
- Unbounded systems allow stress to fall anywhere, without fixed limits on spacing between stressed syllables (Kager 1995: 368).

A key principle of metrical theory is that stress should be represented in its own hierarchical structure, separate from the segmental features of speech (Kager 1995: 368). This is done through a metrical tree, where stress patterns are shown using binary branching structures labelled as strong-weak (sw) or weak-strong (ws), as illustrated in Figure 4. In this framework, stress is seen as a relational property; a node is considered strong only in relation to its weak sister node. For example, in a given structure, the first syllable may be more prominent than the second syllable and the third more prominent than the fourth. The higher-level nodes in the tree also reflect a weak-strong relationship, indicating that the first syllable is more prominent than the third overall (Kager 1995: 368).

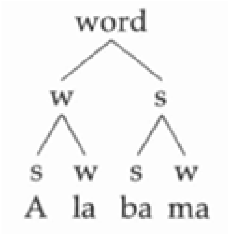

Figure 4: Example of metrical tree (Kager 1995: 368)

Although the metrical tree indicates how prominent different syllables are in relation to each other, it does not capture the pattern of alternating strong and weak syllables or the issue of clash, where two stressed syllables occur next to each other (Kager 1995: 369). Liberman (1975) proposed the metrical grid as a way to represent rhythmic structure. In a grid the height of each column shows how prominent a syllable is. For example, in Figure 4, the third syllable has the highest prominence, the first syllable is slightly less prominent and the second and fourth syllables are the least prominent (Kager 1995: 369). The grid illustrates the alternating rhythm of strong and weak syllables. In early metrical theory, the grid was generated from the tree using a mapping rule that established prominence relationships between syllables governed by sister nodes (Kager 1995: 369).

Figure 5: Example of metrical grid (Kager 1995: 369)

Relational tree structures that do not include feet, like those in Figure 4, are unable to capture certain stress differences that exist even between words with the same tree shape (Kager 1995: 369). For instance, in word pairs like *contest* and *tempest*, the final syllables have different stress patterns, yet their strong-weak trees appear identical. Because of this, relational trees alone cannot consistently represent which syllables are stressed (Kager 1995: 369). To address this issue, Liberman & Prince (1977) utilised a stress feature attached to individual segments. Later, in pursuit of a more fully metrical framework, Vergnaud & Halle (1978) and Selkirk (1980) introduced the concept of the foot as a structural category within the tree. Each foot contains a single head syllable, which is stressed, and may also include weaker syllables (Kager 1995: 369). This innovation allows stress features on individual segments to be dropped, as stressed syllables now correspond to the heads of feet (Kager 1995: 369). These enhanced trees, as shown in Figure 6, fit within a larger hierarchy of prosodic categories: starting from the syllable (σ), then the foot (F), followed by the prosodic word (Wd) and extending to higher levels *n+1* (Kager 1995: 370).

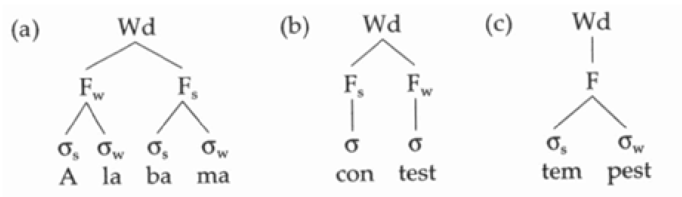

Figure 6: Example of enhanced metrical grid (Kager 1995: 369)

This hierarchy is structured so that each category at level *n* must be contained within a category at level *n+1* (Kager 1995: 370). Additionally, every syllable must be included somewhere in the metrical structure, a requirement known as exhaustivity. Since a prosodic word contains at least one foot, and each foot has a head, every word must have at least one stressed syllable. This is the principle of culminativity *n+1* (Kager 1995: 370).

The structure of metrical feet, how they are assigned and the organisation of metrical patterns above the foot level are all determined by specific parameters. One key distinction is between:

- systems that constrain stress placement to certain distances from other stresses and from word boundaries;
- and systems where stress placement is more flexible (Kager 1995: 370).

This distinction is governed by the boundedness parameter, which has two values: bounded and unbounded. In bounded systems, feet can have at most two syllables, whereas unbounded feet can include more, without size limits (Kager 1995: 370). Feet also consistently branch in one direction, either to the right or to the left. A universal principle, the Maximal Foot Construction Principle, requires that the largest possible foot be built. However, when a word has too few syllables to form a full foot, such as a single-syllable word, a degenerate foot (a minimal, often monosyllabic foot) is permitted (Kager 1995: 371). These are motivated by two constraints:

(a) culminativity, which requires every content word to have at least one stressed syllable (hence, one foot);

(b) exhaustivity, which requires all syllables within a word to be part of the metrical structure.

Degenerate feet are especially needed in words with an odd number of syllables when using bounded feet, as not all syllables can be grouped into full binary feet (Kager 1995: 371).

Another parameter, foot dominance, determines which side of the foot the head appears on. This is expressed through the concepts of dominant and recessive nodes (Kager 1995: 371). In left-dominant feet, left branches are dominant (strong), while right branches are recessive (weak); in right-dominant feet, the opposite holds (Kager 1995: 371). Because recessive nodes cannot branch, left-dominant feet are always left-branching and right-dominant feet are right-branching. According to the unmarked labelling rule, dominant nodes are marked as strong (Kager 1995: 371). However, it is important to maintain a distinction between dominance, which is a structural property, and strength, which is a phonological one. In other terms, trochees refer to bounded left-dominant feet (strong-weak) and iambs refer to bounded right-dominant feet (weak-strong) (Kager 1995: 371).

A third parameter, quantity sensitivity, controls how light and heavy syllables behave within metrical feet. In quantity-insensitive systems, all syllables are treated alike, as there is no special treatment of heavy syllables (Kager 1995: 371-372). In quantity-sensitive systems, heavy syllables must occur in strong (dominant) positions and receive stress. In quantity-determined feet, or Obligatory Branching feet, not only must strong positions contain heavy syllables, but the structure also enforces that dominant terminal nodes must branch (i.e., be associated with heavy syllables) (Kager 1995: 372). An example of these three systems, using left-dominant, bounded feet where dominant syllables are strong, is given in Figure 7, in which Kager (Kager 1995: 372) indicates heavy syllables as H and light syllables as L. When templates include either H or L, they refer specifically to

H or L; the general symbol σ refers to either and is overridden by more specific templates when relevant (Kager 1995: 372). In contrast to the unmarked labelling rule, the marked labelling convention assigns strength to dominant nodes if and only if they dominate a branching structure, which creates an additional foot type known as the Labeling Based on Branching (LBOB) foot (Kager 1995: 372).

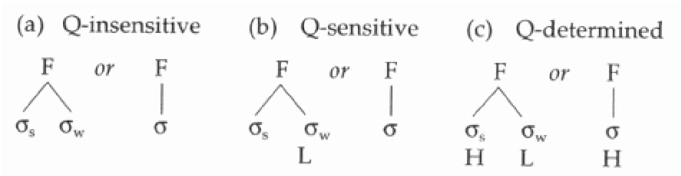

Figure 7: Example of quantity sensitivity systems (Kager 1995: 372)

Hayes (1980) suggests that syllable weight is fundamentally based on whether certain internal parts of a syllable, the rhyme or nucleus, are branching or not. Foot structure uses one of two projections to assess branching. On the rhyme projection, syllables with long vowels or closed codas are heavy, while open short-vowelled syllables are light. On the nucleus projection, only syllables with long vowels count as heavy and all others are light (Kager 1995: 372).

Foot construction is shaped by two key parameters: directionality and iterativity (Kager 1995: 373). Directionality determines where foot construction begins within a word, either from the right edge or from the left edge. Typically, foot construction starts at the edge of the word where the stress pattern remains stable, while the other edge shows variation depending on the number of syllables in the word (Kager 1995: 373). Iterativity, on the other hand, governs whether multiple feet are constructed or just one. In non-iterative systems, only a single foot is built, usually at one edge of the word. In iterative systems, multiple feet are formed moving inward from the designated edge (Kager 1995: 373).

At a higher level than the foot, the word tree structures the relative prominence of stresses (Kager 1995: 373). This tree branches consistently in one direction and its labelling follows principles similar to those at the foot level. The dominance parameter for the word tree can be left-dominant or right-dominant. According to the unmarked labelling convention, dominant nodes are labelled as strong by default, typically placing the main stress on a foot at the edge of the word (Kager 1995: 373). Under the marked rule, a dominant node is only labelled strong if it branches. If it does not branch, it is considered weak, even if dominant (Kager 1995: 373).

Importantly, stress rules at the word level can reference the internal structure of feet, but not the structure of syllables (Kager 1995: 373). This constraint reflects the Metrical Locality Principle (Hammond 1982), which sustains that rules may only reference elements within the same layer of metrical structure or adjacent ones (Kager 1995: 373).

2.2.2 Optimality Theory

Extensive work on word stress typology from a metrical phonology perspective, (Hayes 1995), has shown that stress patterns arise from the interaction of multiple, often conflicting pressures (Kager 1999: 142). These include:

(a) rhythmic regularity, a tendency for alternating strong and weak syllables;

(b) quantity-sensitivity, a preference for aligning stress with syllable weight);

(c) edge-marking, a tendency to place stress near the edges of morphological domains (Kager 1999: 143).

Optimality Theory (OT) is well-suited to model these interactions because it evaluates all constraints simultaneously, through parallelism, allowing it to account for how different prosodic levels influence each other. Additionally, OT's system of constraint re-ranking makes it especially effective for explaining cross-linguistic variation in metrical stress systems (Kager 1999: 143).

Similarly, when it comes to studying how loanwords are adapted, in a broader sense, OT has revealed itself to be an appealing option, as it provides a systematic explanation for both the reasons and the mechanisms behind these processes. At the same time, loanword adaptation serves as compelling support for OT, by raising questions regarding whether only output constraints can explain and shed light on the process of adapting loanwords (Uffmann 2013: 10). Recent investigations regarding English loanword adaptations in Mabia languages (Sandow 2021; Kenstowicz 2006; Inusah & Mahama 2019) shed light on the relevance of exploring this framework in the present study.

OT rejects two core assumptions of previous linguistic models. First, it discards the idea that grammars must precisely define rule-specific structural descriptions and transformations (Prince & Smolensky 1993: 6). Instead, OT introduces Gen, a mechanism that produces a broad set of candidate outputs for any given input by freely applying the basic structures allowed by the theory. The correct output is assumed to be among these candidates, and the grammar's system of constraints determines which is optimal (Prince & Smolensky 1993: 6). Second, OT challenges the traditional belief that constraints are specific to individual languages and reflect their unique phonotactic patterns. OT proposes that constraints are universal and broadly defined, allowing for variation in their evaluation across languages. Each language ranks these shared constraints differently and this ranking resolves conflicts between competing constraints (Prince & Smolensky 1993: 6). While the constraints themselves are simple and general, variation in their ranking accounts for cross-linguistic differences, which is a core concern of linguistic typology. Because constraints are ranked rather than absolute, they can be violated, which has important implications for how linguistic theories are described and developed. It also expands the types of formal generalisations that are possible within the theory (Prince & Smolensky 1993: 6).

The base concept that OT is built upon is that Universal Grammar (UG) consists primarily of a series of constraints around representational well-formedness. It is out of these that individual grammars are formed (Prince & Smolensky 1993: 2). In OT, markedness, one of two main conflicting constraints, is considered to be built into language grammars as universal "output constraints", explicitly stating marked or unmarked patterns, such as "'front vowels are unrounded' or 'syllables are open'" (Kager 1999: 3). Since languages tolerate marked structures, universal markedness constraints can be untrue for the output of a grammar, meaning that constraints are violable. Furthermore, violation does not directly cause ungrammaticality and the total fulfillment of all constraints is not necessary for the output of a grammar. Because constraints are fundamentally in conflict, every possibility of output of any grammar will inevitably be in violation of a constraint (Kager 1999: 3). As a theory of optimality surrounding a grammatical system, rather than well-formedness in relation to specific individual constraints, OT aims to understand which input analysis causes the least violations in conflicting conditions (Prince & Smolensky 1993: 2). As such, in order for the most suitable, or optimal, output form to be selected following the analysis of inputs, grammars should have the ability to regulate these conflicts within universal constraints (Kager 1999: 3). OT is based on the idea that every linguistic output is optimal, as it breaks the fewest and least important rules among a set of conflicting constraints. For any given input, the grammar produces an endless number of output candidates and evaluates them to choose the most optimal one - the one that actually surfaces as the output. This evaluation is done using a hierarchy of ranked constraints, each of which may eliminate candidate outputs until one candidate survives (Kager 1999: 8). This ranking system for universal constraints places them in a "strict dominance hierarchy," with every constraint exhibiting priority over constraints that sit lower in the hierarchy (Prince & Smolensky 1993: 2). The violations of constraints that are ranked higher are, therefore, avoided with more force than those with a lower ranking. The concept of "grammatical well-formedness", then, becomes relative and dependent on the level of fulfilment of the hierarchy of constraints (Kager 1999: 4). Within OT, constraints are universal, while their rankings in the hierarchy are language-specific (Sandow 2021: 44). As such, ranking differences cause cross-linguistic variation (Kager 1999: 4).

In OT, grammar functions as an input–output system, where each input is paired with exactly one output (Kager 1999: 18). This system is made up of two main parts:

- **Generator (Gen)**, which generates a large set of possible output candidates for a given input;
- **Evaluator (Eval)**, which evaluates these candidates using a hierarchy of constraints to choose the best one (Kager 1999: 19).

Essentially, Gen takes an input and provides all plausible candidate outputs for it. Eval filters these through the grammar's ranked constraint system to identify the most well-formed option (Kager 1999: 19). The overall grammar also includes a Lexicon, which holds the underlying forms that serve as inputs for Gen. To summarise, the OT grammar consists of:

- **Lexicon:** the source of morphemes or underlying forms;
- **Generator (Gen):** creates possible outputs from those forms;
- **Evaluator (Eval):** uses ranked constraints to assess the candidates and choose the optimal output (Kager 1999: 19).

In order to better understand the basic mechanisms of OT, it is also important to understand the concept of constraints in more detail. There are two fundamental conflicting constraints in OT:

(a) **Markedness:** involves conditions concerning the well-formedness of an output;

(b) **Faithfulness:** involves conditions that require the complete preservation of the input in the output across multiple aspects (Prince & Smolensky 1993: 4).

More specifically, the term markedness can be used to describe the grammatical influences that favour unmarked structures. The term faithfulness refers to the set of grammatical principles that help maintain distinctions between words as they appear in the lexicon (Kager 1999: 5).

Markedness constraints require output forms to meet some measure of structural well-formedness. Kager (1999: 9) lists some examples of markedness constraints that exist in some languages:

(a) ”Vowels must not be nasal”;

(b) ”Syllables must not have codas”;

(c) ”Obstruents must not be voiced in coda position”;

(d) ”Sonorants must be voiced”;

(e) ”Syllables must have onsets”;

(f) ”Obstruents must be voiced after nasals.” (Kager 1999: 9)

It is important to note that markedness constraints are in reference to output forms and are not sensitive to lexical input (Kager 1999: 9). Any output structure that goes against these requirements violates the markedness constraint, for which faithfulness constraints act as a counterbalance, in an attempt to preserve input elements of the output that violate these markedness constraints. Kager (1999: 10) highlights some faithfulness constraints present in some languages:

(a) ”The output must preserve all segments present in the input”;

(b) ”The output must preserve the linear order of segments in the input”;

(c) ”Output segments must have counterparts in the input”;

(d) ”Output segments and input segments must share values for [voice]”. (Kager 1999: 10)

Any output structure that does not maintain an input feature is not faithful and, therefore, is in violation of faithfulness constraints. Faithfulness constraints are not solely concerned with the output, as they consider both the input and the output. On the other hand, markedness constraints only focus on the output and ignore the input entirely. Importantly, both types of constraints refer to the output; markedness does so exclusively, while faithfulness does so in relation to the input. In OT there are no constraints that only consider the input (Kager 1999: 10).

In its strongest form, the idea that all constraints are part of UG suggests that every constraint exists in the grammar of every natural language. However, this does not imply that every constraint functions the same way across languages. Because languages rank constraints differently, a particular constraint might always be obeyed in one language, violated (yet still relevant) in another and completely inactive in a third (Kager 1999: 11).

Universality can be supported in several ways when it comes to phonological markedness constraints, ideally through a combination (Kager 1999: 11). The first kind of universality is typological. A constraint reflects structural preferences that appear in various unrelated languages. Segmental markedness constraints can be tested, for example, by examining the markedness of segments across language inventories. Relying solely on typological data, however, can be problematic, as it can lead to circular reasoning, where properties are assigned as unmarked due to their more frequent occurrence compared to other marked properties (Kager 1999: 11).

To avoid this, typological observations should be supported by a second, independent criterion, whereby phonological markedness constraints are phonetically grounded in a property based either in articulation or in perception. A cross-linguistic tendency towards a segment rather than others, in certain contexts, should be supported by phonetic evidence from either perception or production (Kager 1999: 11). Constraints can also be defined by their violability, which must be minimal and can only occur as a mechanism to avoid the violation of a constraint that sits higher in the hierarchy (Kager 1999: 12).

2.2.3 Stress in OT

Well-formedness and faithfulness are important themes in OT and, as such, play a crucial role in an OT-based approach to word stress in a language. In order to exemplify an OT analysis of stress, Kager (1999: 148-161) gives a detailed case study overview of constraints and resolutions in Hixkaryana, a language pertaining to the Cariban family, spoken in the Amazon, in northern Brazil. In its stress system, rhythmic vowel lengthening occurs, even though it violates the constraint Dep-μ-IO, which penalises adding moras or vowel length. This happens because foot structure constraints (Ft-Bin and Uneven-Iamb) take priority, forcing the language to modify vowels for rhythmic consistency Kager (1999: 148-161). What makes this case especially notable is that in OT, all constraints, including those governing foot shape and faithfulness to input, are evaluated together in a single hierarchy (Kager 1999: 161). This differs sharply from traditional derivational approaches. In derivational grammar, vowel lengthening happens later in the process to repair poorly formed feet created by earlier rules. This model separates the creation of metrical structure from later quantitative adjustments. In contrast, OT does not allow step-by-step derivations; everything is evaluated simultaneously at the output level. This means that OT integrates both the structure and weight of feet within one unified system, offering a more general and cohesive account of stress patterns (Kager 1999: 161).

Stress systems are typically classified into two main types:

- **Metrical systems:**

    (a) Stress tends to occur near the edges of a prosodic word;

    (b) This edge-oriented placement can be blocked or modified by constraints related to foot structure (Lacy 2002: 1)..

- **Prominence-driven systems:**

    (a) Stress is assigned based on intrinsic properties of syllables, rather than position;

    (b) Syllables are more likely to attract stress if they have features such as:

    - High sonority
    - Long vowels
    - Strong onsets

    (c) These features can override the default edge preference (Prince 1983; Everett & Everett 1984; Everett 1988; Hayes 1995; Lacy 1997; Kenstowicz 1997; Gordon 1999).

Additionally, tone can also influence where main stress falls (Lacy 2002: 1).

In OT, a group of constraints that share a general format is known as a constraint family (Kager 1999:121). In relation to stress in OT, the following are important constraint families to consider:

- *ALIGNMENT constraints;
- FT-BIN (Foot Binarity);
- *NONFINALITY (to account for stress avoidance at the word edge);
- *WEIGHT-TO-STRESS PRINCIPLE (WSP).

The concept of alignment was first developed within phrasal phonology, where it was used to explain how syntactic structures correspond to prosodic phrasing (Selkirk 1986;

Selkirk & Shen 1990). This "edge-based" approach to the syntax–phonology interface was later integrated into OT by McCarthy & Prince (1993), who argued that the connection between prosody and morphology should be captured solely through alignment constraints (Kager 1999: 117-118). While alignment originally focused on matching the edges of morphological and prosodic elements, it has since been extended to include the alignment of phonological units as well, such as syllables, feet and prosodic words (PrWd). In current OT research, alignment has come to play a much broader role than in these early examples (Kager 1999: 118).

Typical alignment constraints work by pairing the edge of a grammatical category, like a word or morpheme, with the edge of a prosodic category, such as a prosodic word or syllable (Kager 1999: 119). An example of these is:

- Align-L: align stress with the left edge;
- Align-R: align stress with the right edge;
- Align-Morph-L: align stress with the left edge of a morpheme.

More generally, alignment constraints can target a variety of morphological units, like stems, roots, or affixes, and prosodic structures, such as feet or moras. This generalised model proposes that alignment constraints differ depending on the types of categories and edges they involve (Kager 1999: 118).

According to Prince & Smolensky (1993: 49), a PrWd must include at least one foot and each foot must consist of at least two moras. This means that lexical words must be at least bimoraic in size. This conclusion follows from the principle known as Foot Binarity (FTBIN), as formulated by McCarthy & Prince (1986: 28). It dictates that feet are binary at some level of analysis (e.g., in moras or syllables). Foot Binarity is not a rule that directly sets a minimum size for feet; rather, it reflects a general structural property of prosodic organisation (Prince & Smolensky 1993: 50). In fact, one advantage of using prosodic structure to account for minimal word size is that it eliminates the need for a separate minimal word constraint. Since syllables are built from moras, the requirement of Foot Binarity implies that the smallest possible foot must be bimoraic (Prince & Smolensky

1993: 50).

Leaving the final syllable of a word out of the prosodic structure is a classic example of extrametricality (Prince & Smolensky 1993: 44). Latin is often cited as the standard case, though similar patterns appear in many other languages. When the extrametricality rule is applied to exclude the word-final syllable, a key issue arises: monosyllabic content words still receive stress, even though their only syllable is final and, by rule, should be extrametrical (Prince & Smolensky 1993: 44). This raises a puzzle: why is this syllable not treated like other final syllables? For example, in Latin, *cór+pus* is well-formed with the final syllable treated as extrametrical, while *cor+pús* (with final stress) is ill-formed. Similarly, méns (a monosyllable) receives stress despite being final, whereas **+mens* (treating the syllable as extrametrical) is not permitted (Prince & Smolensky 1993: 44-45). This apparent exception is the result of a constraint interaction, NONFINALITY, which disfavours stress on final syllables. It can be overridden and is violable under certain conditions (Prince & Smolensky 1993: 45). The key factor is the need to align morphological and phonological categories. Specifically, elements like roots, stems or words in morphology must correspond to phonological categories, usually the PrWd. As each PrWd must contain exactly one syllable that carries main stress, even in monosyllabic words, stress must be assigned to fulfil this requirement, which can override extrametricality constraints (Prince & Smolensky 1993: 45).

Quantity sensitivity refers to the tendency to align syllable weight with stress (Kager 1999: 171). The central constraint governing this tendency is the Weight-to-Stress Principle (WSP) which dictates that heavy syllables must be stressed (Prince 1983; Prince & Smolensky 1993; Kager 1999). WSP directly connects the weight of a syllable to its metrical prominence (Kager 1999: 155). As Prince (1983) explains, this reflects a natural expectation: syllables that are inherently sonorous, and therefore perceptually prominent, should also be marked with stress. This relationship between sonority and prominence appears not only in stress patterns but also in syllable structure, where segments with the highest sonority are preferred as syllable peaks (Prince & Smolensky 1993: 39). This constraint is violated whenever a heavy syllable fails to receive prominence, whether it is inside or outside a metrical foot (Kager 1999: 155).

2.2.4 Stress to Tone Mapping

In regard to stress and tone, different languages have different processes for the adaptation of these elements, based on the languages' stress and/or tone systems. As Kusaal is a tone language and the loanwords of interest in the present study are in English, a non-tonal language with contrastive stress, it is important to note some of the possible processes that can be undergone by words in similar circumstances. The borrowing and donor languages may have distinct stress systems and one or both languages might be tonal, leading to questions regarding how these might be adapted into the borrowing language (Uffmann 2013: 7). Often, with regard to stress, particularly in the case of predictable stress systems in a borrowing language, the L1 stress system is maintained and generally overwrites any borrowed stress. However, there are cases of modification of words to align the stress patterns in the L1 and the L2, for example, through vowel lengthening. There are cases as well in which the original stress system is modified through borrowing, which provides evidence for stress assignment in these languages (Uffmann 2013: 7). To be more specific, stress languages exhibit restrictions in relation to where prominence is allowed to occur. When the input stress position is in violation of the metrical constraints of the borrowing language, the ill-formed structure can take one of two paths of adaptation. It can be repaired through the stress being shifted to an acceptable position, thus maintaining the segmental material intact, or the stressed syllable in the input can take the correct position, in terms of the native metrical restrictions, through segmental truncation or augmentation (Kang 2010: 2304). Effectively, some languages may preserve the segmental information of the input, sacrificing the input language stress, while other languages might preserve the input language stress, either sacrificing segmental material through deletion or modifying segmental duration (Kang 2010: 2306).

In regard to tone, when tone languages borrow from stress languages, the options for adaptation are:

- To map stress onto tones, utilising the effect of stress on pitch;
- To overlook stress and, instead, use L1 tones or let other factors determine which tones should be used in the loanword (Uffmann 2013: 7).

Languages that have a small set of level tones usually relate high (H) tones with stressed syllables and low (L) tones with unstressed syllables (Uffmann 2013: 7). In tone languages, English stress in loanwords can be produced with a rise in pitch toward the stressed syllable, which is followed by a fall in pitch, imitating the H-L intonation that is oftentimes connected with English primary stressed syllables (Devonish 2002; Kenstowicz 2006). There are, however, languages in which input stress is not considered in tone assignment (Uffmann 2013: 8). For instance, Hsieh & Kenstowicz (2008) attest that the selection of H or L attribution in English loanwords in Lhasa Tibetan is dependant on the laryngeal specification of the first segment of the loanword, being L if the segment is a voiced obstruent or sonorant and H if it is voiceless.

There are also cases in which the input language prominence is usually reflected as a variant of a H tone, but there are additional default mechanisms related to the native phonology that also play a role in this adaptation. For example, tone assignment in English loanwords in Mandarin maintains English stress as a variant of a H tone, while also making changes depending on the voicing of the initial consonant (Kang 2010: 2297). In Dholuo, which both retains input stress as a variant of a H tone and also assigns L tone as default, the choice between the latter and the former is determined by the overall form of the output word and not by the segmental composition of the target syllables (Kang 2010: 2298).

Finally, cases exist in which the input language tone, stress or pitch accent position is either partially or entirely overlooked when adapted to a tone language and tone is assigned by a default mechanism (Kang 2010: 2299). This occurs even in languages in which native tonotactic constraints allow the preservation of the input prominence as a variant of a H tone. As such, loanwords follow stricter structural rules than the native phonology. Thus, the foreign input is changed into an unmarked form, even when an apparently more faithful allowed form seems to be available (Kang 2010: 2299). The following three default tone assignment patterns have been described:

- Non-discriminate attribution of a default tone;

- Tone attribution that is sensitive to syllable weight;

- Tone attribution that is sensitive to the laryngeal characteristic of the onset or coda consonant of the syllable (Kang 2010: 2299).

2.3 Stress “deafness“

Experimental evidence suggests that the phonological properties of a listener’s native language influence speech perception, with listeners relying on language-specific phoneme categories to interpret speech (Peperkamp & Dupoux 2002b: 2). The influence of suprasegmental information, and of stress in particular, has also been investigated. Many such studies by Peperkamp, Dupoux and colleagues (Dupoux et al. 1997, 2001; Peperkamp & Dupoux 2002b; Dupoux et al. 2008; Peperkamp et al. 2010) have yielded results that suggest that native speakers of French, a fixed word-final stress language, present difficulties in discriminating pseudo-words that only differ in the location of stress (Dupoux et al. 2001: 1606). The term stress “deafness“, then, refers to the effect of listeners who present difficulties in discerning pseudo-word minimal pairs that differ based on non-native phonological contrasts, whether segmental or suprasegmental. It should be noted, however, that the term is included within quotation marks because listeners do not fail entirely to perceive these contrasts. (Peperkamp & Dupoux 2002b: 2). In the following sections, studies by Dupoux et al. (1997, 2001); Peperkamp & Dupoux (2002b); Dupoux et al. (2008); Peperkamp et al. (2010); Lin et al. (2014) will be presented in detail, to highlight recent research on the phenomenon of stress “deafness“, to better introduce the processes and relevance of the experiment outlined in the present study. Before delving into the following sections, it is important to note that the studies observed use the term ”non-word” to indicate a word that differs from a real word only in stress placement or in a single phoneme difference and constitutes, as such, a minimal pair with its corresponding real word. Various studies on lexical decision tasks distinguish between pseudo-words and non-words (Ziegler et al. 1997; Specht 2003). Specht (2003) elaborates that behavioural evidence indicates that different regions of the brain may be engaged when performing an auditory lexical decision task with pseudo-words, defined as items that sound like real words but lack meaning, compared to tasks involving non-words, defined as both meaningless and phonologically incorrect sequences of phonemes. Based on this distinction, the present study utilises the nomenclature ”pseudo-word” to represent the former category described by Specht (2003) and, therefore, for all instances of this type of word in the studies mentioned in the following sections.

2.3.1 Dupoux et al. (1997)

In their study *A Destressing "Deafness" in French?*, Dupoux et al. (1997) set out to test the ability of native French and Spanish speakers to discern stress contrasts through four experiments. The first and third of these examine their ability to detect stress differences, while the second examines their ability to ignore them. The fourth experiment addresses the level at which any differences in performance between French and Spanish listeners may emerge (Dupoux et al. 1997: 2). The selection of Spanish as the second language for these experiments was determined by the fact that stress is contrastive in Spanish. Indeed, even though the default accent position in multi-syllabic words is on the penultimate syllable, there are many words with different stress positioning. As such, it is possible to find minimal pairs with the same segments but that have different meanings due to different accent positions (Dupoux et al. 1997: 2). The first experiment tested native speakers of both French and Spanish using an ABX discrimination task. This involved three pseudo-words that varied solely in stress contrast being presented to participants, who had to press a button to select whether the third item resembled the first or the second. These items were recorded by three native speakers of Dutch, two females, one male, in order to not advantage either French or Spanish speakers through the differences in the phonetic realisation of phonemes in the languages (Dupoux et al. 1997: 2). Two stress contrasts were tested, using trisyllabic items with a CVCVCV pattern:

bópelo vs. [bopélo];

bopélo versus [bopeló] (Dupoux et al. 1997: 2).

In order to manage the differences in vowel and consonant inventory, as well as in syllable structure in French and Spanish, the pseudo-words were constructed to use a subset of segments and syllable structure that are admissible in both languages. 16 native French speakers and 16 native Spanish speakers participated in the experiment, which comprised 10 practice trials followed by two experimental blocks of 48 trials (Dupoux et al. 1997: 2-3). The error rate calculated through the results of the experiment showed that Spanish participants presented very few errors, while French participants showed difficulty performing the task. The reaction time measurement also yielded the same trend. Seeing as the Dutch inflection in the auditory cues may have contained vowels or consonants that were more archetypal for the Spanish participants than for the French participants, the second experiment was designed to reverse the pattern of results obtained in the first experiment. This was done to create a scenario that might be simpler for the French participants to perform and more challenging for the Spanish participants (Dupoux et al. 1997: 3).

In the second experiment, participants were to ignore stress, which was varied independently of the phonemic structure. This way, relying on stress information would imply chance performance (Dupoux et al. 1997: 3). 12 CVCVCV quadruplets were created by crossing an accent contrast and a phoneme contrast. Stimulus presentation was identical to the first task and the same number of participants took part in this experiment. Results showed that French participants responded with higher speed and accuracy than Spanish participants, implying that the French listeners were able to concentrate solely on segmental information, ignoring stress variations. Spanish listeners made more errors, implying that they had more difficulty ignoring stress variations (Dupoux et al. 1997: 4).

Experiment Three was carried out to evaluate the possibility that the differences found in the previous two experiments were due to the way participants understood the task, rather than to the way they actually perceived stress (Dupoux et al. 1997: 5). This involved a direct comparison for each participant's responses relative to stress and their responses relative to phonemes, while keeping the other variables constant. In this ABX task, a redundant condition was also included. In this, both stress and phoneme information were associated with the same response (Dupoux et al. 1997: 6). 12 new CVCVCV quadruplets were created from crossing a stress contrast and a phoneme contrast. In the task, the A and B stimuli either differed by one phoneme, by stress or by both phoneme and stress. The stimuli were recorded by a female and a male native speaker of Dutch and were presented to 20 French participants and 20 Spanish participants. French participants had slower reaction times and higher error rates in the accent condition compared to the phoneme condition and the stress and phoneme contrast condition (Dupoux et al.

1997: 7).

Experiment Four was carried out to explore the extent of the French participants' difficulties with perceiving stress. This was done by exposing them to two stimuli and having them judge whether they were the same or had pronunciation differences (Dupoux et al. 1997: 8). This kind of experiment is known as an AX discrimination task. The stimuli either differed in stress placement or in one phoneme. Furthermore, there was one condition in which two recordings of the same stimuli were presented. In order to also test the possible effect of memory load, a tone of differing duration was inserted between each stimulus within a pair (Dupoux et al. 1997: 8). In this experiment, French participants were able to discriminate stimuli with stress differences with high accuracy, showing similar results to those for stimuli with phonemic differences. There was, however, a tendency towards more errors in the condition with a longer tone between stimuli (Dupoux et al. 1997: 9). These results indicate that French participants can, in fact, identify stress and maintain a memory of its correlates for longer than two seconds (Dupoux et al. 1997: 9). A possible explanation for the stress distinction having been less difficult is the fact that this AX paradigm only presented two stimuli, allowing for a lower memory load than the ABX paradigm. Another possible explanation is that the stimuli were recorded by the same person (a native Dutch female speaker), meaning that participants could have been using an acoustic representation to discern stress cues, a strategy that is harder to employ with different speakers (Dupoux et al. 1997: 8-9). These results suggest that French listeners may nevertheless be "deaf" to stress contrasts on a more abstract level of processing, shown only through tasks that are more challenging in terms of memory and perceptual resources (Dupoux et al. 2001: 1607).

Firstly, and most notably in relation to the present study, the authors observed that the ABX task used in Dupoux et al. (1997) was not optimal for the following reasons:

(a) Although French participants made significantly more errors than Spanish participants, French subjects still performed better than chance (50%), signifying that, either the ABX task was not challenging enough or that listeners relied on a phonological representation of stress.

(b) The results presented significant individual variability, in which some French participants performed as well as some Spanish participants or, conversely, some Spanish participants performed as poorly as some French participants (Dupoux et al. 2001: 1607).

2.3.2 Dupoux et al. (2001)

Dupoux and colleagues embarked on further experiments, employing different methods with the aim of building a stronger paradigm to study stress "deafness" through a more systemic observation of variables (Dupoux et al. 2001: 1607). Dupoux et al. (2001) focused, once more, on native French and Spanish speakers with the aim to solidify their 1997 paradigm.

The methods utilised in this study involve a sequence recall task (SRT), in which participants were required to learn two CVCV pseudo-word mminimal pairs, with either a phonemic contrast, such as [túku, túpu] or a stress contrast, such as [píki, pikí]. Participants then learnt to associate the pseudo-words to keys [1] and [2] on a computer keyboard and were required to listen to longer and longer sequences of the items. The participants were then asked to remember and transcribe these as sequences of [1] and [2] in the correct order they heard them in (Dupoux et al. 2001: 1608).

Dupoux et al. (2001) ran a second experiment, which replicated the first, with the difference being that the pitch in the tokens was altered through speech resynthesis. The expectation here was that the modification would make it more difficult for French participants to rely solely on acoustic representation, while, in contrast, having no significant impact on Spanish listeners. In the third experiment, participants were given a new set of stimuli. This time they consisted of pseudo-words with different vowel combinations in the two syllables, i.e. [kúti, kúpi], [mípa, mipá] (Dupoux et al. 2001: 1611). The fourth experiment replicated the third, but presented more phonetic variability through the introduction of a new speaker, this time a male. This change was predicted to make it more difficult for French participants to rely on acoustic representation. In the fifth and final experiment, participants were only exposed to one token of each minimal pair. In this scenario, the prediction was for French and Spanish participants to perform equally on both the phonemic and the stress contrast tasks (Dupoux et al. 2001: 1614).

Through these five experiments, Dupoux et al. (2001) improved the methodology used in their previous studies and demonstrated that the stress “deafness“ effect can, in fact, be replicated and can yield results that can be interpreted on an individual basis (Dupoux et al. 2001: 1615). The results show that the size of the effect increases as the amount of phonetic variability increases. In particular, an increase of 5% on pitch variation on stimuli presented by one speaker yielded similar results as the same increase on stimuli presented by two speakers, one male and one female (Dupoux et al. 2001: 1615). Shorter sequences yielded less errors than longer sequences, showing the strong effect of memory load on performance. Through experiments One to Four, however, the stress-phoneme difference score in French speakers had around the same size at the lowest sequence length and at the highest sequence length (Dupoux et al. 2001: 1615). Considering the fact that with the same sequence length as that used for the training sessions, French speakers presented no significant difference between stress and phonemes, the conclusion, according to the authors, is that the amount of memory load is not influential, but its presence is (Dupoux et al. 2001: 1615).

Phonetic variability and memory load did display interaction. In the fifth experiment, with no phonetic variability, there was no stress contrast deficit, no matter the sequence length. However, during the training sessions and with the high phonetic variability present in the fourth experiment (with two different speakers), French participants seemed to have no issue mastering the stress contrast. This implies that the stress “deafness“ effect only appears when both factors are present (Dupoux et al. 2001: 1615). Although French participants made significantly more errors with the stress contrast compared to the phoneme contrast, they still performed notably better than chance. The authors discuss three possible reasons for this, the most unlikely being that an acoustic strategy may survive extended sequence lengths as well as phonetic variability (Dupoux et al. 2001: 1616). The second hypothesis is that there may be residual encoding in the phonological representation; this is made possible if we consider that French does use stress in word segmentation. The third hypothesis the authors present is that a different type of representation may exist, such as a phonetic representation, which may be utilised to encode the stimuli in a way that is universal, but more abstract than the acoustic representation (Dupoux et al. 2001: 1616).

2.3.3 Stress Parameter Model

The Stress Parameter Model (SPM) was established and developed by Peperkamp & Dupoux (2002b) and Peperkamp (2004a). While the Perceptual Assimilation Model (PAM) (Best 1995; Best et al. 1988) and the Speech Learning Model (SLM) (Flege 1992, 1995; Flege et al. 2003) were constructed to address the processes implemented in learning segmental contrasts, the SPM focuses on suprasegmental information, in particular the impact of typology on both the processing and the representation of stress within phonological memory (Lin et al. 2014: 317). According to Peperkamp & Dupoux (2002b: 4), infants determine, with little information, whether or not stress is contrastive in their L1 and, as such, whether or not stress should be encoded in the phonological representation. This task is what Peperkamp & Dupoux (2002b: 4) named the Stress Parameter, which they believe is set within the first two years of life and, at its default setting, is encoded in the phonological representation. The authors further describe the setting of the Stress Parameter in different language acquisition circumstances. In the case of a non-contrastive stress language, if infants are able to recognise the regularity of stress by the time the Stress Parameter is set, they will set it so that stress is not encoded (Dupoux et al. 2001: 1615). However, if they do not recognise the non-contrastive nature of stress in their language, stress will stay in the phonological representation. In a third case, with contrastive stress languages, infants will notice no regularity in stress and, as such, correctly maintain stress within the phonological representation (Peperkamp & Dupoux 2002b: 4).

The authors propose that infants rely on the distribution of stress at utterance confines to set their Stress Parameter. As such, with regular word stress, its predictability will either be at the beginning or at the end of utterances, depending on which edge of the word stress is assigned to in that language (Peperkamp & Dupoux 2002b: 4). The authors hypothesise that before having acquired the full lexicon of their L1, infants utilise stress patterns that occur at utterance edges in order to detect if stress is contrastive or not and, therefore, set the Stress Parameter (Peperkamp & Dupoux 2002b: 5). With this model being established, the authors expanded a similar typology of study as their 2001 investigation to three other predictable stress languages, Polish, Finnish and Hungarian (Peperkamp & Dupoux 2002b; Peperkamp et al. 2010). They also expanded it to L2 acquisition and stress perception in a foreign language, specifically in Spanish on behalf of native French speakers (Dupoux et al. 2008, 2010). Through these studies the possibility arises that if the Stress Parameter has been set to "off" during infancy, it cannot then be reset later in life, as can be seen in Dupoux et al. (2008) and Dupoux et al. (2010), detailed in Section 2.3.4 and Section 2.3.5.

2.3.4 Dupoux et al. (2008)

Dupoux et al. (2008) implemented a SRT with high phonetic variability, much like in their aforementioned research. They also, however, introduced a speeded lexical decision task, which used minimal pairs of words and pseudo-words that only differ in stress position (Dupoux et al. 2008: 6). The reason for the inclusion of this second experiment was to investigate whether the difficulty with stress perception comprises the use of stress for online lexical access, as opposed to being limited to sort-term memory tasks. The researchers explored the use of stress in lexical representations through an auditory lexical decision task in which participants were exposed to real words in Spanish and their pseudo-word counterparts, composed of these same words but with a different stress position (Dupoux et al. 2008: 14).

For the first experiment in this study, Dupoux et al. (2008) implemented a modified version of the methods used for their 2001 study (Dupoux et al. 2001), their approach differing in the following three notable ways:

(a) The sequence lengths presented did not vary, but, rather, stayed at the mid level of four, in order to avoid both floor and ceiling effects;

(b) The stimuli are produced by different speakers, three men and three women, in order to prevent the possibility of relying on acoustic cues;

(c) The speed of presentation is increased; with a fast presentation rate, solely

> automatic phonological encoding is thought to be functioning (Dupoux et al. 2008: 9).

39 native French speakers, who were late learners of Spanish, took part in the experiment. None of the participants had learnt any Spanish before age 11 and no other foreign language before the age of 10. A further 20 native French speakers and 20 native Spanish speakers also participated in the study. The native French speakers had not learnt Spanish and had not studied a foreign language before the age of ten. Similarly, the Spanish speakers had not learnt French and had also not studied a foreign language before the age of ten (Dupoux et al. 2008: 6).

The SRT experiment replicated the procedure described in Section 2.3.2, in which two minimal pairs were constructed, one involving a phonemic (consonantal) contrast and one involving a stress contrast. Participants were required to associate one keyboard key with one word and another with the other word and, subsequently, to replicate the sequence of stimuli they heard in succession (Dupoux et al. 2008: 10). Similarly to their previous study (Dupoux et al. 2001), the SRT results revealed a significant stress "deafness" effect both in the French control participants and in the late learners of Spanish (Dupoux et al. 2008: 14).

For Experiment Two, the auditory lexical decision task, 112 minimal pairs composed of a real word and its pseudo-word counterpart that only differed in stress placement were constructed (Dupoux et al. 2008: 15). In addition, 40 minimal pairs composed of a real word and its pseudo-word counterpart that only differed in one phoneme were constructed and used as control items. Participants were required to listen to one of two lists of these stimuli and decide, as quickly and accurately as possible, whether they were words in English by pressing one of two buttons (Dupoux et al. 2008: 15). In the test condition, for words, the late learners had a moderate error rate, which diminished with a higher level of practice with Spanish, as well as with word frequency. On the other hand, for pseudo-words the error rate was very high, indicating that participants predominantly interpreted the pseudo-words as real words. This error rate increased with word frequency and was not impacted by the degree of practice with Spanish. On the other hand, very few errors were made by the Spanish control participants (Dupoux et al. 2008: 17).

In the control condition, which only comprised high frequency words, the late learners displayed a similar error rate to that displayed for the high frequency words presented in the test condition. However, their error rate for the pseudo-words was significantly lower than the error rate for the high frequency pseudo-words presented in the test condition. Furthermore, the error rates for both words and pseudo-words decreased in correlation with the participants' degree of practice (Dupoux et al. 2008: 18). These results indicated that stress "deafness" extends to lexical access and is, therefore, not solely tied to short-term memory. As such, French learners of Spanish, regardless of their level of mastery of the lexicon of the language, seem to have limited access to the suprasegmental distinction that is related to the encoding of Spanish words. These results suggest that, since regardless of their proficiency in Spanish, French participants displayed levels of stress "deafness", this effect is a processing limitation that is not modifiable through exposure to contrastive stress in a L2, supporting the theory that if the Stress Parameter was set to "off" in infancy, it is not possible to reset it (Lin et al. 2014: 317).

2.3.5 Dupoux et al. (2010)

Dupoux et al. (2010) further extended their research and hypotheses regarding SPM and the stress "deafness" effect to simultaneous bilinguals of French and Spanish, focusing on French and, specifically, on participants' on-line perception of stress at word level. In order to increase the statistical strength of their data, the authors implemented various tasks and calculated a composite score based on them; seeing as many task-specific components are involved in any given paradigm, according to the authors, the analysis of results across different tasks should promote the reduction of the contribution of these task-specific elements while retaining the contribution of the processing levels shared by the tasks (Dupoux et al. 2010: 267). This study aims to understand the factors that determine which of the languages spoken in an infant's environment become their dominant language (Dupoux et al. 2010: 267). As such, the participants selected for the study were simultaneous bilinguals of French and Spanish in two different cities, Paris and Barcelona. Alongside the 23 simultaneous French-Spanish bilingual participants, of which 15 had a native Spanish-speaking father and a native French-speaking mother and eight had a native French-speaking father and a native Spanish-speaking mother, another two control groups also participated in the experiment (Dupoux et al. 2010: 267-268). The first consisted of the same 20 native speakers of Spanish, all born within monolingual Spanish-speaking families, that participated in the study by Dupoux et al. (2008) described in Section 2.3.4. The second control group was composed of the same 39 native French speakers who participated in the same study by Dupoux et al. (2008), who had learned Spanish after the age of ten (Dupoux et al. 2010: 268).

The first two tasks implemented in the experiment involved a SRT. The first followed the same procedure and used the same stimuli as Experiment Three in the study by Dupoux et al. (2001) mentioned in Section 2.3.2. Two pseudo-word minimal pairs were used, recorded by a female speaker, one with a phonemic contrast and the other with a stress contrast (Dupoux et al. 2010: 269). The first pseudo-word of both contrasts was associated with key [1], while the second was associated with key [2] on a computer keyboard.

The second task used the same stimuli and procedure as those used in Experiment One in the aforementioned study by Dupoux et al. (2001). It also invovled two minimal pairs of which one with a phonemic contrast and the the other with a stress contrast. In this case, though, the tokens were recorded by six different speakers, three male and three female. During both tasks, participants were required to listen to all of tokens of each minimal pair by pressing key [1] or key [2]. After indicating they were ready to move to the next step, participants were then asked to listen to a token and judge which group it belonged to, whether [1] or [2]. Once participants had met the success criterion of seven correct matches in a row, the experiment began. This consisted of 40 acoustic trials, split into five blocks of eight repetitions of the minimal pairs, played at different length sequences. The participants' task was to reproduce each sequence by typing the matching key, [1] or [2], for each token in a block. In the second task, however, the interval between blocks was reduced from 80 milliseconds (ms) to 50 ms (Dupoux et al. 2010: 269).

The third experiment, an auditory lexical decision task, used the same stimuli and procedure used in Dupoux et al. (2008). The stimuli consisted of words and pseudo-words, differing solely in stress placement, recorded by a female native speaker of Spanish. The stimuli were primarily disyllabic (96 out of 112) and the remaining 16 were trisyllabic. An additional 40 control minimal pairs were constructed, differing only by one phoneme

(Dupoux et al. 2010: 269-270). Participants were asked to listen to the stimuli and judge, as quickly and accurately as possible, if the sounds they heard were real words or not. Two different lists were created and participants were tested with just one list. The order in which the stimuli was presented to each participant was also randomised. During the experiment, an asterisk appeared in the centre of the screen for 500 ms. The auditory stimulus was presented another 500 ms after the fixation point disappeared (Dupoux et al. 2010: 270).

All three of the tasks yielded results that placed the simultaneous bilingual group of participants between the group of native Spanish speakers and the group of native French speakers (Dupoux et al. 2010: 272). Through a composite performance measure calculated over the results of the three tasks, the authors observed that the overall performance of the simultaneous bilinguals is best reviewed in a bimodal distribution corresponding to a blend of the performance distribution of the French and Spanish control groups, since the bilinguals' results were equally split over these two distributions (Dupoux et al. 2010: 272).

This study was the first of its kind to find a bimodal distribution in simultaneous bilinguals, additionally confirming claims that simultaneous bilinguals can only process one language in a native or near-native manner in terms of phonological perception (Cutler et al. 1989, 1992; Sebastián-Gallés et al. 2005). However, this does not categorically mean that some or all bilinguals do not have native or near-native performance in both languages, which is something that was not tested for in this particular study (Dupoux et al. 2010: 273).

Spanish-dominant bilingual participants' performance was indiscernible from that of the Spanish monolingual participants. The performance of French-dominant bilingual participants, however, was very similar to that of French late learners of Spanish who only had a few years' experience with Spanish. The former had only slightly better results compared to the latter (Dupoux et al. 2010: 273). The fact that close to half of the simultaneous bilingual participants displayed difficulty in the perception of Spanish lexical stress was of particular interest to the authors. This is due to the fat that Spanish stress can be encoded without associated costs for the processing of French, since, of the two languages, only Spanish has contrastive stress (Dupoux et al. 2010: 273). It is possible, according to the authors, that the explanation for this may lie in the competition between incompatible systems in different languages, causing individuals to be impaired in one of the two languages (Dupoux et al. 2010: 273). The main variable found to be the best predictor of language dominance is the amount of early exposure. Furthermore, the two subjective measures included in the study, fluency and importance in the participants' lives, yielded no effect (Dupoux et al. 2010: 273).

The data retrieved from the three tasks are compatible with the hypothesis that early exposure plays a fundamental role in on-line phonological perception. This supports the findings that, at nine months of age, monolingual Spanish- and French-learning infants display differences in relation to their perception of stress. In particular, French-learning infants at this age do not recognise stress contrasts (Dupoux et al. 2010: 274). The results of the studies also corroborate the hypothesis that the language spoken by the mother does not play an independent role and, therefore, prenatal exposure does not affect the selection of the dominant language (Dupoux et al. 2010: 274). Finally, the results of these tasks are compatible with the proposal that the dominant language cannot be changed after a certain sensitive period, at least in terms of on-line perception, and, therefore, current use of a language does not play a relevant role. The overall results of this study reinforce the claim that simultaneous bilinguals, monolinguals in their own language and late learners in their L2 are functionally close to each other (Dupoux et al. 2010: 274).

2.3.6 Lin et al. (2014)

Following Peperkamp, Dupoux and colleagues' various studies, other researchers expanded the research on stress "deafness" and, therefore, on SPM, to other languages, such as:

- Arabic, Chinese, French, Japanese, Korean, Spanish, Turkish (Altmann 2006);
- Dutch, Japanese, French, Indonesian and Persian (Rahmani et al. 2015), thus including tone languages to the investigation of the phenomenon.

The investigation by Lin et al. (2014) involving native speakers of Korean, a tone language with no stress at the word level, with English as their L2 has provided relevant information for the present study, laying out knowledge that has catalysed some of the processes followed for the current investigation.

Lin et al. (2014) compare native Mandarin Chinese and Korean speakers' perception of stress contrasts in English. Although both are typically classed as tone languages, Mandarin Chinese (based on the Beijing dialect, in this case), displays contrastive stress and is produced with similar phonetic characteristics used in English (Lin et al. 2014: 318). As such, minimal pairs exist in Mandarin that differ solely in stress placement. Furthermore, full syllables bear one of the four lexical tones of the language. Syllables that carry such tones are produced in a louder manner and with longer duration and larger amplitude than light syllables. On the other hand, light syllables bear the neutral tone and display significant vowel reduction (Chao 1968), as well as lower articulatory strength (Chen & Xu 2006). In addition, Duanmu (2007) equates Mandarin full syllables to English stressed syllables, which, in turn, are produced with increased intensity, higher pitch and longer duration, and Mandarin light syllables to English unstressed syllables.

On the other hand, Korean does not display lexically contrastive stress or fixed stress at word level (Lin et al. 2014: 318). Korean prosody is built on tone patterns, while English prosody is based on stress accent. Furthermore, the lexical word constitutes the element of prosodic association for English stress, while tone patterns in Korean are correlated with the accentual phrase (Lin et al. 2014: 318). In an accentual phrase (AP) in the Seoul Korean dialect, the default pitch pattern is low–high, low–high (LHLH) (Jun 1998). When the first segment in an AP is aspirated or tense, the AP starts with the H tone (Jun 1998, 2000; Kim & Cho 2009). However, while a higer pitch in English is an acoustic cue for lexical stress, in Korean, the higher pitch does not indicate a lexical shift (Lin et al. 2014: 318).

The authors hypothesise that native Mandarin speakers and native English speakers would display more accurate perception of stress than Korean participants (Lin et al. 2014: 318). Since the Mandarin speakers, as infants, would have been able to use acoustic cues to infer that stress placement is contrastive in their L1, they would have encoded stress in their phonological representation. As such, native Mandarin speakers may be able to apply these stress encoding strategies when learning a language like English, which displays contrastive stress (Lin et al. 2014: 318). In contrast, then, since stress is not a component of the phonetic realisation of the prosodic system in Korean, Korean speakers who learn L2 English may not have access to stress-encoding strategies. As such, they are expected to have difficulty discerning the placement of stress in a way similar to that of French learners of L2 Spanish in Dupoux et al. (2008). To explore this hypothesis, Lin et al. (2014) implemented two experiments, a SRT and a lexical decision task, following the model explored by Dupoux et al. (2008, 2010). The participants that took part in both experiments were 20 Mandarin L2 English learners, 19 Korean L2 English learners and 21 American English monolinguals. Furthermore, participants were required to take an English proficiency test (Lin et al. 2014: 319).

For the SRT, two minimal pairs of pseudo-words involving a phonemic contrast and a stress contrast were constructed and recorded by one female and one male native English speakers. In the testing phase, participants heard sequences of different lengths, from two to six pseudo-words, and were required to press corresponding keys on a computer keyboard (Lin et al. 2014: 319). For the analysis of the data recorded from the SRT, only 100% correct transcriptions of the sequences were registered as correct responses (Lin et al. 2014: 321). The Korean speakers had increased difficulty recording the minimal pair with a stress contrast in comparison to the minimal pair with a phoneme contrast. This asymmetry was not displayed in the Mandarin participants' results and there was no significant difference between the two language groups' results in the phoneme contrast condition (Lin et al. 2014: 323). This indicates that the Mandarin participants' more accurate recall of the stress condition is unlikely to represent a better short-term memory capacity on behalf of the Mandarin speakers. English speakers also had difficulty in the stress contrast condition, performing similarly to Korean participants. Since English speakers would have their Stress Parameter set to encode stress, seeing as English has unpredictable stress, it is unlikely that the origin of the difficulty displayed by the English and Korean participants is the same (Lin et al. 2014: 323). The authors hypothesise that the cause for the English speakers' performance may be due to the use of pseudo-words. The fact that the vowels in the unstressed syllables in the pseudo-words did not undergo reduction in this experiment may have forced speakers to rely solely on suprasegmental cues like pitch, intensity and duration to identify stress (Lin et al. 2014: 323). For lexical access, English speakers do not rely considerably on suprasegmental information, since vowel reduction plays an important role as a stress cue (Cutler 1986). In contrast to Spanish speakers, for example, who must depend heavily on suprasegmental information to distinguish stress contrast minimal pairs, since there is no vowel reduction in Spanish, English speakers can rely on a change in vowel quality without relying on suprasegmental information to identify words, since in English almost all unstressed syllables have vowel reduction. Lin et al. (2014: 323) hypothesise, therefore, that the absence of the vowel cue in the pseudo-words may have had a negative impact on the English participants' performance.

The second experiment in this study is composed of an auditory lexical decision task, designed to expand the information obtained through Experiment One and explore how L2 online lexical access is affected by L1 stress characteristics (Lin et al. 2014: 324). 120 minimal pairs were constructed consisting of real words and their pseudo-word counterparts, created by placing stress on a different syllable. Furthermore, stimuli varied in word frequency to make sure participants would use standard lexical retrieval strategies that had not been impacted by the stress shift of the pseudo-words. Due to the importance of vowel reduction as a stress cue in English, for native speakers, word recognition could be influenced by the presence of vowel change in the pseudo-words (Lin et al. 2014: 325). For this reason, vowel length was manipulated in the pseudo-words. A schwa in an unstressed syllable in the real word would become a full vowel when it became stressed to create a pseudo-word, e.g. in [ˈhyuːmən] the schwa /ə/ is changed to a full vowel /æ/ to make the pseudo-word [hyu'mæn] (Lin et al. 2014: 325).

Alongside the 120 items with stress contrast, another 60 minimal pairs were constructed to be used as controls, this time with real words and pseudo-words created by changing one phoneme in the words, like, for example, in [əˈweɪ, əˈmeɪ] (Lin et al. 2014: 325). These words were created to prevent participants from forming stress-specific processing strategies. The variation in contrasts, sometimes being phonemic and other times being stress-related, would cause participants to consider both segmental and suprasegmental information during lexical analysis.

All of the stimuli were recorded by three different English speakers, two females and one male, and were presented as auditory cues to participants, who were required to decide whether the sound they heard was a real word in English by pressing a ”yes” button or a ”no” button on a computer keyboard. They were also specifically instructed to consider mispronounced words as words that are not real in English (Lin et al. 2014: 325).

The native English speakers were more accurate than both the Mandarin and the Korean speakers in identifying pseudo-words with altered stress location and with an altered phoneme (Lin et al. 2014: 331). Moreover, the Mandarin and the Korean speakers displayed comparable performances when identifying pseudo-words with a phonemic change. The Korean participants displayed more difficulty than the Mandarin participants when identifying pseudo-words with a stress placement change. A considerable word frequency effect was also detected in the Korean participants, but not for the English or the Mandarin participants, indicating that the Korean speakers examined the pseudo-words with the stress position change as real words (Lin et al. 2014: 331). As with Experiment One, the Korean participants had more difficulty with the stimuli involving stress contrasts than those with phonemic contrasts. The results suggest that the absence of phonological representation for stress in the Korean speakers impacted both their short-term memory, when identifying minimal pairs of pseudo-words, and their identification of stress patterns in real words (Lin et al. 2014: 332).

The data obtained from both experiments supported the authors’ hypotheses that assumed SPM, indicating that the difficulty that Korean participants displayed in relation to stress processing may be caused by the absence of efficient strategies to process stress (Lin et al. 2014: 337). Lin et al. (2014) concluded that L2 learners are able to process stress in a native-like manner when stress representation is available in their L1 phonological memory. In contrast, when L2 learners are required to process stress and lexical access at the same time, their more limited lexical proficiency, as well as differences in the L1 and L2 prosodic systems increase learners’ processing abilities (Lin et al. 2014: 337).

3 Methods

This section aims to elaborate the processes undertaken to collect data, create an experiment design and carry out the experiment with the participation of L1 speakers of Kusaal. Section 3.1 and Section 3.2 detail some of the phonological patterns of English, with particular focus on British English (BrE) and Ghanaian English (GhE), and of Kusaal. Section 3.3 offers an overview of the data collection methods used, while Section 3.4 and Section 3.5 provide theories surrounding the relevance of language proficiency levels and word frequency, respectively, in language processing studies. Finally, in Section 3.6 details are given regarding the appropriateness of an auditory lexical decision task for the kind of experiment set out in the present study. The experiment design (Section 3.6.1), materials (Section 3.6.2), procedure (Section 3.6.3) and participants (Section 3.6.4) are all detailed in Section 3.6 to conclude this section.

3.1 Language Sample: English

Although the choice of a national language or a language of education in a multilingual country - and most African countries are exactly that - is a controversial issue, the national language of Ghana is English, as mentioned in Section 1.1 (Beyogle 2015: 46). For the context of this study, a brief summary of both British English (BrE) and Ghanaian English (GhE) will follow, as the Standard British Accent influences the English learnt in Ghana (Adongo 2018: 31).

BrE is a non-tonal language, with seven short, or lax, vowels, /ɪ, e, æ, ʌ, ɒ, ʊ/, and five long, or tense, vowels, /iː, ɜː, ɑː, ɔː, uː/. It also has the following tense diphthongs: /ɪə, eə, ʊə, eɪ, aɪ, ɔɪ, əʊ, aʊ/. Finally, BrE also presents the following tense triphthongs: /eɪə, aɪə, ɔɪə, əʊə, aʊə/ (Roach 2009: 16-19). Its phonemic inventory comprises 24 consonants, presented in Table 2.

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Plosive	p b			t d			k g	
Fricative		f v	θ ð	s z	ʃʒ			ʜ
Affricate					t͡ʃ d͡ʒ			
Nasal	m			n			ŋ	
Lateral				l				
Approximant	w				r	j		

Table 2: Standard British English consonants. Adapted from Abdallah (2020: 32)

The main syllable system of BrE is V, CV, VC, CVC, VCC, CCVC, allowing for onset and coda consonant clusters. Word-initial two-consonant clusters can be of two types in English (Roach 2009: 57). One is composed of /s/, being the pre-initial consonant, followed by one of the following as initial consonants: /t, w, m/, like in [stɪŋ], [sweɪ] and [sməʊk]. The other type is composed of one of about 15 consonants, followed by one of the /l, r, w, j/, e.g., pleɪ, traɪ, kwɪk, fjuː (Roach 2009: 57). Three-consonant clusters in word-initial syllable onset position have a clear connection to the two types of two-consonant clusters; examples of such initial three-consonant clusters include [splɪt], [striːm], [skweə] (Roach 2009: 57). In these clusters, the /s/ functions as a pre-initial consonant, while the following consonants /p, t, k/ serve as the initial consonants and the final consonants in the cluster, /l, r, w/, are post-initial. Notably, the number of permissible three-consonant clusters at the beginning of words is quite limited, as shown in Table 3.

	/l/	**/r/**	**/w/**	**j**
[sp]	[spleɪ]	[spreɪ]		[spjuː]
[st]		[strɪŋ]		[stjuː]
[sk]	[sklɪərəʊsɪs]	[skriːn]	[skwiːk]	[skjuːə]

Table 3: Possible three-consonant word initial clusters in BrE. (Roach 2009: 57)

In word-final position, up to four-consonant clusters are possible in BrE (Roach 2009: 59). All consonants can be a final consonant, appearing as the only consonant in final coda position, with the exception of /h, w, j/. The consonant /r/ is a notable exception; it does not occur word-finally in Standard BrE pronunciation, though in many rhotic varieties of English, syllables can end with /r/ (Roach 2009: 59).

There are two types of two-consonant clusters that can occur in word-final position. In one type the final consonant is preceded by a pre-final consonant, while in the other it is followed by a post-final consonant. The set of pre-final consonants is limited and includes /m, n, ŋ, r, l, s/. Examples include: [bʌmp], [bɛnt], [bæŋk], [bɛlt], [aːsk] (Roach 2009: 59).

Similarly, post-final consonants also form a small set: /s, z, t, d, θ/, as seen in words like [bɛts] 'bets', [bɛdz] 'beds', [bækt] 'backed', [bægd] 'bagged', [eɪtθ] 'eighth'. These post-final elements are often, but not exclusively, identifiable as separate morphemes (Roach 2009: 59). For instance, in [æks] 'axe', the final /s/ is not a distinct morpheme, as it has no separate meaning, but rather part of the word as a whole (Roach 2009: 59). On a pronunciation level, it is to be noted that in clusters involving two plosives, such as /gd/ in 'bagged' or /kt/ in 'backed', the release of the first plosive, /g/ or /k/, is typically unreleased, making it nearly inaudible (Roach 2009: 59). There are two kinds of word-final three-consonant clusters:

(a) Pre-final consonant, followed by final, followed by post-final, e.g., [hɛlpt] 'helped', [bæŋks] 'banks', [bɒndz] 'bonds', [twɛlfθ] 'twelfth'.

(b) More than one post-final consonant in a final cluster: final followed by post-final 1, followed by post-final 2. Post-final 2 is one of the set /s, z, t, d, θ/, e.g., [fɪfθs] 'fifths', [nɛkst] 'next', [læpst] 'lapsed'. (Roach 2009: 59)

Four-consonant clusters can, for the most part, be categorised as having a pre-final consonant, followed by a final and two post-final consonants, e.g., [twɛlfθs] 'twelfths', [prɒmpts] 'prompts' (Roach 2009: 59). However, some cases present no pre-final consonant, but one final consonant followed by three post-final consonants: [sɪksθs] 'sixths', [tɛksts] 'texts' (Roach 2009: 60).

In addition to these rules, there are further phonotactic restraints in BrE, depicted as follows:

(a) /ŋ/ cannot appear in onsets;

(b) /v, ð, z, ʒ/ are not part of onset clusters;

(c) /h/ cannot appear in codas;

(d) Coda clusters composed of a nasal and a plosive are only permitted if they have the same place of articulation;

(e) /lg/ is not a permitted coda cluster. (McMahon 2002: 106)

BrE is neither an entirely fixed-stress language nor an entirely free-stress language (McMahon 2002: 120). This situation is largely due to the unique historical development of English. Originally, from its Germanic roots, English had a fixed stress pattern, typically placing stress on the first syllable of the stem (McMahon 2002: 120). However, the language has since been heavily influenced by Latin, French, and other Romance languages through extensive borrowing. As a result, English now features a blend of Germanic and Romance stress patterns (McMahon 2002: 120). On the one hand, there are minimal pairs that only contrast because of the position of stress, such as [kənˈvɜːt], [prəˈdjuːs], which are verbs and [ˈkɒnvɜːt], [ˈprɒdjuːs], which are nouns (McMahon 2002: 120). On the other hand, there are some rules that allow for stress placement to be predictable: for nouns, stress falls on the penultimate syllable if it is heavy or on the antepenultimate syllable if the penultimate is light. For verbs, the stress falls on the final syllable if it is heavy or on the penultimate if the final syllable is light (McMahon 2002: 120). Disyllabic nouns in English generally tend to have a trochaic pattern, where primary stress is on the first syllable, while, in contrast, disyllabic verbs generally tend to have an iambic pattern, where primary stress is on the second syllable. This contrast is clearly noticeable in noun - verb homographs, e.g. *record*, *permit*, which have different stress placement in the pronunciation of their noun and verb iterations (Davis & Kelly 1997: 446).

The stress rules mentioned so far depend on syllable weight. A syllable with a branching rhyme, composed of either a long vowel or a diphthong, with a coda or without, or of a short vowel with a coda, is considered heavy. A syllable with a short vowel and without a coda is light (McMahon 2002: 120). English nouns typically have stress on the penultimate syllable, as long as that syllable is heavy. However, in the word [ˈdɪ.sɪ.plɪn] 'discipline' the penultimate syllable [sɪ] is light. This is due to the fact that [pl] is a valid onset consonant cluster for the third syllable. [sɪ] has no coda consonant and just a short vowel and, as such, it cannot attract stress by the aforementioned rule. The stress falls, instead, on the previous syllable (McMahon 2002:121). Although, in verbs, stress tends to fall on the last syllable of a word, here too, there are some exceptions; [ˈtæli] ’tally’ and [ˈhʌri] ’hurry’, for instance, have final light syllables consisting, in both cases, of a short vowel in the rhyme. These cannot attract stress and, as such, the stress falls on the syllable that precedes it (McMahon 2002:121).

The stress patterns described above generally help explain where stress falls in many English nouns and verbs, as well as how native speakers adapt the pronunciation of borrowed words to fit English norms (McMahon 2002:121). Nonetheless, there are numerous exceptions. For example, according to the Noun Rule, a word like [spəˈgɛti] ’spaghetti’ should have stress on the antepenultimate syllable, as the penultimate syllable is light. However, in reality, the stress stays on the penultimate syllable, reflecting its Italian origin (McMahon 2002:121). While the Noun Rule typically places stress on either the penultimate or antepenultimate syllables, words like ’machine’, ’police’, ’report’ and ’balloon’ defy this pattern by having final stress. Ultimately, the ”rules” for noun and verb stress placement are better seen as general trends, given the wide range of exceptions (McMahon 2002:121).

In English, as in many other languages, word stress often interacts with morphology, meaning that certain affixes can shift where the stress falls in a word (Chomsky & Halle 1968; McMahon 2002). Most suffixes, however, are stress-neutral and, as such, do not change the original stress pattern of the word. For example, adding [aɪz] ’-ise’ to [ˈætəm] ’atom’ results in [ˈætəʊmaɪz] ’atomise’ and adding [li] ’-ly’ to [ˈhæpi] ’happy’ or [ˈgrʌmpi] ’grumpy’ gives [ˈhæpɪli] ’happily’ and [ˈgrʌmpɪli] ’grumpily,’ all without altering the stress (McMahon 2002: 122-123). Moreover, there are two groups of suffixes that do affect stress. The first group includes stress-attracting suffixes, which carry the main stress when added to a base word, like [ɛt] ’-ette’ in [kɪt͡ʃənˈɛt] ’kitchenette’ (McMahon 2002: 123). The second group, which includes suffixes like ’-ic’, ’-ity’ and the adjective-forming ’-al’, does not receive stress themselves but instead causes the stress in the base word to shift one syllable to the left, as can be seen in the following examples:

ˈ**æ**.təm ’atom’ > [ə.ˈ**tə**.mɪk] ’atomic’;

ɪ.ˈ**lɛk**.trɪk ’electric’ > [ɛlɪkˈ**trɪ**səti] ’electricty’;

ˈ**peə**.rᵊnt ’parent’ > [pə.ˈ**rɛn**.tᵊl] ’parental’. (McMahon 2002: 123)

Field (2005) and Hahn (2004) indicate that placing lexical stress incorrectly can lead to communication breakdowns among English speakers. In fact, correct stress placement plays a key role in making speech understandable, particularly in L2 English (Lomotey 2018: 38). While there is general agreement that lexical stress is important for intelligibility, researchers seem to disagree on just how much of an impact it has. Some studies (Anderson-Hsieh et al. 1992; Bond 2005; Donselaar et al. 2005; Zielinski 2008) argue that misplacing stress significantly hinders understanding, while others claim that it has minimal or no effect (Cooper et al. 2002). For instance, (LePage & Busà 2014) found that both incorrect stress placement and poor vowel reduction lessens intelligibility for French and Italian learners of English. Similarly, (Field 2005) argues that incorrect stress placement can seriously disrupt communication for both native and non-native listeners. Furthermore, Grosjean and Gee (Grosjean & Gee 1987: 144) sustain that stressed syllables help listeners break speech into individual words. This happens because people use patterns of strong and weak syllables to identify natural breaks in the flow of speech, making it easier to distinguish separate words and syllables. Grosjean & Gee (1987: 147) also suggest that stressed syllables assist in word recognition, as listeners use the stressed syllable to generate possible word matches, which then helps them figure out the surrounding, unstressed syllables. Stress in English, then, plays a role in shaping the overall structure or profile of a word, helping listeners identify and understand it more easily (Lomotey 2018: 39).

3.1.1 Ghanaian English

The 12 vowels of BrE, mentioned in Section 3.1 become five for many speakers of Ghanaian English (GhE): /i, ɛ, a, ɔ, u/ (Huber 2008). In addition, out of the eight aforementioned BrE diphthongs, six GhE ones are noted as corresponding: /aɪ- ai/, /aʊ- au/, /ɔɪ- ɔi/, /ɪə- iɛ/, /ʊə- ua/ and /eɪ- eə/ (Abdallah 2020: 30-31). Furthermore, patterns of restructuring of some vowel sounds in BrE have been recorded in GhE (Bobda 2000: 187-193). These are summarised in Table 4.

BrE	GhE
ʌ	ɔ, a
ɜː	ɛ
post-tonic /ə/ <-er, -re, -or, -our, -ur, -ure, -us, -ous, -um>	a, ɛ
post-tonic /ə/ before final /n/	a, ɛ
/ə/ in -able and -ative words	a

Table 4: Patterns of vowel restructuring from BrE to GhE. Adapted from Bobda (2000:187-193)

A key feature of West African English is the pronunciation of the vowel /ʌ/ (as in ’cut’, ’sun’) as /ɔ/, especially in countries like Ghana (Bobda 2000: 187). However, in modern GhE, /a/ has largely replaced /ɔ/, influenced by spelling, assimilation processes, speaker ethnicity and especially age. While /ɔ/ was common in older generations, younger speakers now almost universally use /a/, marking a shift in accent (Bobda 2000: 188). This change is surprising given Ghana’s similar colonial history to neighbouring countries, which still mostly use /ɔ/ (Bobda 2000: 189). Another trend in Ghana is the substitution of /ʌ/ with /ɛ/, not tied to spelling or sound patterns but rather to specific words or speakers (Bobda 2000: 189). Meanwhile, Ghanaian Pidgin retains older /ɔ/ forms, though higher-register speech reflects the influence of these evolving pronunciation trends (Bobda 2000: 189).

In West Africa, the BrE vowel /ɜː/ (as in ’bird’, ’first’) is commonly realised as /ɔ/, /e/, /a/ or /ɛ/, depending on the country and speaker’s linguistic background (Bobda 2000: 189). Nigeria, Sierra Leone and The Gambia typically substitute /ɜː/ with /ɔ/ in words with spellings like <or>, <ur>, <our>, and <ir> (e.g. ’first’, ’bird’), and even <er> in ’person’, especially in more basilectal forms influenced by Krio, e.g. [pɔsin] (Bobda 2000: 189). Yoruba-accented English, dominant in Nigeria, tends to use /a/. Hausa-accented English, in northern Nigeria, also uses /a/, though it is increasingly influenced by southern norms (Bobda 2000: 190).

Cameroon shows two main patterns:

- <or>, <ur>, <our> become /ɔ/;
- <er>, <ear>, <ir>, <yr> become /ɛ/ (Bobda 2000: 190).

/a/ appears in some variants (e.g. [d͡ʒamani] ’Germany’, [mataniti] ’maternity’, [transfa] ’transfer’), possibly due to assimilation with surrounding syllables (Bobda 2000: 190).

Ghana stands out by consistently using /ɛ/ for /ɜː/, unlike the varied substitutions found elsewhere in West Africa. This is a relatively recent shift, replacing an older /ɔ/ pronunciation still found in older generations (Bobda 2000: 190).

In much of Africa, including West Africa, the post-tonic vowel /ə/ (often spelled <er>, <re>) is commonly realised as /a/, though Ghana is distinctive in applying /a/ more broadly to graphemes like <or>, <our>, <us> and <um> (Bobda 2000: 191). This pattern, also found in northern Nigeria and East/Southern Africa, contrasts with the more conservative West African use of /ɔ/. In Ghana, factors like age, ethnicity and assimilation influence this pronunciation, with younger generations overwhelmingly using /a/ (Bobda 2000: 191). Interestingly, Ghana is the only country in the region where educated speakers have retained this /a/ feature as well (Bobda 2000: 192). A less common but notable variant in Ghanaian English is /ɛ/, found in words like ’visitor’ and ’villager’ (Bobda 2000: 192).

In West Africa, post-tonic /ə/ before final /n/ is realised in various ways depending on region, speaker, spelling and context. Typically, when spelled <a> (as in ’African’, ’Ghanaian’), it is pronounced /a/, but Ghanaians often use /e/ (Bobda 2000: 192).

The ending /-in/ is widespread across West Africa, influenced by early Krio-speaking teachers during colonial times. In Krio, many words like ’cotton’ and ’eastern’ are pronounced with /-in/: [kɔtin], [istin]. Words ending in <ion>, like ’mission’ and ’position’ typically keep /-ɔn/ (Bobda 2000: 192).

West African countries diverge in how far they follow this Krio-influenced pattern:

- Cameroonians use /-in/ mainly after high front vowels, like in [klintin], ’Clinton’ (Bobda 2000: 193).
- Ghanaians, however, apply /-in/ even in <ion> words like [relid͡ʒin] ’religion’ and [definiʃin] ’definition’, where other varieties use /-ɔn/ (Bobda 2000: 193).

This strong preference for /-in/ is also reflected in Ghanaian Pidgin English, where many English-derived words ending in <ion> are pronounced with /-in/ rather than /-ɔn/ (Bobda

2000: 193).

In most of West Africa, the unstressed endings *-able* and *-ative* are typically pronounced as [ebl] and [etiv], preserving the vowel [e] instead of reducing it to [ə] like in BrE. This reflects a general pattern in West African English of avoiding vowel reduction (Bobda 2000: 193). However, Ghanaian English often departs from this trend, using a spelling-based /a/ instead. This variation is influenced by Ghana's own stress patterns rather than BrE stress (Bobda 2000: 193). For instance, words like 'communicative' and 'tentative' are stressed differently in Ghanaian English, which leads to /a/ being used in unstressed syllables where other West African varieties would have /e/. Notably, this Ghanaian pattern aligns more closely with East and Southern African English than with other West African varieties (Bobda 2000: 193).

GhE has 22 consonants, drawn from the aforementioned 24 in BrE, which can be found in Table 5. The dental fricatives /θ/ and /ð/, common in BrE, are often being replaced with /t/ and /d/ respectively (Ofori et al. 2014: 53).

	Bilabial	Labio-dental	Alveolar	Post-alveolar	Palatal	Velar	Labio-velar	Glottal
Plosive	p b		t d			k g		
Fricative		f v	s z	ʃ ʒ				h
Affricate				t͡ʃ d͡ʒ				
Nasal	m		n			ŋ		
Lateral			l					
Approximant				r	j		w	

Table 5: Ghanaian English consonants. Adapted from Ofori et al. (2014: 51)

In regard to stress, a peculiarity regarding the Alternating Stress Rule (ASR) has been attested in GhE, contrasting its effects on BrE and many varieties of native English (Bobda 2000: 194). Generally, the rule affects words composed of three or more syllables that end with a strong cluster, that is, with a tense vowel or a diphthong as the nucleus of the final syllable or ending with a consonant cluster (Chomsky & Halle 1968: 89). The main stress of such words, typically on the last syllable due to the strong cluster, moves, in these cases, to the antepenultimate position, by virtue of the ASR, thus weakening the stress of the last syllable from primary to secondary (Chomsky & Halle 1968: 89). In general, the ASR does not apply in West African English, maintaining the stress on the last syllable (Bobda 2000: 194). In contrast, educated Ghanaian English speakers do shift the primary stress onto the antepenultimate syllable, but do not retain a secondary stress on the last syllable. This results in verbs having the same rhythm as their corresponding adjectives or nouns, in the case of such words as 'separate', 'advocate' and 'stimulate', for example (Bobda 2000: 194). A form of hypercorrection in Ghanaian English pronunciation involves placing stress even further toward the beginning of the word (i.e., on the syllable before the antepenultimate) in words with more than three syllables (Bobda 2000: 194). This results in words like 'appreciate', 'negotiate', 'articulate' and 'identify' being pronounced with the main stress on the first syllable and no secondary stress on the final syllable. This particularity aside, GhE tendentially maintains the stress system of BrE (Bobda 2000: 194).

In her study on lexical stress placement in Ghanaian English, Lomotey (2018) analysed the recordings of 200 Ghanaian university students speaking Ghanaian English. These participants had the following as their native languages: Akan, Ewe, Gonja, Ga-Dangme, Dagbani, Gurenɛ, Dagaare, Nzema and Kasem. Although Kusaal is not involved in this pool, other Mabia languages are (Dagbani, Gurenɛ, Dagaare and Kasem). Among these, Kusaal is mutually intelligible with Gurenɛ and Dagbani and is closely related to the latter (Berthelette 2001: 4).

The findings by Lomotey (2018: 43) suggest that there was variability and fluidity in the manner in which speakers assigned lexical stress. For instance, some words made up of more than one syllable, such as 'teachers', 'another' and 'recommended', did not exhibit stress contrasts between syllables; the author sustains that the full word was stressed (Lomotey 2018: 43). A possible explanation for this occurrence is the influence of the syllable structure in the speakers' native languages. According to Lomotey (2018: 44) in Ghanaian languages, speech tends to follow a syllable-timed rhythm, meaning that each syllable in a word is produced with roughly equal timing, loudness, pitch and vowel quality. In words made up of two syllables, some fluidity was displayed by the speakers. In some instances the stress would be placed on one syllable and in others it would be placed on the other syllable (Lomotey 2018: 44-45). Examples like ’TEAcher’ vs ’teaCHER’ and ’PERform’ vs ’perFORM’ show that speakers placed stress on either syllable, irrespective of where it is usually expected to be placed in English (Lomotey 2018: 45). Similarly, fluidity and variability in stress were observed in polysyllabic words as well, namely in three-, four- and five-syllable words. In the case of the former, examples like ’DIfficult’ vs ’diFFIcult’ vs ’diffiCULT’, spoken by the same person, highlight a clear shift in lexical stress, irrespective of where it would be expected to land in English (Lomotey 2018: 47). Four-syllable words also were pronounced with shifting stress between all of the syllables within the word, while in five-syllable words the first syllable never received stress (Lomotey 2018: 48). As demonstrated by Lomotey (2018: 48), it was not just a few of the participants who displayed fluidity in stress placement, but rather almost all of the speakers, allowing for the assumption that this phenomenon may be general and not idiosyncratic.

It is important to note that Ghanaians have limited exposure to native English speakers in their everyday interactions, as most of their communication occurs among fellow Ghanaians, with occasional contact involving other West Africans (Lomotey 2018: 50-51).

3.2 Language Sample: Kusaal

Kusaal has two dialects: Agole, or the Eastern dialect, and Toende, or the Western dialect (Sandow 2021: 5). Variation between these dialects occurs both on the lexical level and on the phonological level; in the case of the latter, the variations occur in word-medial and word-final position (Sandow 2021: 5-6). Examples of lexical and phonological variations between the two dialects are presented in Table 6 and Table 7 respectively.

With the exception of Niggli (2014), all of the literature consulted throughout this study refers to the Agole dialect.

In Ghanaian languages, tone is phonemic, but mostly not represented in writing (Cahill 2001: 2). This is true for Kusaal as well, where tone is unmarked in its orthography; this is not, however, to diminish the importance of tone in the morpho-syntactic structure of the language, but rather reflects a practical compromise aimed at making the core

Agole	Toende	Gloss
bɛŋa	tia	beans
niŋ	ɛ̃ŋ	to do
gɛɛŋ	zalʊg	mad person
pɛʊg	ti'ʊk	basket
dau	buraa	male
gɔsim	bihim	to look

Table 6: Lexical differences between the Agole and Toende dialects (Musah 2018: 70-71)

Agole	Toende	Gloss
mɔr	mɔt	to have
yʊ'ʊr	yʊ'ʊt	name
nɔɔr	nɔɔt	mouth
basim	bahim	to stop
tisim	tihim	to give

Table 7: Phonological differences between the Agole and Toende dialects (Musah 2018: 70-71)

grammatical patterns more accessible to both native and non-native speakers, without requiring them to navigate the shifting tonal variations of Kusaal (Musah 2018: 43). In many instances, the context of the speech event alone is enough to convey the intended meaning without needing tone marks (Musah 2018: 43). Furthermore, those responsible for developing writing systems for Ghanaian languages, whether native English speakers or Ghanaians extensively educated in English, tend to see the English alphabet as the standard or default approach and, therefore, are inclined to favour an alphabet that most closely resembles the English writing system (Cahill 2001: 3). The main reason for the hesitation to mark tone is rooted in a bias among decision-makers. This bias is further reinforced by the fact that Akan, the most widely spoken language group in Ghana, does not use tone marking at all (Cahill 2001: 4).

According to Eddyshaw (2024: 12), Kusaal has four tones, or, rather, tonemes, namely high (H), low (L), mid (M) and circumflex (X). Various other studies (Musah 2018; Bodomo & Abubakari 2017; Niggli 2014; Musah 2010; Abubakari 2018) identify Kusaal as having three tones, H, M, L, with a downstep high tone. M tones seem to be lexically conditioned, since they are commonly realised in verbs. Cases of three minimal pairs are not as common as cases of two minimal pairs in Kusaal, though this does not minimise the importance of the existence of three tones in the language (Abubakari 2018: 45). The most common type of minimal pair is between H and L tone, compared to H and M or L and M (Abubakari 2018: 45). As such, there is a hypothesis that Kusaal may have a hybrid tone system that is in the process of shifting from a three-tone to a two-tone structure. This idea is supported by above observations regarding the difficulty in consistently identifying three distinct minimal pairs, as well as the fact that M tones mainly occur in verbs (Abubakari 2018: 45). Kusaal allows combinations of H, L and M tones in both two- and multi-syllable words, producing nine possible tone sequences: HH, HL, HM, LL, LH, LM, MM, MH, and ML (Musah 2017; Abubakari 2018).

Tone plays a significant role in Kusaal morpho-syntax, serving both lexical and grammatical purposes (Musah 2018: 61). In fact, tone serves a lexical role in cases where words share the same segmental structure but differ in tone, with these tonal differences leading to changes in meaning (Abubakari 2018: 47). Tone also conveys grammatical information, for example, perfective and future negation is indicated by tonal variation on preverbal particles (Abubakari 2018: 47).

Generally, the tone-bearing unit (TBU), the sound element to which a tone is attached (Zsiga 2017: 380), can be related to the syllable or to the mora (Niggli 2014: 79). Some studies propose the syllable as the TBU in Kusaal (Niggli 2014; Eddyshaw 2024). According to Niggli (2014: 79), this decision is supported by the fact that, in Kusaal, when tone spreads, it affects the syllable rather than the mora. Syllables, rather than morae, are used to describe tonal distribution patterns. Other studies (Musah 2010, 2017, 2018; Abubakari 2018), on the other hand, sustain that the mora is the TBU in Kusaal. In support of this claim, Musah (2017: 186) posits that different tone changes in the language are limited by whether the syllables involved are light or heavy. Syllables with only one mora take just one level tone, H, M or L, whilst a sequence of HH, MM or LL tones may be taken by syllables with two morae. Consonant codas, including nasal codas, are not moraic and, as such, do not exhibit tone marking (Musah 2017: 186). Additionally, bimoraic stems may present Rising or Falling contour tones, which are a combination of two different level tones that occur on adjacent morae. Furthermore, two different tonemes of any type cannot be realised on a light monomoraic segment (Musah 2017: 186). For a second tone to be associated to a light syllable, a vowel often undergoes lengthening or a sequence of vowels is incorporated, causing the monomoraic syllable to become bimoraic (Musah 2017: 187). For example, *pí* 'bury' carries just one tone, while the verb *píā* 'speak' contains two tonemes, as it is a heavy syllable with two vowels. As such, according to Musah (Musah 2017: 187), contour tones may only appear on heavy bimoraic syllables.

Regarding syllable structure, Kusaal generally restricts the formation of any kind of consonant cluster (Musah 2018: 68). In fact, within words, CC clusters are exclusively final /mm/, intervocalic /nn/, /mm/, /ll/, /mn/ and nasal + C between prefix and root (Eddyshaw 2024: 4). Syllable weight is another influential factor in Kusaal syllable configuration; syllables with just one segment in the rime are considered light-weight, while two or more constitute a heavy-weight syllable (Musah 2010, 2017, 2018). Additionally, complex onsets and codas of any kind are not allowed in Kusaal (Sandow 2021: 19). Syllables in Kusaal can be divided into four types, represented as follows:

2. (a) Peak only: *m*, 'I, me' (1SG); *o* 'he, him' (3SG);

   (b) VC (also VVC, not *VCC): *ɛl* 'marry'; *ul* 'horn';

   (c) CV (also CVV, not *CCV): *li* 'fall'; *sia* 'a certain';

   (d) CVC (including CVVC, CVVVC): *tis* 'give'; *biig* 'child'. (Musah 2018: 68).

Peak only syllables consist solely of a nucleus or peak. They may be classified as light or heavy, depending on whether they contain one or two morae. The moraic unit can be one of three types: a bilabial nasal, a single vowel or a vowel sequence, such as a long vowel or a diphthong. Syllables made up of only a peak appear exclusively at the beginning of words. Some examples of these rules are as follow:

3. (a) *m* 1SG; *o* 3SG;

   (b) *ie* 'to search'; ɛ̃ɛ̃ 'yes';

(c) *a.naŋ* ’Mr. Scorpion’; *a.tiig* ’Mr Tree’;

(d) *i.sig* ’to wake up’; *ɛ̃ɛ̃.rig* ’to shift’;

(e) *ɛ̃.bis* ’to scratch’; *á.la* ’thus’;

(f) *a.yi* ’two’; *a.gol* ’up’;

(g) *ãa.ruŋ* ’boat’; *uu.sug* ’dust’ (Musah 2018: 69).

VC syllables are closed and begin with a moraic segment. In this case, the mora must be a vowel, which may be short, long or a sequence of vowels. Furthermore, syllabic nasals are not permitted. Any consonant may appear in the coda position of these closed syllables, except for the following: /kp/, /gb/, /v/, /z/, /h/, /w/, /nw/, /y/, and /j/ (Musah 2018: 69). Examples are as follow:

4. (a) *ɛl* ’to marry’, *ɛ̃ɛs* ’to wipe’;

   (b) *ʊk* ’to lift’, *ʊʊn* ’dry season’;

   (c) *is* ’to remove’, *ĩak* ’to fly’;

   (d) *ɔ̃b* ’to chew’, *ul* ’horn’;

   (e) *on* 3SG.EMPH, *uak* ’to flood’. (Musah 2018: 69).

The CV syllable is open and forms a large number of words in the language. While some doubly articulated consonants, like those found in the examples in (5f), may resemble consonant clusters, they are not treated as such, as clusters are not permitted in Kusaal. Similarly, adjacent consonants at syllable boundaries are not considered consonant clusters. In CV syllables, the moraic element may be a single vowel, a long vowel or a vowel sequence, but never a syllabic nasal (Musah 2018: 69). Examples include the following:

5. (a) *li* ’fall’, *mɛ* ’to build’;

   (b) *fʊ* 2SG, *bã* 3PL;

   (c) *laa* ’bowl’, *nua* ’chicken’;

   (d) *pie* ’to wash’, *naae* ’to finish’;

(e) *tãu* ’female sibling’, *mɔ* ’to wrestle’;

(f) *gba* ’even’, *kpalug* ’dawadawa’. (Musah 2018: 70).

The CVC syllable type is among the most distinctive and functionally important in Kusaal. Unlike some other Mabia languages that simplify final consonants by adding a vowel sound, Kusaal retains the full syllable structure, especially at the end of words. For example, the word for ’ear’ appears as *tɔbrɛ* in Gurenɛ, *tibili* in Dagbani and *toore* in Dagaara, but remains *tʊbʊr* in Kusaal (Musah 2018: 70). Additional examples include the following:

6. (a) *man* 1SG.EMPH, *bil* ’small’;

   (b) *tãs* ’to shout’, *pʊd* ’to name’;

   (c) *zab* ’to fight’, *pɔ̃r* ’to approach’;

   (d) *lɛm* ’to taste’, *kpar* ’to close (lock)’. (Musah 2018: 70).

Syllables where the vocalic segments are either a long vowel or a sequence of vowels are included in the CVC class of syllables in Kusaal (Musah 2018: 70). Examples include:

7. (a) *maal* ’to make’, *kpa’ʊŋ* ’guinea fowl’;

   (b) *bʊʊg* ’goat’, *wiak* ’to hatch’;

   (c) *buŋ* ’to part open’, *piel* ’white’;

   (d) *lɛɛg* ’to dig’, *buol* ’call’;

   (e) *vɔ̃ɔr* ’hole’, *yaog* ’grave’;

   (f) *ni’im* ’meat’, *ziiŋ* ’fish’. (Musah 2018: 70).

Possible single-syllable word structure combinations in Kusaal are represented in Table 8.

Based on the structures seen in Table 8, a variety of combinations of these are allowed in Kusaal, forming words containing up to five syllables, though these are rare in the language (Musah 2018: 71). Furthermore, all forms of syllable types can be found in

Syllable	Kusaal	Gloss
N (nasal)	m	1SG
Vː	ɛ̃ɛ	yes
VV	ie	search
VC	ʊk	carry
VːC	ul	horn
VVC	ĩak	to fly
CV	mi	to know
CVː	maa	alone
CVV	sia	waist
CVC	nan	not yet
CVːC	paal	new
CVVC	luak	to find
CVːV	paae	to reach
CVVV	guoe	to restrain

Table 8: Single syllable combinations in Kusaal. (Musah 2018: 70-71)

word-initial position, a fact that is untrue for word-final position. The most commonly encountered word-final syllable types are CV and CVV, while VV is not allowed in this placement (Abubakari 2018: 41). In the case of VV in word-final position, this is remedied by the epenthetic use of the glide /j/ as an intervening segment, as seen in the examples of pluralisation included in Table 9.

The scarse literature on stress in Kusaal offers differing perspectives on stress in the language. A heightened pitch level is involved in relation to stress in Kusaal and stress is predictable in the language, appearing on the penultimate syllable (Niggli 2014: 97). However, according to other authors, all roots in Kusaal have underlying stress (Eddyshaw 2024: 12). On the other hand, it has been posited that Kusaal, and Mabia languages as a whole, do not mark stress (Abubakari & Appah 2024: 10). In fact, according to Hudu (2010: 19), it is a widespread belief that Gur languages are not stress-marking. This view is supported by Abubakari (2018: 143), who, instead, remarks that Kusaal speakers utilise prosodic focus marking, which involves using suprasegmental features like stress and intonation to highlight focus, meaning the focused element in a sentence is given greater

Noun stem	Suffix	Output	Gloss
gʊ	-rɛ	gʊʊ.r(ɛ́)	cola nut
gʊ	-aa	gʊ.yá(a)	cola nuts
zʊ	-rɛ	zʊ́ʊ.r(ɛ́)	tail
zʊ	-aa	zʊ́.yá(a)	tails
nyu	-rɛ	nyúu.r(ɛ̀)	yam
nyu	-aa	nyú.yá(a)	yams
zuo	-rɛ	zúó.r(ɛ̀)	mountain
zuo	-aa	zúó.yà(a)	mountains

Table 9: Examples of remedy for VV in final position. (Abubakari 2018: 42)

emphasis or prominence than the surrounding elements.

Kusaal features nine phonemic vowels: /i, ɪ, e, ɛ, a, ɔ, o, ʊ, u/, each of which has a corresponding long form: /iː ɪː eː ɛː aː ɔː oː ʊː uː/ (Asitanga et al. 2024: 104). These vowels are categorised based on tongue root position into two groups: Advanced Tongue Root [+ATR] vowels, /i, u, e, o/, and non-Advanced Tongue Root [-ATR] vowels, /ɪ, ʊ, ɛ, ɔ/ (Asitanga et al. 2024: 104). However, according to Musah (2018: 55), /a/ may occur in both [-ATR] and [+ATR] groups. There is no current evidence of minimal pairs that display phonemicity in vowel harmony in Kusaal, although further research is required in this field (Abubakari 2018: 36). Table 10 illustrates the vowel inventory of Kusaal.

	Front	Central	Back
High	i ɪ		u ʊ
Mid	e ɛ		o ɔ
Low		a	

Table 10: Kusaal vowel inventory. (Musah 2018: 55)

Comparatively, the [-ATR] vowels /ɪ, ʊ, ɛ, ɔ/ have a wider range of usage than the [+ATR] vowels /i, u, e, o/ (Musah 2018: 56). This may be evidence, according to Musah (2010: 92-93), of an ongoing process of coalescence in Kusaal, which may result in the eventual merge of the [+ATR] vowels into the [-ATR] vowels. Additionally, the language includes five nasal vowels, /ɪ, ɛ, ɔ, ʊ, a/, all of which belong to the [-ATR] category. The Agole dialect of Kusaal also permits eight vowel sequences: [ɪa], [ɪʊ], [aɪ], [aʊ], [ʊa], [ʊɔ], [ɔɪ], and [ʊɔɪ], all articulated with a retracted tongue root. On the other hand, Toende restricts them to /aʊ/, /ɔɪ/, /aɪ/, and /ɪʊ/ (Musah 2017: 104). Notably, [+ATR] vowels do not occur in sequences in Kusaal (Asitanga et al. 2024: 104). Furthermore, /o/ and /e/, along with their corresponding long vowels, are restricted in their use and are primarily found in loanwords, while not commonly found in open syllables. Neither /o/ nor /e/ occur in syllable-initial position and are both more common in diphthongs (Musah 2018: 47). More specifically, /e/ generally occurs as the final vowel in diphthongs and has very few occurrences in other positions, while /eː/ is even less common (Musah 2018: 56). Within diphthongs, /o/ is most common after /u/, including in the presence of a glottal stop placed intervocalically between /o/ and /u/ (Musah 2018: 56). Additionally, /o/ occurs more frequently in borrowed terms that came from English via Hausa and from English via Akan. Similarly to /eː/, /oː/ is also less common than its short counterpart in Agole (Musah 2018: 56), while /eː/ and /oː/ are commonly used in Toende (Musah 2017).

The following diphthongs are found in Kusaal: /uo/, /ae/, /aʊ/, /ɪa/, /ua/, /ɛɔ/, /ɔɪ/, /aɪ/, /au/, /ie/, /ɛʊ/, /ei/ (Musah 2018: 57).

Triphthongs are not common in Kusaal, but do exist and are often formed by, but not limited to, a combination of long vowels as the initial component, followed by a vowel from a differing level, such as /ʊɔɛ/ (Musah 2018: 58).

Kusaal has 24 consonants, as shown in Table 11. The following ten of these do not occur in word-final position: /kp, gb, v, z, ɟ, h, ɲ, ɲw, j, w/. A further three do not occur in word-initial position: /ʔ, ŋ, r/. The glottal stop /h/ also does not appear in word-medial position, although, in the Toende dialect, /s/ can alternate with /h/ in intervocalic positions (Sandow 2021: 14). It is also unclear whether /r/ is to be treated as a phoneme or an allophone of /d/, as it alternates with /d/ in intervocalic positions, occurring as /ɾ/, but becomes a /r/ in word-final position. In the Toende dialect, however, /r/ is realised as /t/ in word-final position (Sandow 2021: 14).

	Bilabial	Labio-dental	Alveolar	Palatal	Velar	Labio-velar	Glottal
Plosive	p b		t d [r]		k g	kp gb	ʔ
Fricative		f v	s z	[ʝ]			h
Nasal	m		n	ɲ	ŋ		
Labialised nasal				$ɲ^w$			
Approximant				j		w	
Lateral			l				
Trill			r				

Table 11: Kusaal consonants. (Musah 2010: 31)

3.2.1 Loanword Adaptation Processes in Kusaal

As seen in Section 2.2.4, loanwords may undergo a variety of different processes when borrowed from one language into another. Various processes are undergone by English loanword borrowed into Kusaal. For the purpose of this study, this section will focus on suprasegmentals and, in particular, processes that may alter the syllable structure of the borrowing language, as one of the parametres considered in the results is syllable number. Most loanwords used in Kusaal were adopted early and, as such, underwent the typical word-internal tone spreading processes of the language (Eddyshaw 2024: 71). However, loanwords from English do not always follow the typical tone patterns of Kusaal. English loanwords, unless borrowed through Hausa, display atypical tonal patterns; for instance, the H tone corresponding to English stress remains consistently fixed (Eddyshaw 2024: 71). This becomes apparent if we compare the adapted loanword *lɔ́r* ’lorry, car’ (plural *lɔ́yà*) with *gɛ́l* ’egg’ (plural gɛlá). In contrast, English words borrowed into Kusaal through Hausa do follow the standard tonal rules of Kusaal. For instance, *wadá* ’law’ comes from the English word ’order,’ borrowed via the Hausa form *oodàa* (Eddyshaw 2024: 28).

Syllable structure constraints in Kusaal prohibit consonant sequences and clusters within a syllable or at syllable boundaries, the only exception to this phonotactic constraint involving syllabic nasals followed by homorganic consonants, as seen in examples like: *nin-daa* ‘face’, *bʊmbɔk* ‘hole’, *tampiinr* ‘a bastard’ and *nɔŋgban* ‘lip’ (Sandow 2021: 90). As a result, loanwords containing such clusters must be adapted or re-syllabified to conform to the permissible syllable patterns of Kusaal (Sandow 2021: 90). Re-syllabification occurs when unfamiliar consonant clusters or vowel sequences from the source language are reorganised to align with the syllable structure of the target language (Asitanga et al. 2024: 44). Borrowed words that contain complex consonant or vowel structures are often simplified through deletion or substitution to fit the phonological patterns of the borrowing language (Asitanga et al. 2024: 44). In re-syllabification, to compensate for segments that are deleted in the process, for instance, original consonants may take the form of compensatory lengthening, resulting in either long vowels or diphthongs, the consonants may be replaced or new vowel elements may be introduced (Asitanga et al. 2024: 44).

Vowel epenthesis is a common phenomenon in loanword adaptation when the borrowing language's phonotactic constraints are tighter than those of the donor language (Uffmann 2006: 1). This phenomenon serves as a repair strategy used by Kusaal speakers to adapt source words that contain syllable structures not permitted in the language. A central idea is that the epenthetic vowels in Kusaal are typically /i, ɪ, u, ʊ/ and their selection is context-sensitive and determined by the features of adjacent vowels, particularly ATR and lip posture, like roundness and backness (Sandow 2021: 91). For instance, when the vowel near the epenthetic site is a [+ATR] back vowel, the inserted vowel will match these features. Similarly, if the nearby vowel is a [–ATR] front or back vowel, the epenthetic vowel will also be [–ATR] and match in frontness or backness accordingly. Crucially, epenthetic vowels harmonise with the closest adjacent vowel to the right of the insertion site (Sandow 2021: 91). However, in cases where there is no vowel to the right, harmony is instead determined by the vowel to the left (Sandow 2021: 91). Another observed pattern is that vowel harmony tends to break down when the harmonising vowel is /a/ or when the initial consonant in a cluster is /s/. In these situations, /ɪ/ is typically used as the epenthetic vowel (Sandow 2021: 91).

Table 12 exhibits examples, extracted from the corpus, of the different placements epenthesis can occur in.

As seen in Table 12, the addition of vowels transforms the syllable structure of the loanwords once adapted into Kusaal; for instance, the etymon [pleɪt] goes through monph-

	BrE	Kusaal	Gloss
Word-initial syllable onset	pleɪt	pilet	plate
	skuːl	sakur	school
	klʌt͡ʃ	kʊlɔk	clutch
Syllable boundary	dɒktə	dʊʔata	doctor
	sɪlvə	sɪlɪba	silver
	kəʊlpɒt	kurupɔt	coal pot
Coda clusters	mɪks	migis	mix
	t͡ʃɪps	kɪbɪs	chips
	kæptɪn	kabitɪn	captain
Word-initial and word-final	spəʊks	sɪpugus	spokes
	spɛks	sɪpɛgɪs	specs

Table 12: Examples of epenthesis occurrences and placement.

thongisation of the diphthong [eɪ] into [e] and receives an epenthetic vowel, [i], to break up the consonant cluster [pl], thus adding an extra syllable to the word. Similarly, [spɛks], having two consonant clusters, in word-initial syllable onset position and in word-final coda position, receives [ɪ] to separate them and, as such, is re-syllabified into a trisyllable.

Paragoge, ”the word-final addition of non-etymological vowels” (Uffmann 2006: 146), is not a common loanword adaptation process in Kusaal. However, six cases of paragogic vowels are reported in Table 13.

BrE	Kusaal	Gloss
bæg	baːgi	bag
bʌkɪt	bʊʔata	bucket
kɔːt	kɔtʊ	court
peɪnt	pɛnti	paint
tɪkɪt	tigiti	ticket
vælv	vɔliba	valve

Table 13: Examples of paragogic vowel epenthesis occurrences.

Epenthesis is the most common process adopted by Kusaal, and many other languages, in order for source words to conform to the phonotactics of the borrowing language

(Sandow 2021: 105).

While not as frequent as epenthesis, however, segment deletion is also a productive strategy in Kusaal loanword adaptation. It primarily serves to eliminate sequences of two consonants at syllable boundaries and to resolve certain coda clusters. Deletion is also employed to avoid the occurrence of specific consonants in word-initial and word-medial positions. In general, consonant sequences involving two plosives at syllable boundaries, as well as word-final clusters, are often repaired through deletion, typically targeting the least voiced segment. In most cases, plosives are the segments that are most frequently deleted. Syllable deletion may also occur in word-medial position in Kusaal (Sandow 2021: 105).

Tables 14 and 15 present examples illustrating the placements of consonant deletion and syllable deletion, respectively.

Although vowel deletion features primarily as an adaptation process with Akan and Hausa loanwords, in the corpus used in the present study one such occurrence was encountered. In the word [lɔr] 'lorry', from the etimon [lɒri], the final close front vowel [i] is dropped, turning the word from disyllabic in BrE to monosyllabic in Kusaal.

	BrE	**Kusaal**	**Gloss**
Word-medial	maːstə	masa	master
	ɪnspɛktə	sʊpɛta	inspector
	səʊld͡ʒə	sɔgia	soldier
Coda clusters	pɪkæks	pɪŋgaːs	pickaxe
	t͡ʃɛst	kɛs	chest
	θaʊzᵊnd	taːsin	thousand

Table 14: Examples of consonant deletion occurrences and placement.

	BrE	**Kusaal**	**Gloss**
Word-initial	ɪnspɛktə	sʊpɛta	inspector
Word-medial	mɪnɪt	mit	minute
Word-final	sɪgᵊrɛt	sigaːr	cigarette

Table 15: Examples of syllable deletion occurrences and placement.

3.3 Data Collection and Structure

84 English loanwords were extracted from *Loanword adaptation in Kusaal* (Sandow 2021). The full list of these can be found in Section 7. The data were retrieved and manually transcribed, using the International Phonetic Alphabet (IPA), into a Google Sheets document, with the following criteria arranged into different columns:

(a) Phonetic transcription in Kusaal
   i. Collected from Sandow (2021);

(b) Gloss in English;

(c) Phonetic transcription in BrE;

(d) Phonetic transcription in GhE;

(e) Number of phonemes
   i. Calculated based on the BrE transcription;

(f) Number of syllables;
   i. Calculated based on the BrE transcription;

(g) Word frequency based on the COCA
   i. the Corpus of Contemporary American English (Davies 2008);

(h) Word frequency based on the BNC
   i. the British National Corpus (BNC) (Davies 2004);

(i) Reference (author, year, page number);

(j) Notes.

It should be mentioned that, in his study, Sandow (2021) did not focus on tone and stress, signifying that these elements were not accounted for in the transcription of the data. The phonetic transcription in Ghanaian English (GhE) is included as well, as the author utilised this variant as the English reference instead of BrE, stating that, ”English loanwords in Kusaal are taken from the variety of English spoken in Ghana which to some extent differs from the Standard British English” (Sandow 2021: 20). For the purpose of this study, on the other hand, the BrE pronunciation will be considered, in order to best test participants’ perception of stress in L2 English, without the influence of adaptations.

Of the 84 loanwords collected, 31 are monosyllabic, 45 are disyllabic, 5 are trisyllabic and 3 are quadrisyllabic. For the purpose of this study, the 31 monosyllabic terms were excluded from the experiment design. Of the 53 remaining loanwords, 40 were further selected and utilised for the experiment. These comprised of: 33 disyllabic words, 5 trisyllabic words and 2 quadrisyllabic words.

These were, in turn, ranked by frequency, and separated into 14 high frequency words, 13 medium frequency words and 13 low frequency words, as can be found in Table 16, Table 17 and Table 18, respectively.

Gloss	BrE	Pseudo-word	COCA	BNC
table	ˈteɪbᵊl	teɪˈbᵊl	216,362	19,128
service	ˈsɜːvɪs	sɜːˈvɪs	194,447	29,976
seven	ˈsɛvᵊn	sɛˈvᵊn	111,526	16,878
teacher	ˈtiːt͡ʃə	tiːˈt͡ʃə	106,844	8,576
doctor	ˈdɒktə	dɒkˈtə	106,763	10,066
address	ˈədrɛs	əˈdrɛs	93,060	6,679
insurance	ɪnˈʃʊərᵊns	ˈɪnʃʊərᵊns	87,915	6,924
machine	məˈʃiːn	ˈməʃiːn	63,558	8,450
garden	ˈgɑːdᵊn	gɑːˈdᵊn	56,342	10,726
thousand	ˈθaʊzᵊnd	θaʊˈzᵊnd	52,097	10,106
driver	ˈdraɪvə	draɪˈvə	50,903	5,054
chairman	ˈt͡ʃeəmən	t͡ʃeəˈmən	49,469	11,169
pleasure	ˈplɛʒə	plɛˈʒə	40,599	4,969
engine	ˈɛnd͡ʒɪn	ɛnˈd͡ʒɪn	35,637	4,806

Table 16: High frequency loanwords included in study.

Of the 33 disyllabic words, 25 have trochaic stress patterns and two have iambic stress patterns. All five of the trisyllabic terms and both of the quadrisyllabic terms have word-

Gloss	BrE	Pseudo-word	COCA	BNC
lawyer	ˈlɔɪə	lɔˈɪə	53,420	2,098
border	ˈbɔːdə	bɔːˈdə	50,492	3,783
bible	ˈbaɪbᵊl	baɪˈbᵊl	37,218	1,919
soldier	ˈsəʊld͡ʒə	səʊlˈd͡ʒə	24,770	1,702
cigarette	ˈsɪgᵊrɛt	sɪgᵊˈrɛt	19,343	2,040
nylon	ˈnaɪlɒn	naɪˈlɒn	3,013	668
powder	ˈpaʊdə	paʊˈdə	17,656	1,307
bucket	ˈbʌkɪt	bʌˈkɪt	13,124	1,052
aeroplane	ˈeərəpleɪn	eəˈrəpleɪn	11,299	587
balloon	bəˈluːn	ˈbəluːn	8,019	627
madam	ˈmædəm	mæˈdəm	5,094	762
cushion	ˈkʊʃᵊn	kʊˈʃᵊn	3,904	500
lorry	ˈlɒri	lɒˈri	309	1,289

Table 17: Medium frequency loanwords included in study.

initial stress, while two words, one disyllabic, one trisyllabic, can be correctly pronounced both with primary stress on the first syllable or on the last:

(a) ’address’ can be pronounced [əˈdrɛs] when used as a verb and [ˈædrɛs] when used as a noun;

(b) ’cigarette’ can be pronounced [ˈsɪgəˌrɛt] or [ˌsɪgᵊrˈɛt]; the former being more commonly used in BrE and the latter more commonly used in American English (AmE).

Point (a) above is clarified by the general rule mentioned in Section 3.1, where English disyllabic nouns tend to have a trochaic pattern, while disyllabic verbs tend to have an iambic pattern (Davis & Kelly 1997: 446). The contrast in pronunciation between BrE and AmE and the acceptability of both, as in point (b) above, is explained, in this case, through the concept that French loanwords, in general, tend to be adapted with different stress patterns in BrE and in AmE (Fournier 2016; Schultz 2012; Svensson 2004). More specifically, there is a stronger tendency in BrE than in AmE to adapt French loanwords by giving them initial stress (Poldauf 1984: 76).

Gloss	BrE	Pseudo-word	COCA	BNC
generator	ˈd͡ʒɛnəreɪtə	ˈd͡ʒɛnəreɪtə	5,846	434
shovel	ˈʃʌvᵊl	ʃʌˈvᵊl	4,440	196
tighten	ˈtaɪtᵊn	taɪˈtᵊn	4,011	422
plywood	ˈplaɪwʊd	plaɪˈwʊd	2951	167
bodyguard	ˈbɒdigɑːd	bɒˈdigɑːd	2,567	168
gutter	ˈgʌtə	gʌˈtə	2,188	365
charger	ˈt͡ʃɑːd͡ʒə	t͡ʃɑːˈd͡ʒə	1905	88
chisel	ˈt͡ʃɪzᵊl	t͡ʃɪˈzᵊl	854	172
tape measure	ˈteɪpmɛʒə	ˌteɪpmɛˈʒə	420	59
spanner	ˈspænə	spæˈnə	155	157
air condition	ˈeəkənˌdɪʃᵊn	ˌeəkəndɪˈʃᵊn	38	1
pickaxe	ˈpɪkæks	pɪkˈæks	22	11
coal pot	ˈkəʊlpɒt	kəʊlˈpɒt	3	0

Table 18: Low frequency loanwords included in study.

All 80 of the words used in the study, composed of the loanwords and their pseudo-word counterparts, were recorded individually by three native speakers of BrE, one male and two female, in soundproof recording booths using Audacity (Muse 2025), a free, open-source software application for editing and recording digital audio. One female speaker recorded 15 words, the other 14 and the male speaker recorded 15 words, to be used for the trial (four words and their pseudo-word counterparts) and test sections of the experiment. The words were distributed among the speakers based on word frequency, to ensure that every speaker was recording a similar amount of high, medium and low frequency words. Recordings were done as a continuum, with a pause taken between each word, and were subsequently cut into approximately 100 ms individual recordings, one per word, in Audacity. These were then saved on a personal computer, with backups saved to a Google Drive. Each speaker recorded their set of words four times and all of the sets underwent the same cutting and saving process. Once all of the words had been saved individually, they were placed into a folder corresponding to the speaker and one recording of each word was randomly selected to be used for the experiment.

Furthermore, 20 minimal pairs were constructed to serve as controls and were recorded by the same three speakers as the stress contrast minimal pairs. All three speakers recorded eight words each, to be used for the trial (four words and their pseudo-word counterparts) and test sections of the experiment. The minimal pairs were created by taking 20 disyllabic real words and creating pseudo-word counterparts with a phonemic contrast. The purpose of this was to make sure participants were not relying on stress-specific processing mechanisms. Participants would, thus, be forced to consider segmental and suprasegmental information during lexical judgement, since some pseudo-words differed from real words in phonemes and others in stress placement (Lin et al. 2014: 325). The 20 real words were selected from the items used by Lin et al. (2014) in their study. This control group included seven high frequency words, seven medium frequency words and six low frequency words, based on the English Lexicon Project (Balota et al. 2007). These can be found in Table 19, Table 20 and Table 21, respectively. The same recording, saving and selection procedures and software were used for the 20 control phoneme contrast minimal pairs as for the stress contrast minimal pairs.

Gloss	**BrE**	**Pseudo-word**
support	səˈpɔːt	səˈkɔːt
between	bɪˈtwiːn	bɪˈpwiːn
order	ˈɔːdə	ˈɔːtə
contact	ˈkɒntækt	ˈkɒnkækt
common	ˈkɒmən	ˈkɒbən
continue	kənˈtɪnjuː	kənˈpɪnjuː

Table 19: High frequency control words used in study.

Gloss	**BrE**	**Pseudo-word**
perform	pəˈfɔːm	pəˈsɔːm
solid	ˈsɒlɪd	ˈsɒrɪd
quantum	ˈkwɒntəm	ˈkwɒnsəm
county	ˈkaʊnti	ˈkaʊnsi
magazine	ˌmægəˈziːn	ˌmægəˈfiːn

Table 20: Medium frequency control words used in study.

Finally, for the trial segment of the experiment, a further eight minimal pairs were constructed, four with a stress contrast and four with a phonemic contrast, to replicate the

Gloss	BrE	Pseudo-word
bracket	ˈbrækɪt	ˈbræpɪt
donkey	ˈdɒŋki	ˈdɒŋpi
behold	bɪˈhəʊld	bɪˈvəʊld
scandal	ˈskændᵊl	ˈskænpᵊl
demise	dɪˈmaɪz	dɪˈtaɪz
cocoon	kəˈkuːn	kəˈpuːn
endorse	ɪnˈdɔːs	ɪnˈbɔːs
ensign	ˈɛnsaɪn	ˈɛntaɪn
fossil	ˈfɒsᵊl	ˈfɒvᵊl

Table 21: Low frequency control minimal pairs used in study.

types of stimuli used in the experiment. These were recorded by the same three native speakers of BrE, two females and one male, and also presented high, medium and low frequencies. Again, the same procedures were followed for these sets of words as for the previous ones, in regard to recording, saving and selecting the stimuli. The phonemic contrast minimal pairs used in the trial can be found in Table 22, while the stress contrast minimal pairs can be found in Table 23.

Gloss	BrE	Pseudo-word	COCA	BNC
always	ˈɔːlweɪz	ˈɔːlmeɪz	492,990	43,918
enough	ɪˈnʌf	ɪˈlʌf	396,440	30,767
industry	ˈɪndəstri	ˈɪngəstri	125,963	19,461
defend	dɪˈfɛnd	dɪˈzɛnd	30,696	1,986

Table 22: Phoneme contrast minimal pairs used in trial study.

Gloss	BrE	Pseudo-word	COCA	BNC
public	ˈpʌblɪk	pʌbˈlɪk	374,048	38,032
fever	ˈfiːvə	fiːˈvə	13,124	1,052
tailor	ˈteɪlə	teɪ’lə	2,983	388
funnel	’fʌnᵊl	fʌ’nᵊl	2,562	161

Table 23: Stress contrast minimal pairs used in trial study.

3.4 Language Proficiency and Frequency

In language assessment, proficiency can be measured either through external methods, such as standardised tests or teacher evaluations, or through internal methods, such as self-assessment (Oscarson 1989: 1). For the purpose of this study, to test participants' L2 English proficiency, both strategies were implemented; a self-assessment test and the Lexical Test for Advanced Learners of English, or LexTALE (Lemhöfer & Broersma 2012). The self-assessment test was included in the experiment link, constituting the second part of the study that participants partook in through the PCIbex link (discussed in detail in Section 3.6.1). For this study, responses were measured using a Likert scale, which was developed in 1932 and was designed to measure attitudes in a scientifically valid way (Edmondson 2005). This kind of self-assessment test consists of a series of statements related to a real or hypothetical situation and participants indicate how much they agree or disagree with each one, typically on a scale ranging from ”strongly disagree” to ”strongly agree” (Joshi & Pal 2015: 397). These statements work together to reflect a particular aspect of a person's attitude toward the topic, meaning they are closely connected and collectively represent the underlying attitude being assessed (Joshi & Pal 2015: 397). The present study used a five-point Likert scale, which allowed the participant to choose the option that is nearest or closest to their response. Using scales with five to seven points tends to enhance reliability and validity compared to scales with fewer options, while increasing the number of points beyond that does not lead to further improvements in these areas (Dawes 2008: 63). For the present study, details of which are available in Section 7, the scales used were as follows:

(a) Never, rarely, sometimes, often, always;

(b) Very poor, limited, moderate, good, excellent;

(c) Strongly disagree, disagree, neutral, agree, strongly agree;

In experimental psychology, most studies on language proficiency depend solely on participants' self-assessed proficiency and background questionnaires (Lemhöfer & Broersma 2012: 325-326). On the other hand, researchers who try to assess second-language aptitude more objectively face a wide array of available tests, both commercial and not, many of which haven't been tailored to or validated for use in experimental contexts (Lemhöfer & Broersma 2012: 326). LexTALE, on the other hand, provided an external assessment of the participants' proficiency in English. This is a fast and easily implemented vocabulary test designed for intermediate to advanced learners of English as a second language, which uses a straight-forward visual lexical decision task that is not timed (Lemhöfer & Broersma 2012: 326). LexTALE is accessible online (http://www.lextale.com/) and only takes about five minutes to complete. Unlike many traditional vocabulary or proficiency tests, LexTALE was specifically developed for use in cognitive research. The test is intended for adult learners who began studying English in school around the ages of 10 to 12 (a common starting age in many countries) and who continue to be exposed to English, whether in university settings or through media exposure (Lemhöfer & Broersma 2012: 326). In the case of the present study, the participants would largely fall in this category in relation to Ghanaian English.

Both an internal and an external assessment of language proficiency were chosen for this study as a way to solidify data. Self-ratings can be efficient and display high levels of validity. This is not always the case, however, particularly with populations that are rather heterogeneous in L2 proficiency and L1 background (Lemhöfer & Broersma 2012: 340).

Higher frequency words provide a processing advantage in both native and non-native speakers (Lin et al. 2014:324), suggesting that word frequency and L2 proficiency are interrelated. This claim is supported both by studies that conducted auditory lexical decision tasks (Weber & Cutler 2004; Dupoux et al. 2008; Petrova et al. 2011) and by studies that conducted visual lexical decision tasks (Baek et al. 2023; Grainger 1990). For this reason, following the perspective sustained by Lin et al. (2014: 325), it was important to include words with different frequency levels in this study, in order to make sure participants relied on typical lexical retrieval processes that were not influenced by the altered stress patterns of the pseudo-words constructed.

3.5 Frequency

In relation to word frequency, exemplar theory is an important approach in understanding its impact on perception (Lacerda 1995; Johnson 1997; Pierrehumbert 2001). Phonetic detail is not only associated with languages or dialects but can be tied to individual words (Hooper 1976; Bybee 2000). For instance, in a study on the varying occurrence of schwa reduction and syllable loss in English, especially before sonorant sounds like /r/ and /n/, it was found that in high-frequency words such as 'every' and 'evening', the schwa tends to disappear entirely and the syllable it once formed is no longer present (Hooper 1976). In moderately frequent words like 'memory' and 'salary,' the schwa typically becomes a syllabic /r/, while in less common words like 'mammary' and 'artillery,' the most frequent outcome is the retention of the full schwa plus /r/ combination (Hooper 1976).

As Johnson (2005: 290) points out, while phonetic research mainly focuses on how speech perception and production shape a language's sound system, the exemplar-based approach emphasises how phonological knowledge is anchored in cognitive representations. Speaker normalisation is a proposed perceptual mechanism that reduces variation between speakers before linguistic categories are identified. Although the concept is interpreted in different ways, all versions generally involve transforming a speaker-specific signal into a more neutral or generalized form, which likely serves as a suitable reference for accessing stored linguistic knowledge (Johnson 1997). Exemplar theory, as proposed by Johnson (1997: 590), is a speech perception model that does not involve any speaker normalisation processes.

Exemplar theory originated in psychology as a model of perception and categorisation (Pierrehumbert 2001: 3). It was later applied to speech, particularly vowel categorisation, by Johnson (1997) and Lacerda Lacerda (1995). Goldinger (1996b) extended the model proposed by Hintzman (1986) to word recognition. Exemplar theory makes several key assumptions, supported by empirical findings, that are especially useful for modelling phonological knowledge. Categories are represented as clusters of stored memory traces, or exemplars, in a multi-dimensional cognitive space (Pierrehumbert 2001: 3). Similar experiences are stored near each other; dissimilar ones, further apart. For example, a category like the vowel [ɛ] includes many variants in pitch (f0), duration and formants, reflecting real-life variation across speakers and contexts (Pierrehumbert 2001: 3-4). These exemplars are not rigid symbols but perceptual memories and each one can belong to multiple categorisation schemes. A phrase like "Supper's ready!" could simultaneously index the words, speaker identity (e.g., “Mom”) and voice type (“female speech”) (Pierrehumbert 2001: 4).

If every heard speech token is stored individually, frequent categories will naturally accumulate more exemplars than rare ones. This, according to Pierrehumbert (2001: 4), is a key factor in explaining frequency effects. While human memory can store an impressive number of experiences, as noted by Johnson (1997), it is unrealistic to assume that we retain every instance of every word we hear. Exemplar theory addresses this by proposing two solutions: first, that memories decay over time and, second, that the perceptual space is limited in resolution (Pierrehumbert 2001: 4). This means minor differences, such as those below the just noticeable difference (JND) in f0, are not stored distinctly but grouped together. As a result, an exemplar represents a cluster of similar experiences rather than a single event. Each exemplar also has a strength or resting activation level, with more recent or frequent experiences being more strongly activated (Pierrehumbert 2001: 4).

In exemplar theory, when a person encounters a new speech token, this token is classified based on how similar it is to previously stored exemplars. This involves placing the token within a multidimensional space defined by perceptual features. The similarity between the new token and each stored exemplar is measured by calculating the distance between them in this space (Pierrehumbert 2001: 5). To determine the most likely label for the new token, the system considers a fixed-size neighbourhood around it, identifying the nearby exemplars. Each of these exemplars contributes to the classification, with their influence weighted by their activation level, or a value determined by how frequently and recently similar tokens have been encountered (Pierrehumbert 2001: 4). This model follows that posited by Lacerda (1995) and includes a decision rule that selects the label with the strongest support from nearby exemplars. For example, in a simplified case distinguishing the vowels /ɪ/ and /ɛ/ using only the second formant (f2) as a dimension, the model assesses activation levels of exemplars near the new token. Even if there is overlap between the two vowel categories due to natural variation, the label with more exemplars or more strongly activated exemplars within the neighbourhood, often the higher-frequency label, tends to win. In the example, /ɪ/ is chosen because it has more and more active exemplars in the relevant range (Pierrehumbert 2001: 5).

While some other models (Kruschke 1992) use all exemplars regardless of label, they also emphasise those closest to the stimulus, leading to similar outcomes. Some models may also factor in attention or context (Pierrehumbert 2001: 5). Ultimately, the label selected depends on the balance of activation among competing exemplar clusters. Labels tied to high-frequency words often dominate, due to denser and more active exemplar representations, especially under ambiguity. This prediction is supported by various experimental findings (Pierrehumbert 2001: 6).

It is important to note that these decision rules summarise outcomes rather than describe literal cognitive steps. Instead of using explicit calculations, the brain likely uses mechanisms of activation and inhibition; exemplars spread activation to associated labels and the label with the highest total activation suppresses others. This framework aligns with theories that link decision speed in phonological and lexical tasks to the time it takes for activation to reach a threshold, offering insights into reaction time data (Pierrehumbert 2001: 6).

3.6 Auditory Lexical Decision Task

When it comes to recognising spoken words, this process entails sorting out the spoken input from any other word form that the input also supports (Ernestus & Cutler 2014: 3). These different alternatives are activated in a listener's mind and compete with one another, causing slower recognition in the case of a multitude of alternative interpretations. Since these features involved in recognition (ie. numerous word-form activation and inter-form competition) originate in the composition of vast vocabularies through the use of small speech-sound inventories, they are, essentially, universal across languages. (Ernestus & Cutler 2014: 3).

In relation to second-language word recognition, then, L2 learners face the task of learning to perceive, as well as produce, new phonemic contrasts; they must also construct a lexicon that presents the phonetic and phonological information equated with these contrasts. The difficulty associated with perceptual and/or lexical encoding may cause the activation of ill-suited elements during the recognition of spoken words, a phenomenon also known as spurious lexical activation. It may also cause lower efficiency in competition between candidates (Barrios & Hayes-Harb 2021: 2).

Auditory lexical decision involves the classification of uttered words and non-words or pseudo-words (Goldinger 1996a: 559). As this type of task requires full lexical processing, its applicability is extensive. In fact, this method may be used to study basic processes undergone in word recognition, attributes of the mental lexicon, potential effects of word frequency, as well as neighbour effects and other aspects of word perception. Auditory lexical decision may also be utilised to measure priming and context effects, as well as as an indicator of impairments caused by damage to the brain (Goldinger 1996a: 559). Auditory lexical decision tasks, then, also offer potential evidence in regards to spurious lexical activation, through tasks that require participants to discern whether an auditory stimulus is a word or not (Barrios & Hayes-Harb 2021: 2).

Along with the purpose of investigating stress perception, as in the present study and in the research mentioned in Section 2.3 (Dupoux et al. 2008, 2010; Lin et al. 2014), auditory lexical decision tasks have been employed in research on bilingual word recognition, to examine whether lexical access is language-selective or non-selective. According to the language non-selective view, bilinguals activate lexical items from both languages, even when only one is contextually relevant (Lagrou et al. 2013: 508). The authors use an auditory lexical decision task to investigate whether sentence context, semantic predictability and speaker-related sub-phonemic cues limit parallel lexical access during auditory word recognition. Dutch-English late bilinguals, operating in an L1-dominant environment, performed an auditory lexical decision task in English (L2). The task involved sentences varying in semantic constraint and in speaker accent (Lagrou et al. 2013: 514).

Participants responded more slowly to interlingual homophones (e.g., [liːf] 'lief' – [liːf] 'leaf') than to control words, suggesting simultaneous activation of both L1 and L2 word representations. These researchers found that lexical access is language non-selective and that parallel activation occurred regardless of whether the speaker was a native or non-native, suggesting that bilinguals do not restrict lexical access based on speaker-specific cues, even if this results in less efficient word recognition (Lagrou et al. 2013: 516).

Auditory lexical decision tasks have further been used in studies testing L2 speech perception and lexical processing specifically in regards to confusable L2 phonemes, such as: [d**æ**f] for [d**ɛ**f] ’deaf’ and [l**ɛ**mp] for [l**æ**mp] ’lamp’ (Barrios & Hayes-Harb 2021: 2).

These misperceptions lead to spurious lexical activation, where listeners mistakenly access real-word entries in their mental lexicon when hearing pseudo-words. It remains unclear whether these difficulties stem from problems in perceiving phonetic detail or from mismatches at the lexical level (Barrios & Hayes-Harb 2021: 2). L2 speech perception and lexical processing often show asymmetries, particularly when two L2 phonemes map onto a single L1 category but differ in how well they fit that category (Barrios & Hayes-Harb 2021: 2). According to Best’s Perceptual Assimilation Model (Best 1995), one phoneme typically aligns more closely with the L1 category (the ”dominant” category), while the other is less familiar or robustly encoded (the ”non-dominant” category). Barrios & Hayes-Harb (2021) designed an auditory lexical decision task in order to test how native speakers of English, Korean and Mandarin process the English /æ/-/ɛ/ and /l/-/ɹ/ sound contrasts. The stimuli included real English words containing these target phonemes, as well as pseudo-words formed by swapping the target sound with its counterpart, such as:

- ’lecture’: [ˈ**l**ɛkt͡ʃə] vs. [ˈ**ɹ**ɛkt͡ʃə];
- ’battle’: [ˈb**æ**tᵊl] vs. [ˈb**ɛ**tᵊl] (Barrios & Hayes-Harb 2021: 10).

For the /æ/-/ɛ/ contrast, all three language groups correctly recognised real words with very high accuracy and displayed an asymmetry in rejecting pseudo-words, performing better when the pseudo-word contained /æ/ than when it contained /ɛ/. In contrast, the /l/-/ɹ/ distinction produced three different patterns across the groups. Native English speakers performed with high and balanced accuracy on both words and pseudo-words. Native Mandarin speakers showed a bias toward /l/, indicating greater difficulty distinguishing these sounds at the perceptual level, while native Korean speakers showed opposite biases, favouring /l/ in word recognition but [ɹ] in rejecting pseudo-words, suggesting challenges at the lexical encoding level (Barrios & Hayes-Harb 2021: 15). These results highlight the potential of the auditory lexical decision task for pinpointing the source of L2 learners' difficulties with specific phonological contrasts (Barrios & Hayes-Harb 2021: 16-17).

3.6.1 Experiment Design

The auditory lexical decision task used in this study was created, shared to and accessed by participants on Penn Controller for Ibex (PCIbex), a free and open-source platform developed by Zehr & Schwarz (2018). It is built upon another web-based experiment creation tool called Ibex Farm, functioning as a library that offers a range of ready-to-use features. PCIbex was specifically created for research in the field of psycholinguistics. This platform operates entirely online and uses its own simple scripting language, which is largely based on JavaScript (Fonseca et al. 2021: 8). One of its key advantages is that it comes with its own server, called PCIbex Farm, where experiments are hosted and run. It does not require any software installation, making it compatible with any computer and even mobile devices. This proved a crucial advantage during the present study, as all of the participants in this study are based in Ghana and were able to access the link to the experiment online at their own convenience.

The auditory lexical decision task was created entirely on PCIbex and was shared with participants through the following link made available via email:
https://farm.pcibex.net/p/UAkjtc/

Based on previous studies using auditory lexical decision tasks to measure stress perception (Dupoux et al. 2008, 2010; Lin et al. 2014), it was expected that the participants would show little difficulty with phonemic contrasts. It was expected, on the other hand, for participants to show lower accuracy and longer response times when it came to discerning stress contrasts. Following Lin et al. (2014), approach, stimuli were designed to differ in word frequency, having been selected, in an even distribution, from varying degrees of frequency from high to medium to low. Since the advantage in processing high-frequency words is a well-established effect seen in native and non-native speakers (Grainger 1990; Weber & Cutler 2004), replicating this pattern in the real words would ensure that the participants relied on typical lexical retrieval processes, unaffected by the stress manipulation in the pseudo-words.

3.6.2 Materials

A corpus of 40 loanwords, of varying frequencies and syllable and phoneme counts, and their pseudo-word counterparts, differing solely in stress placement, was used for the lexical decision task in this study, amounting to a total of 80 words. Of the stress contrast minimal pairs, 33 words have two syllables, five words had three and two words had four. A further 20 words, also of varying frequencies and syllable and phoneme counts, along with their pseudo-word counterparts, this time differing solely in one phoneme, were utilised as controls, amounting to a total of 40 words. Of the 20 minimal pairs, 18 words were made up of two syllables and two were made up of three syllables.

The trial featured auditory cues composed of eight minimal pairs, four with a stress contrast and four with a phonemic contrast, to replicate the cues of the experiment. Within these, seven words were disyllabic and one was trisyllabic. All of the stimuli, both for the trial segment and for the test segment, were recorded by three native speakers of BrE, two females and one male.

As in Dupoux et al. (2010), two separate lists were constructed, List 1 and List 2, to ensure that each participant heard only one item, either the real word or the pseudo-word, from each minimal pair. For instance, if the real word ’service’ [ˈsɜːvɪs] was included in List 1, its pseudo-word counterpart [sɜːˈvɪs] was placed in List 2. The sequence of stimuli presented to each participant was randomised as well. Participants were randomly assigned to one of the two lists, as programmed into the code of the experiment in PCIbex.

3.6.3 Procedure

The first three pages of the experiment presented a written consent form, a personal data questionnaire and instructions, explaining the task required from the participant. The questionnaire required the following information:

(a) Full name;

(b) Email address;

(c) Age;

(d) Country of birth;

(e) Country of residence;

(f) Level of education;

(g) Laterality (right-handed or left-handed);

(h) Gender;

(i) Whether the participant is a native speaker of Kusaal;

(j) Whether the participant is a native speaker of English;

(k) Whether the participant speaks any other languages;

(l) If so, which languages they speak.

Once the questionnaire and consent form were filled out, the participant was taken to the trial section of the experiment, during which they were instructed on the study procedure and led through a practice round that was an exact emulation of the experiment. After completing the trial, participants were taken to the experiment, where they were asked to listen to a sequence of sounds and judge whether it formed a word in English or not. The auditory cues were composed of individual words, each spoken by one of three speakers (one male, two female), and were either a real word pronounced with correct stress or a pseudo-word that differed from a real word either in stress placement or in a phonemic difference, e.g., [ˈbʌkɪt] vs. [bʌˈkɪt], [ˈsɒlɪd] vs. [ˈsɒrɪd]. Participants were informed, in the instructions page, that some of the words may sound like real words being mispronounced and were instructed to regard these as errors and, therefore, as not well-formed words in English. Participants heard each stimulus once. The 100 ms recording of the individual real word or pseudo-word started after a fixation cross (+) appeared on the screen. The fixation cross remained for the duration of the auditory cue and participants were instructed to make their judgement after the fixation cross disappeared from the screen. If the stimulus was judged to form a word in English, participants were to press the F key on their computer keyboards. In the case of a stimulus being judged to not form a word in English, participants were to press the J key on their keyboards. The fixation cross remained visible for a total of 200 ms, with the auditory cue (with a duration of 100 ms) commencing after 100 ms, before disappearing. During this time the participant was to make their judgement, pressing the F or J keys. After the selection had been made, another fixation cross appeared to indicate the start of the next auditory cue. This procedure is in line with the methods used by Dupoux et al. (2010). Each participant heard and responded to 8 minimal pairs in the trial section and 60 minimal pairs in total during the experiment.

After the last stimulus in the experiment was listened to and judged, the participants were taken to a ”thank you” page, which stated that they had finished the task and that they would then be asked about their language background. This was a self-assessment English language proficiency test that used the Likert scale to record responses. Images of the questions included in this part of the experiment can be found in Section 7.

Participants, finally, were also asked to take an L2 English proficiency test through LexTALE (Lemhöfer & Broersma 2012). They were further instructed to send their results via email (a feature offered on the platform at the end of the test) directly to my email address for analysis. As with the PCIBex experiment, participants had the option to remain anonymous and not provide any personal information to the server.

3.6.4 Participants

Four native speakers of Kusaal, three male and one female, completed the experiment proposed in this study. Their professions are: students (two), teachers (one) and journalists (one). The participants had varying education levels, including secondary school (one), Bachelor’s degree (one) Master’s degree (one) and Doctorate degree (one). Their ages range between 30 and 33 and all four are right-handed. Two participants speak Asante Twi and one speaks Gurenɛ, in addition to Kusaal and English. English proficiency was tested through self-assessment, accessed through the PCIbex link
(https://farm.pcibex.net/p/UAkjtc/), following the auditory lexical decision task, and through the LexTALE test, accessed through the following link:
https://www.lextale.com/takethetest.html.
Participants were able to access all parts of the study online and were instructed to do

so using a computer, as PCIbex cannot record responses given through a touch screen of a mobile or tablet.

4 Results and Discussion

In this section the results of the auditory lexical decision task will be presented, analysed and discussed. They will be further compared with one another, if and when possible, in order to draw possible conclusions or hypotheses regarding correlations between variables. Although the amount of participants is low, some of the results give strong information that sets a solid starting point for future investigations. These future studies will be necessary not only to verify these preliminary results, but also to provide more stable results on some of the variables tested.

4.1 Stress Perception Response Time

Response time (RT) data for the condition (stress contrasts and phonemic contrasts) and type (real words and pseudo-words) studied in the lexical decision task experiment, is presented in Figure 8. The graph illustrates that participants had, on average, a slower RT when faced with pseudo-words than with real words in responding both to stimuli with a phonemic contrast and to stimuli with a stress contrast. Participants' RT for correct stress contrast was lower than that for correct phoneme contrast (0.827 seconds vs. 0.914 seconds), while RT for incorrect stress contrast was higher than for incorrect phoneme contrast (1.003 seconds vs. 1.001 seconds).

The median (central line in each box) is fairly consistent across all four conditions. Slightly faster, or lower, RTs, were recorded for the phonemic contrast stimuli than for the stress contrast stimuli, both for real words (Word) and pseudo-words (Pseudoword). Additionally, real word responses tend to have a marginally lower median RT than pseudo-word responses.

Additionally, it is apparent how the stress condition has more variability (indicated by taller boxes and longer whiskers) than the *phonemic* condition; this is particularly noticeable in the pseudo-words with a stress contrast group (stress–pseudo-word condition in

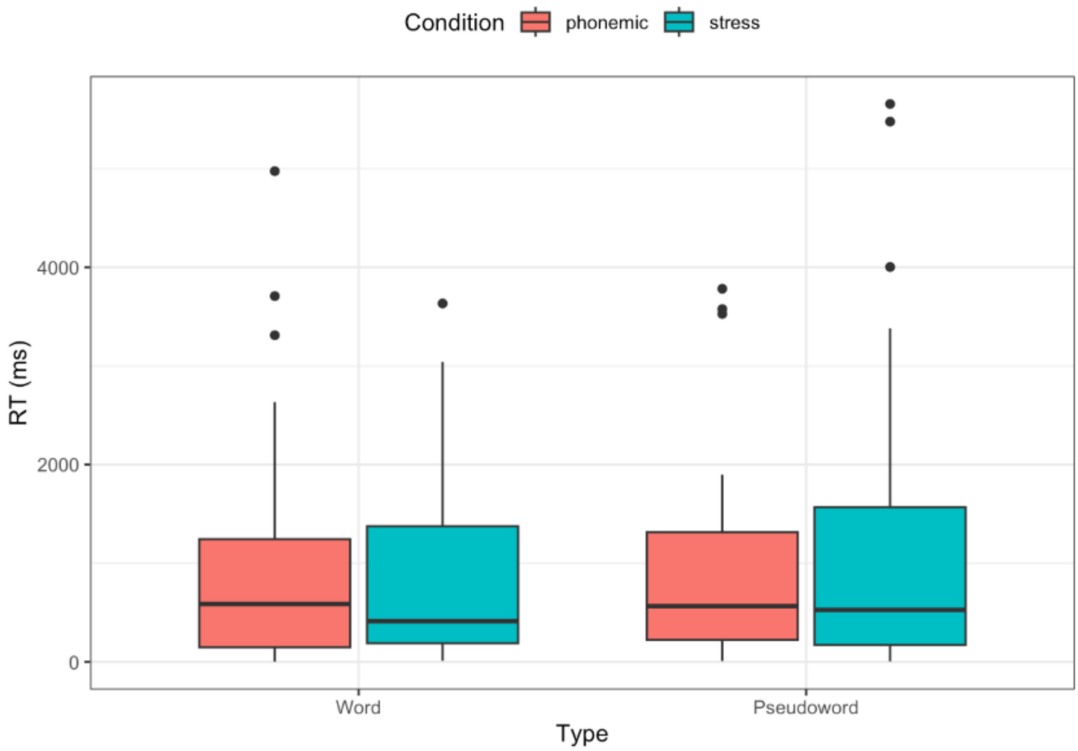

Figure 8: Graph representing RT for real words and pseudo-words in stress contrast and phoneme contrast conditions.

the graph). Furthermore, several outliers, shown by the dots in Figure 8 appear above the whiskers, especially in the stress–pseudo-word condition, suggesting that some participants took much more time to respond.

Participants responded more quickly and consistently in the phonemic condition than in the stress condition, suggesting that segmental cues are easier to process for native Kusaal L2 English speakers. In contrast, stimuli with stress contrasts resulted in slower and more variable reaction times, especially for pseudo-words. This pattern indicates that lexical stress may be a less reliable cue for participants, particularly when the word itself is unfamiliar. Pseudo-words may introduce slightly more processing difficulty than real words, especially under the Stress condition. This heightened difficulty suggests that participants struggle to apply stress-based lexical processing strategies in the absence of stored lexical representations.

4.2 Stress Perception Accuracy

Figure 9 shows relevant information regarding participants' accuracy in their perception of stress in BrE loanwords for the conditions and types studied in the lexical decision task experiment (stress contrasts and phonemic contrasts in real words and in pseudo-words), as well as an interaction effect between type (word or pseudo-word) and condition (stress contrast or phonemic contrast). Participants were accurate in identifying real words in both conditions, though they displayed a slightly better performance in the stress condition for real words. This could possibly be due to stress providing additional prosodic cues that help recognition. As seen in 3.2, stressed syllables in English loanwords are usually adapted into H tones in Kusaal (Eddyshaw 2024: 28). As such, correctly stressed English words may align more closely with familiar Kusaal (L1) tonal patterns, facilitating recognition. This effect highlights the role of cross-linguistic prosodic mappings in L2 lexical processing and may partially explain participants' difficulty in rejecting pseudo-words with incorrect stress. Such items may not violate Kusaal-based prosodic expectations strongly enough to be flagged as words that are not real.

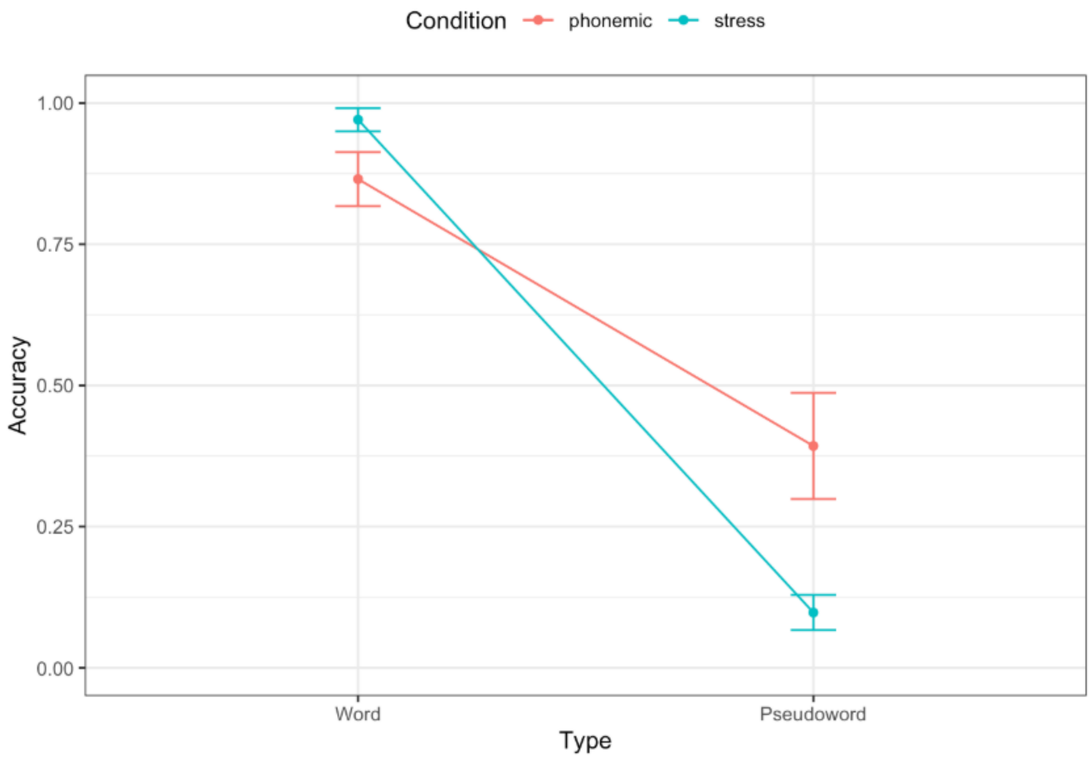

Figure 9: Graph representing participant accuracy

Accuracy in recognising pseudo-words with a phonemic contrast is moderate; participants were able to recognise that these are not real words, suggesting that they can detect segmental mismatches reasonably well. On the other hand, in regards to pseudo-words with a stress contrast, accuracy drops sharply. Participants frequently mistook these pseudo-words for real words, implying that they struggled to detect incorrect stress patterns and were more likely to accept these pseudo-words as real words. These results are congruent with initial predictions, as well as with the results obtained by Dupoux et al. (2008, 2010) and by Lin et al. (2014). Participants, therefore, appear to be less sensitive to stress errors than to phonemic errors. Stress contrast pseudo-words were often misidentified as real words, which may suggest a reduced perceptual salience of stress cues in L2 English, limited lexical encoding of stress in participants' mental lexicon or, possibly, a reliance on segmental (phonemic) information over prosodic cues when making lexical decisions. This supports the hypothesis that L2 learners may not perceive or encode stress as robustly as phonemic contrasts. This could have broader implications for theories of L2 phono-lexical encoding, showing that prosodic features like stress may be under-represented compared to phonemic features.

Figure 9 also points to an interaction effect, which, in statistics, can be defined as situations where two or more variables work together at the same time to influence an outcome (Rahman 2019). In the case of the present study, the effect of one independent variable (e.g., condition, or stress contrast vs. phonemic contrast) depends on the level of another variable (e.g., type, or real word vs. pseudo-word). In other words, the fact that the difference between stress and phonemic conditions seems to change depending on whether the item is a real word or a pseudo-word indicates a significant interaction.

In the phonemic condition, participants showed high accuracy for real words, with scores around 0.9, and moderate accuracy for pseudo-words, with values around 0.45 to 0.5. This indicates that they were generally good at recognising real words and could detect when a word differed by a phoneme. In the stress condition, accuracy for real words was high, reaching approximately 0.98 to 1.0, suggesting participants had little difficulty recognising correctly stressed words. However, for pseudo-words in this condition, accuracy dropped dramatically to just 0.05 to 0.1, showing that participants often mistook incorrectly stressed pseudo-words for real words. In real words, there is a small difference in accuracy between conditions, while in pseudo-words the difference is large and performance plummets in the stress condition. The lines cross in the graph, suggesting a strong interaction; the effect of the stress contrast vs. phonemic conditions is not consistent across real word vs. pseudo-word (Type). For real words, both conditions are handled well by participants, although they perform slightly better in the stress condition. This is possibly due to added prosodic cues helping recognition, as mentioned above. For pseudo-words, on the other hand, there is a significant divergence. Phonemic contrast pseudo-words are detected fairly well, while stress contrast pseudo-words are often not rejected, leading to very low accuracy, suggesting that participants often processed pseudo-words pronounced with incorrect stress as real words (pronounced with correct stress).

To summarise, the significant interaction between condition and type indicates that the ability to correctly classify items in the stress condition is highly dependent on whether the item is a real word or a pseudo-word. While participants performed well across both conditions for real words, their ability to reject pseudo-words diverged sharply. Pseudo-words with phonemic contrasts were rejected more accurately than those with stress contrasts, suggesting that participants were more sensitive to segmental mismatches and less attuned to prosodic deviations. This underscores a specific difficulty in detecting mis-stressed items, not just a general challenge with pseudo-words. The interaction effect shows that stress perception deficits only surface under the challenge of pseudo-word recognition, when the participant cannot rely on stored lexical representations. In contrast, phonemic differences are easier to detect, even when the stimulus is unfamiliar.

4.3 Summary of Stress Perception RT and Accuracy

Figure 10 shows a summary of the data reported above, providing detailed information on RTs and accuracy results, broken down into condition, where *phonemic* represents pseudo-words differing by a phoneme (segmental control) and where *stress* represents pseudo-words differing by lexical stress (key experimental condition). In type, *C* represents items with correct pronunciation (real words), while *I* represents items with incorrect pronunciation (pseudo-words, either phoneme- or stress-altered). *N* inidicates the number of responses, while SD indicates the standard deviation (presented both for RT and for accuracy). Regarding mean RT, participants responded most quickly and accurately to real words with correct stress, initially suggesting strong familiarity with canonical stress patterns. However, for pseudo-words, especially those with stress manipulations, they were both slow and inaccurate, indicating that stress-based differences were not salient or meaningful enough to drive accurate lexical decisions.

Regarding mean accuracy, based on Figure 10, participants were highly accurate at recognising correctly pronounced words, especially with correct stress (0.97). However, they struggled significantly to reject incorrectly pronounced pseudo-words, particularly those with stress changes, which they accepted as real words about 90% of the time.

condition	type	N	Mean RT	SD RT	Mean Accuracy	SD Accuracy
phonemic	C	52	914.3846	1059.9155	0.8653846	0.3446423
phonemic	I	28	1001.4286	1071.6334	0.3928571	0.4973475
stress	C	68	827.0147	889.1336	0.9705882	0.1702139
stress	I	92	1002.7609	1168.7909	0.0978261	0.2987072

Figure 10: Summary of result statistics

4.4 RT Interaction with Variables

Given the limited number of participants, two of the variables, namely number of syllables and word frequency, did not yield significant results. Similarly, number of phonemes and L2 proficiency did not yield results that were conclusive, but that might, at least, be an indication of trends. A general linear model (GLM) with a Gaussian (normal) distribution to predict RT, as illustrated in Figure 11, sheds clearer light on these results.

4.4.1 RT and word frequency

Regarding word frequency, the reference level is high-frequency words, so the estimates for L (low) and M (medium) frequency show how RTs for less frequent words compare to high-frequency ones. Both coefficients are negative, -88.16 for L and -44.53 for M, meaning that, compared to high frequency words, low frequency words were responded to 88 ms faster on average, while medium frequency words were 45 ms faster, but these dif-

```
##
## Call:
## glm(formula = RT ~ condition * type + frequency + syllable +
##     phoneme + proficiency, family = "gaussian", data = data.df)
##
## Coefficients:
##                         Estimate Std. Error t value Pr(>|t|)
## (Intercept)              1103.34     320.22   3.446 0.000677 ***
## conditionstress          -132.00     174.98  -0.754 0.451405
## typeI                      51.09     222.33   0.230 0.818443
## frequencyL                -88.16     149.48  -0.590 0.555917
## frequencyM                -44.53     154.09  -0.289 0.772843
## syllable                 -136.18     203.39  -0.670 0.503816
## phoneme                   112.72      65.51   1.721 0.086649 .
## proficiencymid           -986.73     121.20  -8.141 2.43e-14 ***
## conditionstress:typeI     128.02     268.66   0.477 0.634154
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for gaussian family taken to be 881343.5)
##
##     Null deviance: 266941794  on 239  degrees of freedom
## Residual deviance: 203590359  on 231  degrees of freedom
## AIC: 3977.3
##
## Number of Fisher Scoring iterations: 2
```

Figure 11: RT data for all variables

ferences, however, are not statistically significant. The counterintuitive direction (faster responses to low frequency words) suggests that frequency was not a reliable predictor of RT. This could be due to limited variability in frequency levels, the influence of other variables, insufficient data or, potentially, frequency not being salient in auditory presentation for native Kusaal speakers of L2 English, though this would go against extensive research on exemplar theory (see Section 3.4).

4.4.2 RT and Syllable Count

Regarding syllable count, each additional syllable was associated with an average 136 ms faster RT, but this result is not significant ($p = 0.504$). Surprisingly, longer words (i.e., higher syllable count) were responded to in a slightly faster manner by participants, by around 136 ms per syllable, but this pattern was not statistically meaningful. Like frequency, syllable count may not play a strong role in lexical decision tasks for L2 speakers of English, as sustained by Altmann (2006: 80), possibly because other cues (like stress patterns, phonemes, or familiarity) are more dominant. Alternatively, this could reflect task-specific strategies (e.g., participants giving faster rejections to longer pseudo-words) or simply noise in the data.

4.4.3 RT and Phoneme Count

As shown in Figure 11, for every additional phoneme in a word, the GLM predicts 112.72 ms longer RT, holding other variables constant. Dissimilarly to syllable count, then, this effect is marginally significant ($p \approx 0.087$), suggesting a potential trend; longer words (in phonemes) tend to take more time to process. However, this is not definitive at conventional significance thresholds (like 0.05). This statistic, contradicting that of syllable counts, might imply that lexical access takes longer for longer words, possibly due to increased perceptual and processing demands (more auditory material to analyse or greater memory load).

4.4.4 RT and L2 English proficiency

The LexTALE proficiency test yielded the following percentages: 56.25%, 56.25%, 71.25% and 87.5%. In light of these, the GLM shows that participants at the mid proficiency level (56.25%) had RTs almost 987 ms slower than participants with high L2 proficiency (71.25% and 87.5%). This could be a strong and statistically significant effect, although the sample size is too small for definitive conclusions. Proficiency seems to play a critical role in processing speed. More proficient participants likely process and judge auditory lexical items much faster, possibly due to better phonological representations, greater familiarity with English stress/phoneme patterns, or more efficient decision strategies. This result may show that L2 auditory processing efficiency improves measurably even at advanced stages.

4.4.5 Summary of RT Interaction with Variables

To summarise, word frequency and syllable count did not significantly influence reaction times in this study. Interestingly, the direction of both effects went opposite to typical native-speaker patterns (i.e., faster responses to low frequency and longer words), but these trends were weak and unreliable. Native Kusaal speakers of L2 English may, then, rely less on lexical familiarity or word length and more on pronunciation accuracy and their own proficiency when making lexical decisions in an auditory task.

In the RT model, only proficiency and phoneme count approached or reached statistical significance, while other predictors such as frequency and syllable count did not significantly influence response latency. Proficiency seemed to have the strongest effect, with mid-proficiency participants responding significantly more slowly than high-proficiency participants (Estimate = –986.73, p < .001), suggesting that higher proficiency is associated with greater processing efficiency. This finding aligns with the idea that as learners become more proficient, they are not only more accurate but also faster in making lexical decisions (Harrington 2006; Issa et al. 2022). Phoneme count showed a marginal effect (Estimate = 112.72, p = .087), indicating that items with more phonemes may take slightly longer to process, although this effect did not reach conventional significance levels. Other variables, including word frequency and syllable count, did not significantly predict RT.

4.5 Accuracy Interaction with Variables

Similarly to the information presented in Section 4.4, the data in Figure 12 is taken from a GLM with binomial family output and allows us to interpret accuracy interactions in all of the variables accounted for in this study.

```
##
## Call:
## glm(formula = accuracy ~ condition * type + frequency + syllable +
##     phoneme + proficiency, family = "binomial", data = data.df)
##
## Coefficients:
##                        Estimate Std. Error z value Pr(>|z|)
## (Intercept)             1.51779    1.17496   1.292 0.196435
## conditionstress         1.58023    0.82947   1.905 0.056765 .
## typeI                  -2.37938    0.58004  -4.102 4.09e-05 ***
## frequencyL             -0.25493    0.50513  -0.505 0.613778
## frequencyM             -0.11139    0.55207  -0.202 0.840094
## syllable                0.45653    0.72272   0.632 0.527589
## phoneme                -0.03562    0.23323  -0.153 0.878624
## proficiencymid         -0.44536    0.42622  -1.045 0.296076
## conditionstress:typeI -3.44211    0.98599  -3.491 0.000481 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 330.69  on 239  degrees of freedom
## Residual deviance: 153.64  on 231  degrees of freedom
## AIC: 171.64
##
## Number of Fisher Scoring iterations: 6
```

Figure 12: Accuracy data for all variables

4.5.1 Accuracy and Word Frequency

In this category, as seen in Figure 12, estimates are small and negative; there is a reduction of approximately 25% in log-odds of correct responses for low frequency words and a reduction of approximately 11% for medium frequency words. p-values are shown to be 0.61 and 0.84, which do not yield significance.

Aside from the possible effect of the sample size being too small for significant results, word frequency may also not play an important role in this case due to different factors. These may include the task type itself, in that in an auditory lexical decision task, phonological cues may dominate over lexical familiarity. Depending on proficiency in English L2, participants may not have fully internalised BrE word frequency, so it might not guide their judgements the way it might for native speakers of BrE.

4.5.2 Accuracy and Syllable Count

In regard to syllable count effect, the GLM records a slightly positive estimate, of +0.457, according to which more syllables equalled slightly higher accuracy, but this result is not significant ($p = 0.53$). This may be due to participants not having any clear perceptual difficulty with longer words or not using syllable count as a cue. Once more, with only four participants, there is limited power to detect small effects. Word length in syllables, then, did not help or hinder decision-making, possibly because other cues (like stress correctness) were more salient.

4.5.3 Accuracy and Phoneme Count

The GLM shows a slight negative estimate, of -0.036, suggesting that more phonemes mean very slightly reduced accuracy. However, with $p = 0.88$, this result is, again, not significant; the effect is too small to be considered, with a coefficient of almost zero. It would appear, once more, that phoneme count does not signify perceived difficulty; especially in L2, it may not be how many sounds a word has, but how familiar those sounds are that matters. Considering that all pseudo-words had similar phoneme numbers to those of real words, we could deduce that phoneme count would not distinguish real words from pseudo-words. Phoneme count was, therefore, not a meaningful cue to accuracy, either perceptually or statistically.

4.5.4 Accuracy and L2 English proficiency

The GLM statistics shown in Figure 12 show that the effect of proficiency on accuracy was not statistically significant in the model (Estimate = –0.445, p = 0.296). This indicates that participants with mid proficiency (score of 56.25%) were somewhat less accurate than participants with high proficiency (scores of 71.25% and 87.5%), though this difference did not reach significance. One likely reason for this is the extremely limited sample size, which severely restricted the power to detect differences in a binary outcome like accuracy. In addition, there may have been relatively low variability in performance between these groups: if both mid- and high-proficiency participants performed well on real words but poorly on pseudo-words, the similarity in their accuracy patterns could obscure any meaningful difference. Notably, the earlier reaction time model showed a large and significant effect of proficiency on speed, suggesting that proficiency may contribute more to processing efficiency than to overall correctness. In other words, higher proficiency participants may not necessarily be more accurate, but they are likely to make decisions more quickly. This implies that once learners reach a mid-to-high level of proficiency, accuracy in lexical decision tasks may level off, while gains in speed and processing fluency continue to reflect proficiency-related differences.

4.5.5 Summary of Accuracy Interaction with Variables

Word frequency, syllable count and phoneme length did not significantly predict accuracy in the model, which may be attributed to several factors. First, it appears that participants relied more heavily on phonological cues, particularly stress placement and phoneme accuracy, as discussed in Section 4.1 and Section 4.2, than on lexical familiarity when making lexicality judgements. Second, the stimuli were carefully controlled for linguistic features such as length and frequency, which likely limited variability and reduced the potential for these factors to influence performance. Additionally, the nature of the task required participants to judge whether each item sounded like an actual English word, rather than to access or process its meaning; this may have further diminished the role of lexical properties like frequency or length. Proficiency level similarly showed no significant effect on accuracy, which is likely due in part to the small sample size, as well as the possibility that both groups possessed sufficiently advanced language skills to perform well across most conditions.

5 Implications for Further Research

Given the small pool of participants, the most urgent step to take for future research on the topic of stress perception in L2 English in native Kusaal speakers would be to secure a larger group of participants. This would ensure more results to analyse and, as such, would provide more reliable and potentially conclusive data. One possible change to the procedure in order to fulfil this step could be to organise a specific time for participants to take the experiment in the presence of the researcher, in order to ensure that the task is completed. Furthermore, offering compensation for participation may help attract more participants to the study.

Following previous studies on stress perception and stress "deafness" (Dupoux et al. 2008, 2010; Lin et al. 2014), implementing a second part to the experiment, involving a sequence recall task, may also provide more data and, as such, solidify results. In their study, Lin et al. (2014) altered vowel quality in their stimuli, as nearly all unstressed syllables in English undergo vowel reduction. This was to prevent native English speaking participants from depending on changes in vowel quality, rather than suprasegmental features, to recognise words (Lin et al. 2014: 324). Similarly, as Kusaal is a tone language and as English stress generally is adapted as a H tone in English loanwords (Eddyshaw 2024: 28), manipulating pitch in the production of the stimuli may reduce the possibility of participants relying on non-stress-based cues when making decisions.

In relation to the inconclusive results yielded by syllable and phoneme counts, aside from the necessity of more data, once more, accuracy might be increased by matching syllable and phoneme numbers and syllable stress patterns across word frequency levels. This would ensure that for each word frequency group the same amount of syllables and phonemes were represented, as well as the same stress pattern (initial, medial or final stress).

6 Conclusion

Over the course of this study, a phonological and psycholinguistic framework surrounding loanword adaptation and lexical stress were built, creating a bridge between these two disciplines regarding their perspectives on these phenomena. Through the understanding of some of the different theories and processes involving loanwords, lexical stress and how different languages interact with them, this study constructed a base for an experiment aimed at developing and deepening our understanding of the perception of lexical stress and its interaction between two languages, Kusaal and English. Section 2 offered phonological and psycholinguistic perspectives on loanword adaptations to build knowledge on and importance of different points of view when dealing with complex linguistic processes. A more in-depth analysis of some of the frameworks used by phonologists to tackle and decipher lexical stress cross-linguistically was contrasted, once more, by an analysis of perception-based experimental studies on stress “deafness“.

As seen in Section 3.1 and Section 3.2, BrE, GhE and Kusaal have unique phonological properties. Of particular interest to this study is the stark contrast in scientific knowledge in the literature regarding stress systems in English and in Kusaal. Although information is scarce on the existence (and subsequent nature and placement) of lexical stress in Kusaal, the literature offers details of the language’s tonal system and syllable structure. Given this scarce information on stress in Kusaal and based on knowledge that speakers of tonal languages, in general (Uffmann 2013: 8), and Kusaal, in particular (Eddyshaw 2024: 28), tend to map L2 lexical stress as tones in L1, following the pattern of H tone for stressed syllables and L tone for unstressed syllables, the prediction for the results of the lexical decision task conducted in this study was that native Kusaal speakers would display difficulty in perceiving stress in BrE loanwords. Although only four native Kusaal speakers completed the study, the results yielded information about stress perception and its interactions. In fact, the data show that participants generally responded more slowly to pseudo-words than to real words, regardless of whether the contrast was phonemic or stress-based. Reaction times (RTs) were faster for correctly identified stress contrasts than for phoneme contrasts, but errors in stress contrast had slightly higher RTs than phoneme errors. Overall, phonemic contrasts led to quicker and more consistent responses, especially compared to stress contrasts, which showed greater variability, particularly in the pseudo-word condition. The increased variability and presence of outliers in the stress pseudo-word group suggest that participants had more difficulty processing stress cues, especially when the word was unfamiliar. This indicates that segmental (phonemic) information may be easier for native Kusaal speakers to process than suprasegmental (stress) cues, likely because stress-based cues are harder to use without a known lexical reference.

Participants were generally accurate in identifying real words, performing slightly better in the stress condition, possibly due to prosodic cues aligning with familiar Kusaal tonal patterns. This suggests that correctly stressed English words may be easier for Kusaal speakers to recognise because of cross-linguistic prosodic mappings. However, this familiarity might also explain why participants struggled to reject pseudo-words with incorrect stress. These items may not have clearly violated their expectations based on Kusaal prosody.

When it came to accuracy, for pseudo-words performance varied sharply by contrast type. Participants showed moderate accuracy when rejecting pseudo-words with phonemic contrasts, indicating that they could detect segmental mismatches reasonably well. In contrast, accuracy dropped significantly for pseudo-words with stress contrasts; participants often accepted these as real words. This suggests that they had greater difficulty perceiving or encoding incorrect stress patterns, likely due to a heavier reliance on segmental cues over prosodic ones in L2 lexical processing. These results align with the present study's prediction and with prior findings (Dupoux et al. 2008, 2010; Lin et al. 2014), supporting the idea that L2 learners may under-represent stress in their mental lexicon, focusing more on phonemes than on prosody.

Additionally, a significant interaction was observed between word type (real word vs. pseudo-word) and contrast type (phonemic contrast vs. stress contrast). While both conditions yielded high accuracy for real words, performance diverged sharply for pseudo-words; phonemic contrasts were rejected more successfully than stress contrasts. This interaction reveals that difficulties with stress perception only become prominent when participants cannot rely on familiar, stored lexical forms and, as such, when processing novel, non-lexical items.

The study found that word frequency and syllable count did not significantly affect RTs and their effects ran counter to typical native-speaker patterns (i.e., faster responses to low-frequency and longer words), though these trends were weak and inconsistent. This suggests that native Kusaal speakers of L2 English may depend more on pronunciation accuracy and language proficiency than on lexical familiarity or word length when processing spoken words. In the RT model, proficiency was the most reliable predictor: higher-proficiency participants responded significantly faster than mid-proficiency ones, indicating more efficient lexical processing. Phoneme count had a marginal effect, with longer words (in terms of phonemes) tending to slightly increase processing time, though this was not statistically robust. Word frequency, syllable count and phoneme length did not significantly affect accuracy, likely because participants relied more on phonological cues than on lexical familiarity when judging whether items sounded like real words. Since the task focused on sound-based recognition rather than meaning, lexical properties like frequency and length may have played a minimal role. Proficiency level also did not significantly influence accuracy, possibly due to the small sample size and the fact that both proficiency groups performed well overall.

Overall, although the limited sample size of the study limits its reliability, the research conducted provides a base for future experimentation on stress interaction and perception in L1 Kusaal speakers of L2 English. This study also contributes to overall knowledge of some of the adaptation processes that English loanwords undergo when they are adapted into Kusaal, in turn contributing to knowledge on phonological processes in Mabia languages as a whole. By adding to the scarce literature on stress systems in Kusaal, this study offers a deeper understanding of some of the complex structures within this language, deepening current knowledge and helping to broaden perspectives and add a new voice to the rich linguistic chorus that reflects the diversity of African languages.

7 Supplementary Materials

Supplementary data are available at the following link:

https://github.com/Portophon/kusaal_stress_loanwords/tree/main

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