Phonetics of Southern Welsh Stress

Zirui Liu

Abstract

This study is concerned with the phonetic manifestations of primary and secondary stress in Southern Welsh. The study found effects of primary stress on duration and F2 in the language. Specifically, vowels with primary stressed had longer duration and horizontally expanded vowel space when compared to unstressed vowels. Although there was significant difference in F0 between primary stressed vowels and their unstressed counterparts, F0 trajectory suggested no effect directly associated with stress. No significant effects of secondary stress were found in the present study. Due to the position shift of primary stress from the ultima to the penultimate (around the eleventh century) (Williams & Ball, 2001), vowels that occupy the ultima syllables were also included in the investigation. No clear stress related phonetic prominence was found for ultima vowels, except for word-final lengthening.

Keywords: stress, prosody, Welsh, Celtic

1 Introduction

Lexical stress is a suprasegmental linguistic phenomenon, which can provide rhythmic structure in a fixed-stress language such as in Turkish Kabardian and Polish (Gordon & Applebaum, 2010; Hayes, 2009). It can also encode lexical information in a language with phonemic stress, as in English and Spanish (Hayes, 2009). Earlier denotations on word level stress emphasised the strength of articulation during production of the stress bearing syllable, more specifically on ‘force’ and ‘loudness’ (Jones, 1949; Bloomfield, 1933; Bloch & Trager, 1942; Fry, 1958; Kingdon, 1958; Morton & Jassem, 1965).

This paper aims to examine which phonetic measures correlate with word stress in Welsh spoken in the southern region of Wales (primary and secondary). Not much research on stress has been done in the Celtic language family. Therefore, it is of interest to determine which cross linguistic features of stress extend into a language such as Welsh, and what its language-specific stress related characteristics are. There has been little experimental work done on word stress in Welsh and its sister languages – Breton and Cornish. Williams conducted her experimental study on Welsh stress for a PhD thesis in 1983. However, due to experimental designs, Williams’s study had several confounds and no consistent control group for the evaluation of acoustic properties in stressed vowels (see section 1 for details).

Earliest experimental study on the acoustic correlates of linguistic stress goes back to Fry’s work in English. Fry explored two phonetic manifestations of stress in English - duration and intensity (Fry, 1955). The experimental material consists of English words that change from a noun to a verb triggered by a change of stress location, such as in ‘object, digest and permit’ (Fry, 1955, P.765). Results of measurements and perceptual tests showed that both duration and intensity cue perception of stress, with duration having a more salient effect (Fry, 1955). Later in

1958, Fry extended his investigation into other acoustic cues including fundamental frequency, and confirmed its positive effect on stress perception; furthermore, he proposed the explicability of vowel quality (vowel space reduction) as a physical correlate to word stress (Fry, 1958). Since then, experimental work on word stress has mostly focused on the four acoustic correlates mentioned above cross linguistically – duration, F0, intensity and vowel quality.

In general, stressed vowels are related to phonetic correlates such as raised pitch, amplified intensity, longer duration, change in vowel quality and reduction in unstressed vowels (Gordon & Applebaum, 2010). Suggested by a great volume of research in stress hitherto, longer duration is said to be a constant cue to stress across languages (Ortega-Llebaria & Prieto, 2010). Consequently, supported by the 'Hyper- and Hyperarticulation' theory, when a vowel is unstressed, it is reasonable to suppose that shorter articulation time would lead to phonetic undershoot – centralisation of unstressed vowels (Lindblom, 1990 ; Garellek & White, 2015, p.26). Thus, a reduction in vowel space for unstressed vowels may be a phonetic characteristic in stress languages. However, typological differences across languages and other factors such as accentual conditions on the suprasegmentally level have resulted in varied conclusions on which correlates signal stress in different languages. For example, Ortega-Llebaria and Prieto (2010)'s work on Castilian Spanish and Central Catalan showed that stress correlates perform differently according to the focus status of the word. They found that duration serves as a strong cue to stress under both conditions in both languages, but not intensity, fundamental frequency or spectral-tilt (Ortega-Llebaria & Prieto, 2010). However, research done in Dutch, Polish, Macedo-nian, American English and Bulgarian suggest that change in vowel quality functions as a robust correlate to word stress (Sluijter & van Heuven, 1996a; Sluijter, 1995; Ortega-Llebaria & Prieto, 2010; Crosswhite, 2003; Ortega-Llebaria & Prieto, 2010; Plag, Kunter & Schramm, 2011).

Typological differences in stress manifestation may be due to phonological properties of the language under investigation (Gordon & Applebaum, 2010; Garellek & White, 2015). For example, pitch may not be used to signal stress in a language that has lexical tones, which is supported by results of Everett (1988) in Pirahã and Gandour, Harper & Potisuk (1996) in Thai, where tones are phonemic in both languages (Everett, 1988; Gandour, Harper & Potisuk, 1996; Gordon & Applebaum, 2010). According to Gordon & Applebaum (2010)'s paper on Turkish Kabardian, pitch and duration have a positive correlation with stress and intensity has minor effect on the production of stress. Notably, Turkish Kabardian employs a 'vertical three-vowel system', where only the vowel height is contrastive. There are many allophones of these vowels in the language due to its phonological rules of assimilation, such as labialisation, velarisation and fronting, depending on the succeeding consonant (Gordon & Applebaum, 2010, p.36).

Thus, according to Gordon and Applebaum, the inconsistent results of vowel reduction as a function of stress may be resultant of Turkish Kabardian's assimilation rules that signal surrounding consonants, which leaves less room for vowel reduction (Gordon & Applebaum, 2010). In the Garellek and White (2015) paper on stress in Tongan, a reduction or expansion in vowel space was not found, but an upward shift – lowering of the first formant. Motivation behind the shift in vowel space in Tongan may also be due to the fact that there are few phonemes in the language's vowel inventory, and a reduction in vowel space could harm perceptual distinctiveness (Garellek and White, 2015). Therefore, it is of interest to inspect whether there exists

an interaction between vowel space and stress conditions in Welsh, and if so, how such effect manifests according to the language's typological features.

This study will investigate acoustic correlates of stress and secondary stress in Southern Welsh, specifically regarding the six short vowels. Due to the Old Welsh Accent Shift (shift of stress position from word ultima to the penult), a compelling amount of literature suggests that the new penultimate stress in Welsh only serves as a rhythmic function, and the language's phonetic salience, such as F0, had remained in the ultima (Williams, 1983; Jones, 1949; Thomas, 1984; Watkins, 1993). Williams's study also suggests certain acoustic salience of the ultima syllable (Williams, 1983). Therefore, due to Welsh's language-specific characteristics, in addition to the primary and secondary stressed syllable, the ultima syllable will be included in the study.

This paper has the following structure: firstly, the paper will introduce some typological properties of Welsh and review previous research done on Welsh stress. Then, an overview of language background will be given, which include information on Welsh's phonemic inventory, stress pattern and the Old Welsh Accent Shift. Thirdly, experimental methods and material will be explained, followed by reporting of the study's results. Finally, discussion of outcomes, their implications for research in acoustic properties of stress and a conclusion of this study will be drawn.

1.1 Typological features and previous research of Welsh stress

Southern Welsh has eleven monophthongs, specifically six short vowels and their long counterparts, except for the short mid central schwa. Similar to the Williams paper, the five long vowels will not be examined for the purpose of this study, since they only occur in stressed positions and mostly in monosyllabic words (Williams, 1999). Since there exists distinction between long and short vowels in Welsh, duration may not serve as a strong cue to stress for the sake of greater perceptual distinctiveness. Stress is non-contrastive in Welsh, primary stress mainly falls on the penultimate syllable; secondary stress is alternating and falls on the second to the last stressed syllable from the right edge of the word. Recall that Gordon and Applebaum (2010) noted in their paper that the limited effect of stress on vowel reduction in Turkish Kabardian may be due to the non-phonemic status of stress in the language. This could also be the case in Southern Welsh.

Williams' research consists of four main parts – preliminary measurements of stressed vowels based on listener judgements; further measurements of actual stressed vowels in spontaneous speech; measurements of stressed and unstressed consonants, followed by perceptual tests with artificially manipulated stimuli (modifying coda consonant /m/) (Williams, 1983). In the preliminary study, materials were recordings of one male Southern Welsh speaker producing 12 regularly stressed polysyllabic words in a carrier sentence. The carrier sentence used was 'Dydi hi ddim yn ddigon i YSGRIFENNU ___' ('It's not enough to WRITE ___'); transcribed in IPA as /dədı hı ðım ən ðıgɔn ı sgrıvɛnı ___/ (Williams, 1983, p.28). Therefore, Williams's results regarding duration and pitch could have been confounded by the utterance final position of target words, namely under the effects of utterance/phrase final lengthening and boundary tones (Xu & Wang, 2009).

Twelve acoustic parameters were used to compare target syllables (syllables **judged** as stressed in the preliminary study and stressed syllables in the second study) to other syllables **within** the same word. These parameters include 'shorter duration', 'lower estimated amplitude integral', 'F0 change (within vowel) of less than 15 Hz',

‘higher F0 at start of vowel’, ‘greater mean amplitude’, ‘greater peak amplitude’ and their conversed counterparts (Williams, 1983, p.30).

Two monolingual English speakers judged syllables that correspond to the following properties to be stressed - ‘longer duration’, ‘greater estimated amplitude integral of vowel’, ‘F0 change greater than 15Hz’ and ‘greater peak amplitude’ (Williams, 1983, p.31). The Welsh speaker showed an opposite trend in judgement results. According to such results, monolingual English speakers judged the position of stress according to acoustic cues in their native language. Since stress is predictable in Welsh, the native Welsh speaker’s judgement reflects the actual trend of acoustic properties of stressed syllables in the data (compared to other syllables within the word).

However, as noted previously, such results are likely to be due to comparison of the stressed syllables to other syllables in the word, especially to the word initial and final syllables. Moreover, position of the target word in the carrier sentence may have further confounded the data trend as a result of sentence/phrase final lengthening. According to Williams, the conclusion that stressed syllables have shorter duration may also be due to the fact that the phonologically short schwa is permitted in the ultima position in Welsh (Williams & Ball, 2001).

The second part of Williams’ research measured stressed syllables produced during spontaneous speech. Results of this part of her study exhibited a parallel trend in acoustic properties with the Welsh speaker’s judgement from the preliminary study. Influence of sentential position may be smaller for the second part of the study, yet the same confounds were present regarding Williams’ choice of control group or the lack thereof. In addition, effects of word initial and final lengthening were not taken into account. Research done in Mandarin Chinese (Xu & Wang, 2009) and English (Nakatani, Aston & O’Connor, 1981) both support the effects of word-edge lengthening. All in all, Williams concluded that stress in Welsh is marked by **shorter** duration, **lower** amplitude and **lack** of pitch raise (Williams, 1983).

Since the schwa does not appear in word ultima position in Welsh, Williams later conducted research in which the schwa was omitted, in order to control for its effects on duration results. However, it is still difficult to disentangle effects of word/phrase-final lengthening in the results. Interestingly, this research shows that stressed penultimate vowels are slightly longer than unstressed antepenultimate vowels. In this study, mean durations for unstressed and primary stressed vowels ware 71ms and 75ms respectively. However, sample sizes used were significantly asymmetrical (349 cases for primary stress and 97 for unstressed) (Williams & Ball, 2001, p.180).

In the third part of Williams’ study, 176 consonants’ durations were measured by stress categories –syllable onset and coda positions when stressed and unstressed. Williams found significant post-vocalic lengthening effect when the syllable bears stress (Williams, 1999, p.3). Furthermore, Williams’s final perceptual study found that longer duration of stressed coda consonant cues stress even in stimuli with a superimposed flat F0 contour, and that F0 does **not** affect listeners’ stress perception (Williams & Ball, 2001; Williams, 1999). Such findings of consonant strengthening by stress may suggest overall lengthening of the stressed syllable in Welsh. This prominence induced consonantal lengthening effect has also been found in early studies of Dutch, which uses duration to encode stressedness of vowels. It was observed that stressed consonants had longer duration in both syllable onset and coda positions. (Nooteboom, 1972).

Contradictory results have been reported regarding Williams (1983)'s conclusion on the lack of F0 change in stressed vowels. Later research showed that stressed penult has higher pitch compare to unstressed syllables by around 17 Hz. However, similar to Williams's updated study mentioned above, sample sizes are highly uneven, and thus it is hard to determine the correlation between stress and F0 from the data. Therefore, it is necessary for a study with new experimental designs to be conducted, in order to gain a more comprehensive understanding of the phonetics of Welsh stress. More specifically, using word and phrase medial unstressed vowels as the control group.

1.2 Background on the Welsh language (Southern dialect)

Table 1 Southern Welsh vowel (top) and consonant (bottom) inventory

	Front		Central		Back	
	short	long	short	long	short	long
Close	ɪ	iː			ʊ	uː
Mid	ɛ	eː	ə		ɔ	oː
Open			a	aː		

	Bilabial	Labial -dental	Dental	Alveolar	Post-alveolar	Velar	Uvular	Glottal
Plosives	p b			t d		k g		
Nasal	m̥ m			n̥ n		ŋ̥ ŋ		
Trill				r̥ r				
Fricative		f v	θ ð	s	ʃ		χ	h
Lateral-fricative				ɬ				
Lateral-approximant				l				

1.2.1 Vowel inventory

As table 1 demonstrates, Modern Southern Welsh has six phonological short vowels and five long vowels. However, vowel length is only contrastive in monosyllabic words (see example 1 below for minimal and near minimal pairs).

(1) [ˈmeːl] mêl 'honey' [ˈmɛlɪn] melin 'mill'
[ˈtoːn] tôn 'tune' [ˈtɔn] ton 'wave'
[ˈkʰuːn] cŵn 'dogs' [ˈkʰʊn] cwm 'valley'
(adopted from Hannahs, 2013, p.24)

Long vowels only appear in stressed syllables and is sometimes marked by a circumflex such as 'mêl' and 'tôn' in example (1) above. Table 1 reflects vowel inventory of the southern variety of Welsh. In addition, Northern Welsh has a high central vowel /ɨ/ and its long counterpart /ɨː/. The present study focuses on the southern dialect.

1.2.2 Language background and the Old Welsh Accent Shift

The Welsh language emerged from its mother language Common Brittonic (belonging to the Celtic family in the Indo-European language, also referred to as British) around the fifth century, then was recognised as an independent language by the mid-sixth century (Willis, 2009; Williams, 1999). There was little to no written documentation of the language (Old Welsh) until the mid-eighth century.

Literature that makes use of manuscripts from the ninth to eleventh centuries dates the Old Welsh Accent Shift to the thirteenth century, although this is still controversial (Griffen, 1991&1992; Williams & Ball, 2001; Hannahs, 2013). Despite controversy of the specific dating, large amount of documentation suggests a clear shift of stress location in the language. Welsh's parent language Brittonic had stress on the penultimate syllable, while the ultima position was occupied by inflectional endings (Williams, 1983; Hannahs, 2013). The loss of inflectional ending around the sixth century marked the transition from Brittonic to Old Welsh (Williams, 1999). Due to deletion of the last syllable, Old Welsh was then stressed on the ultima, the Old Welsh Accent Shift refers to when stress relocated to the penultimate syllable around the late eleventh century (Williams & Ball, 2001; Williams, 1999).

1.2.3 Stress patterns

In Modern Welsh, regular primary stress falls on the penultimate syllable in polysyllable words and the ultima in monosyllabic content words (see example 2a); monosyllabic function words do not bear stress (Czerniak, 2015; Williams, 1983). Secondary stress appears in words with four syllables or more and sometimes on the first syllable of trisyllabic words with irregular main stress on the ultima. Secondary stress is alternating and falls on the second syllable to the last stressed syllable (see example 2b). (Williams& Ball, 2001).

Irregular primary stress can fall on the ultima or antepenultimate. These cases mainly occur in loanwords (see example 2c) or stress reassignment triggered by morphological context (see example 2d).

(2) a. [ˈtaːd] tad 'father'
[ˈtada] tadau 'fathers'
[bləˈnəðɔɪð] blynyddoedd 'years'
b. [ˌbɛndɪˈgɛdɪg] bendigedig 'blessed'
[ˌkanɪaˈtaːd] caniatâd 'permission'
c. [ˈparagraf] paragraff 'paragraph'
[ˈtɛstamɛnt] testament 'testament'
d. [əmˈlaːð] ymlâdd 'to be concerned'
[əsˈtoːl] ystôl 'stool'
(adapted from Czerniak, 2015, p.133 and Williams & Ball, 2001, p.166)

1.2.4 Schwa distribution

A final matter worth noting is the distribution of the schwa in Welsh. As mentioned previously, the schwa in Welsh is permitted in the ultima position. Yet, unlike other languages such as English and Russian, it can freely occupy the stressed penult

(Hannahs, 2013, p.24). Furthermore, it lacks a long counterpart unlike other vowels in the inventory. This may be due to the language specific rule that long vowels only occur in monosyllabic words and the schwa could not occupy that position in Welsh (Hannahs, 2013).

3 Methodology

3.1 Participants

Four female native Welsh speakers of the southern dialect living in London participated in this study. They were all aged between 20 and 45 years old and are originally from areas around Cardiff (on the Southern coast of Wales). All participants have lived in London for at least 3 years, however they stated that they communicate with friends and families in Welsh daily. Participants all received a compensation of seven pounds and fifty pence per hour for their involvement.

3.2 Stimuli

There were in total ninety-four words used in the study. Mainly four-syllable words (ˌCVCV̲ˈCV̲CV̲) were used for primary stressed, ultima and unstressed vowels. Words with irregular stress (i.e. certain loanwords and morphologically complex words) were not used in this study. Regularity of stress location for all stimuli was confirmed by a native Welsh language informant who did not participant in later recordings. There were nine three-syllable words used for primary stressed vowels and vowels at the ultima position; this was due to difficulties finding four-syllable words that fit the local environment criteria of the required vowel (such as /a/ and /ɔ/at the ultima position and /ɪ/ at the penultimate position). There were also difficulties in finding /ɛ/ and /ʊ/ in an open syllable at word final position. In this caseˌ CVCVˈCVCV̲C words were used instead.

For secondary stress, five-syllable words (CVˌCV̲CVˈCVCV) were used, most of them had plural or derivational suffixes added to four-syllable words. This is to avoid word-initial boundary effects on the secondary stressed syllable in four-syllable words. Note that there are two ways to pronounce the plural suffix ‘-au’ - /ai/ in formal register, and /ɛ/ in informal register. In order to maintain consistency, speakers were informed to pronounce the plural suffix in the colloquial way (/ɛ/).

For the control group - unstressed vowels, antepenultimate syllables in four-syllable words were used, also to minimise effects of word boundaries in three-syllable words. In order to control local environment to minimise effects of coarticulation, surrounding consonants were kept constant to a few natural classes. Most neighbouring consonants were fricatives, in conjunction with some nasals, the liquid /l/ or the trill /r/.

See Appendix for full word list.

3.3 Procedure

The stimuli were presented as a wordlist written in Welsh on A4 papers, and were read out loud by the participants. A carrier sentence was used to embed every word – ‘*Dywedwch y gair ____ i fi*.’ ([dəuˈɛdʊχ ə ˈgai ___ ɪ ˈvɪ]), *‘Say the word ___ for me’*. There were three repetitions for each word, five words per stress level (word position) and per vowel, which produced 115 tokens per repetition, same set of tokens for

unstressed vowels were later used as the control group for comparison. There were 345 tokens from each speaker, yielding 1380 tokens in total. For the repetitions, the original word list was randomised in excel to avoid any priming effects. All recordings were done at the UCL Phonetics lab, in a sound-proof booth, and with a RØDENT1-A microphone. Recordings were made using Audacity, at a sampling rate of 44.1 kHz, then saved as .wav files. Tokens were then labelled manually in PRAAT using textgrid (Boersma & Weenink, 2009). Segment boundaries were determined according to clear onset and offset of the second formant (F2). The labelled files were analysed in VoiceSauce (Shue et al, 2011). Six acoustic parameters were chosen for measurements of F0, duration, energy (intensity), formant heights and voice quality (see table 2 below for details).

Table 2. Acoustic measurements

Measurements	**Description**	**Parameters used in VoiceSauce**
Fundamental Frequency	Pitch – in Hertz (Hz)	STRIGHT algorithm (Kawahara, Masuda-Katsuse & de Cheveigné, 1999)
Duration	Duration of vowels – in milliseconds (ms)	Running Duration
Intensity/Loudness	RMS energy	Energy
First Formant (F1)	Height of F1 – in Hz	Snack SoundToolkit(sjölander, 2004)
Second Formant (F2)	Height of F2 – in Hz	Snack SoundToolkit(sjölander, 2004)
Voice Quality	H1*-H2* and CPP	CPP – algorithm by Hillenbrand, Cleveland & Erickson (1994)

(adapted from Garellek & White, 2015, p.16&17)

Mean values of measurements for the whole vowel were computed by VoiceSauce and output as a text file. For voice quality, H1*-H2* measures the amplitude (dB) difference between the first and second harmonics (Garellek & White, 2015). Typically, spectral structures of breathy voice include higher amplitude of the first harmonic (higher spectral tilt); on the other hand, creaky voice has a lower first harmonic but higher second, third or fourth harmonic in amplitude (Hillenbrand, Cleveland & Erickson, 1994). Thus, in comparison to values of modal voice, lower values usually correspond to creaky voice and higher values to breathy voice (Bickley 1982; Garellek & White, 2015). Central peak prominence (CPP) measures the distance from the cepstral peak to the cepstrum regression line, and ceptral peak is usually less prominent for breathy voice (Hillenbrand, Cleveland & Erickson, 1994). Noise in the voice such as aspiration or irregular voicing in creaky voice are both associated with lower CPP values (Garellek & Keating, 2011).

3.4 Confounds and exclusions.

Due to choice of carrier sentence in this study, following segment of the target word is the vowel (/ɪ/), which may lead to glottalisation of the vowel in word-final open

syllables. Thus, results of CPP and H1*-H2* for vowels at the ultima position may be influenced.

Out of 1380 tokens, ten were excluded during labelling. For speaker two, this include two secondarily stressed /ʊ/ and one secondarily stressed /ɛ/ (mis-pronunciation). For speaker four, three unstressed /ʊ/, three secondarily stressed /ʊ/ and one primarily stressed /ʊ/ were excluded. All exclusions of /ʊ/ were due to severe reduction of the vowel around liquid consonants or possibly shortened duration for unstressed instances. The aforementioned cases all had reduction to the point of unidentifiable or missing segments (of target vowels).

During data analysis, any values more than three standard deviations from the mean were removed before statistical testing.

4 Results

4.1 Linear mixed effects model

This part of the study was concerned with determining which acoustic parameters are used to cue stress in Southern Welsh, and if word final vowels differ phonetically from unstressed vowels. Significant difference between unstressed and stressed/ultima vowels will be reported. Results of each acoustic measurement (see table 2) are analysed with linear mix effects models using the *lmer()* function provided in the *lme4* package. The aim of the analysis was to investigate the relationships between the acoustic values and stress/Welsh ultima effects. All statistical analysis was done in the software - *R* (R Development Core Team, 2008). Analysis procedure followed the instructions in Baayen (2008a) Chapter 7.

Three models were constructed for comparisons between stressed (primary and secondary) and unstressed vowels, and unstressed and ultimate vowels. The models used all included maximal random effects/slopes structures, such approach attests to better retain analytical power compared to conventional ANOVA analysis (Barr et al, 2013). These models each had a fixed effect for vowel (six short vowels, see table 1) and stress (word position for comparison between ultima and unstressed vowels). Note that the schwa was excluded for comparison between ultima and unstressed vowels. Three random effects were also included in the models – speaker, word and order (order of word production during recording). These random intercepts should account for uncontrollable variables such as speaking rate, speaker and word differences. By-speaker and by-order random slopes for the effects of stress/ultima effect were also included in the models. By including random slopes, model fit was significantly improved, according to likelihood ratio tests performed with the function *anova()* in R (Baayen, 2008a). Random slopes should account for the variability in stress/word position's effectiveness on speakers and order of production.

For analysis of the effects of stress in general (for all vowels), comparison using *anova()* was made, between models including fixed effects for stress and vowel and null models with one fixed effect (vowel). *p*-values and X^2-values provided in the likelihood ratio tests output will be reported. Where there **is** a significant effect according to the likelihood ratio test, *t*-value in the model output will be reported. Analysis of effects of the ultima follows the above procedure, by replacing stress as fixed effect with word position (the ultima) in the models.

For individual vowels, a vowel by stress interaction will be added to the general model, to determine if the interaction significantly improves model fit. If significant effects for vowel by stress interaction are observed, additional models will be fitted

for each individual vowel by sub-setting the data. The models for within vowel comparisons had a fixed effect of stress, (no fixed effect for vowel), and random intercept and slopes for speaker only. Random intercepts and slopes for word and order had to be excluded due to convergence problem (possibly due to not enough within vowel observations for the model to estimate the effects of word and order) (Barr et al, 2014).

4.2 Fundamental frequency (F0)

Table 3 Mean F0 (Hz) for vowels with primary stress and no stress, *t*-values taken from linear mix effect model output, X^2 values and p-values adapted from likelihood ratio tests output (for standard deviation see parenthesis).

Vowels	Primary stress	No stress	*t*-value	χ^2-values	*p*-values
/ɪ/	207.17(17.44)	217.14(21.09)	-1.53	$X^2(1) = 2.31$	0.13
/ɛ/	195.70(16.60)	215.25(23.00)	-3.51	$X^2(1) = 6.51$	<0.01*
/a/	194.52(16.44)	209.89(22.83)	-2.83	$X^2(1) = 5.19$	<0.02*
/ɔ/	193.85(19.46)	214.86(21.25)	-3.39	$X^2(1) = 6.20$	<0.01*
/ʊ/	202.78(19.45)	207.20(20.87)	-1.20	$X^2(1) = 1.52$	0.22
/ə/	203.81(16.73)	215.55(18.21)	-3.88	$X^2(1) = 7.18$	<0.007**
Overall	199.64(18.34)	213.32(21.41)	-3.03	$X^2(1) = 5.64$	<0.02*

Figure 1: Mean F0 (Hz) bar plot for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N – no stressed; P - primary stress; S- secondary stress).

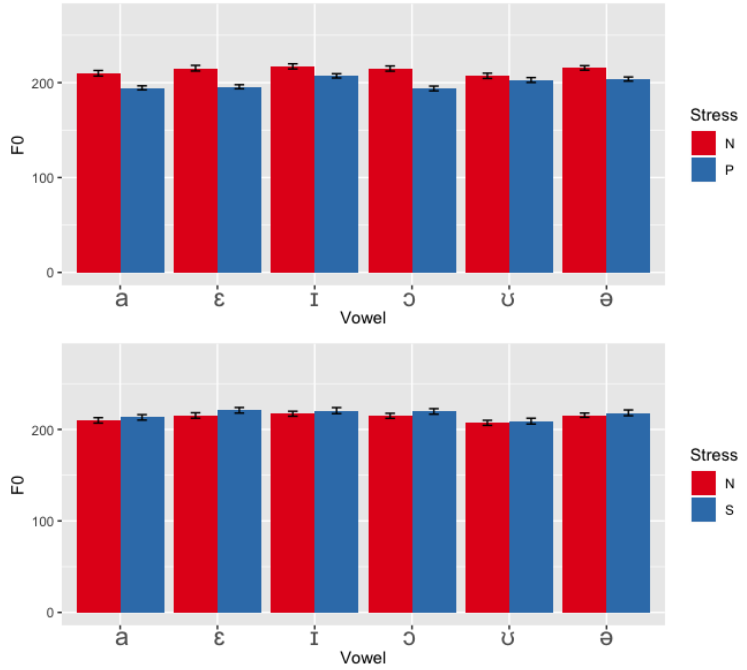


Figure 2: Mean F0 (Hz) bar plot by vowel for ultima vowels and unstressed vowels. Error bars indicate standard error of the mean. (N - no stress; U – ultima).

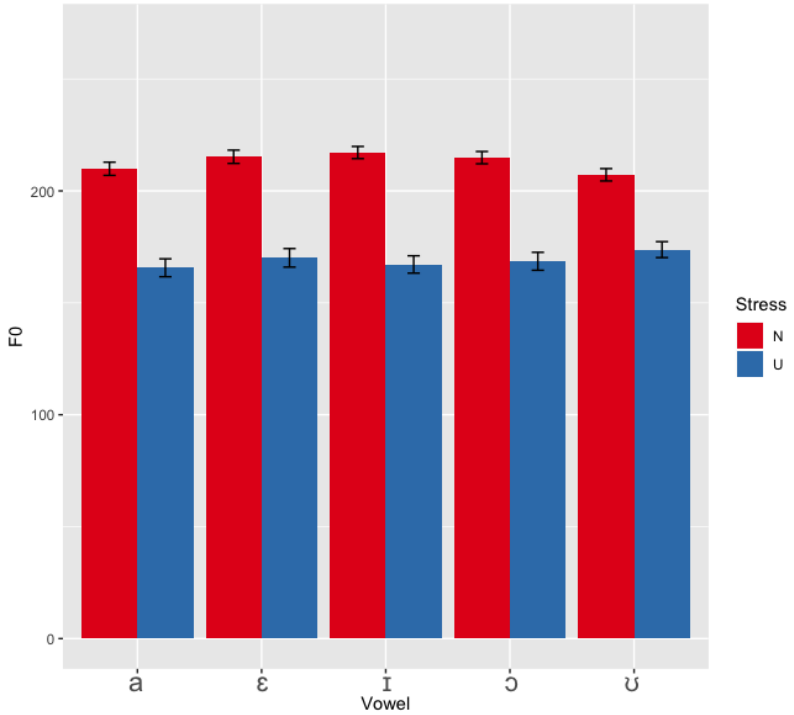


Figure 1 illustrates the means of fundamental frequency for each vowel under stressed (primary and secondary) and unstressed conditions. It is shown that vowels with main stress have significantly lower F0 values (overall by 13.68Hz) ($X^2(1) = 5.64$, $p<0.02$*), and this effect is least significant with the vowel /ʊ/. By adding a vowel by stress interaction in the model, likelihood ratio tests showed significant improvement of model fit ($X^2(5) = 19.46$, $p<0.002$**). Therefore, additional models were fitted for individual vowels for the effect of primary stress, in order to locate the variabilities. Results show that for /ɪ/ and /ʊ/, effect of primary stress on F0 is insignificant while the rest remained significant (see table 3).

Contrarily, secondary stressed vowels showed a positive effect on F0 values (see lower panel in figure 1). However, comparison between models with and without secondary stress as fixed effect did not have a significant result ($X^2(1) = 1.51$, $p= 0.22$).

Figure 2 shows that all vowels in ultima positions have lower pitch than unstressed syllables. Likelihood ratio tests shown significant results for such effect ($t = -4.85$, $X^2(1) = 8.802$, $p<0.003$**). No significance was found by adding interaction in the model for vowel by stress ($X^2(4) = 8.90$, $p= 0.06$). This indicates that the observation of overall pitch lowering in this case are similar across vowels.

4.3 Duration

Table 4 Mean duration (ms) for vowels with primary and no stress, *t*-values taken from linear mix effect model output, X^2 values and p-values adapted from likelihood ratio tests output (for standard deviation see parenthesis).

Vowels	Primary stress	No stress	*t*-values	χ^2-values	*p*-values

/ɪ/	87.58(28.79)	58.75(23.27)	7.52	$X^2(1) = 13.69$	<0.0002***
/ɛ/	125.77(33.88)	65.68(27.32)	5.54	$X^2(1) = 9.58$	<0.002**
/a/	129.99(30.07)	77.98(21.50)	5.38	$X^2(1) = 9.46$	<0.002**
/ɔ/	106.73(35.77)	60.34(21.68)	4.66	$X^2(1) = 8.76$	<0.003**
/ʊ/	73.36(36.18)	37.80(21.84)	6.37	$X^2(1) = 13.63$	<0.0002***
/ə/	61.06(21.03)	51.80(17.76)	1.16	$X^2(1) = 1.48$	0.22
Overall	97.52(40.38)	58.90(25.39)	5.93	$X^2(1) = 10.89$	<0.001**

Figure 3: Mean duration (ms) bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

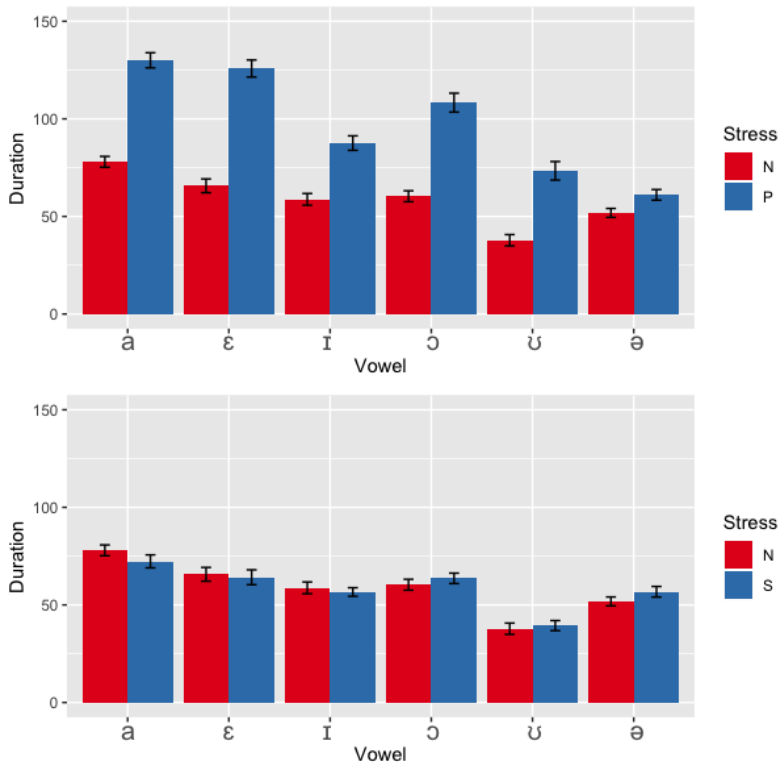


Table 5 Mean duration (ms) for ultima vowels and unstressed vowels, *t*-values taken from linear mix effect model output, X^2 values and *p*-values adapted from likelihood ratio tests output (for standard deviation see parenthesis).

Vowels	Ultima	No stress	*t*-values	χ^2-values	*p*-values
/ɪ/	128.99(39.62)	58.75(23.27)	5.99	$X^2(1) = 10.24$	<0.001**
/ɛ/	128.98(40.97)	65.68(27.32)	5.31	$X^2(1) = 9.27$	<0.002**
/a/	128.89(42.95)	77.98(21.50)	3.35	$X^2(1) = 6.19$	<0.01*
/ɔ/	138.08(46.61)	60.34(21.68)	4.83	$X^2(1) = 8.69$	<0.003**

/ʊ/	103.43(43.73)	37.80(21.84)	3.67	$X^2(1) = 6.10$	<0.008**
Overall	125.74(44.07)	60.34(26.46)	4.58	$X^2(1) = 8.90$	<0.003**

Figure 4: Mean duration (ms) bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U – ultima).

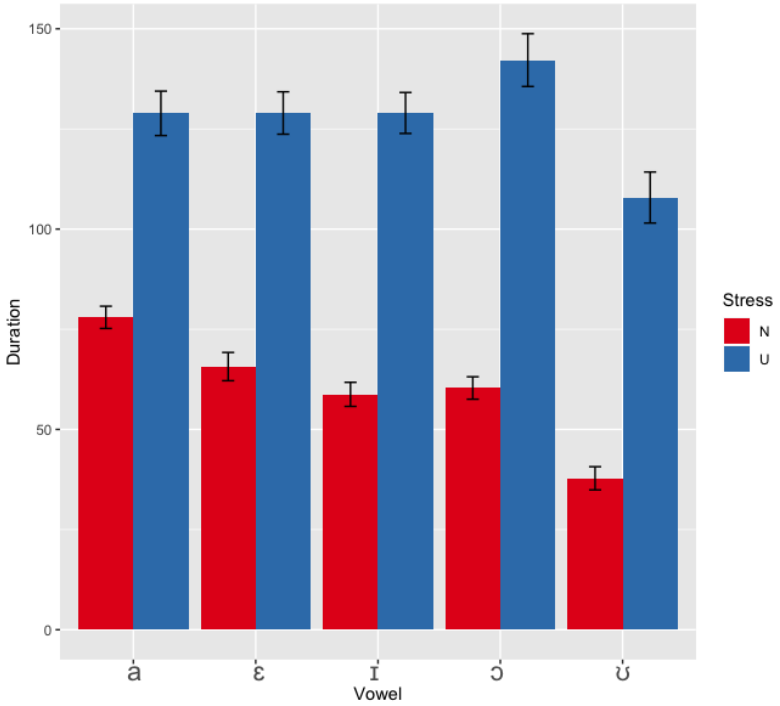


Figure 3 shows mean vowel duration values under the effect of stress (primary and secondary) and without. For primary stress, there is a significant effect of stress except for the vowel /ə/ ($X^2(1) = 10.891$, $p<0.001$**). Overall, vowels with main stress has a longer mean duration of 38.62ms (see table 4). By adding a vowel by stress interaction, likelihood ratio tests showed significant improvement of model fit ($X^2(5) = 33.001$, $p<0.0001$***). Thus, within vowel models were fitted for evaluations of primary stress's effect on duration for each vowel. Each likelihood ratio test results suggests significance effect of primary stress on duration, apart from the vowel /ə/ (see table 4). Figure 3 also demonstrates mean durations of secondary stressed and unstressed vowels. Figure 3 (lower panel) shows inconsistent results of the effect of secondary stress, likelihood ratio tests also indicated that no significant effect on duration was found for secondary stress ($X^2(1) = 0.643$, $p= 0.42$).

Figure 4 shows that vowels at word ultima position all have longer durations compared to when unstressed, overall by 65.40ms (see table 5). Likelihood ratio tests without vowel by stress interaction showed significant result ($X^2(1) = 8.902$, $p<0.003$**). Tests with vowel by stress interaction also indicated significance of the effect on duration by word final position ($X^2(4) = 26.484$, $p<0.0001$***). Therefore, further likelihood ratio tests were performed with additional models, accordingly to each vowel. The further tests demonstrate that there exists significance of duration difference for every vowel (see table 5). However, such results do not directly suggest any (Welsh) language internal word final lengthening effect. In other words, residual stress related effects from the Old Welsh Accent Shift. It is difficult to disentangle

cross linguistic effect of word/phrase edge lengthening from the significance seen here. Further evaluations will be made in the discussion section subsequently (see section 5.1).

4.4 RMS energy

Figure 5: Mean RMS energy bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

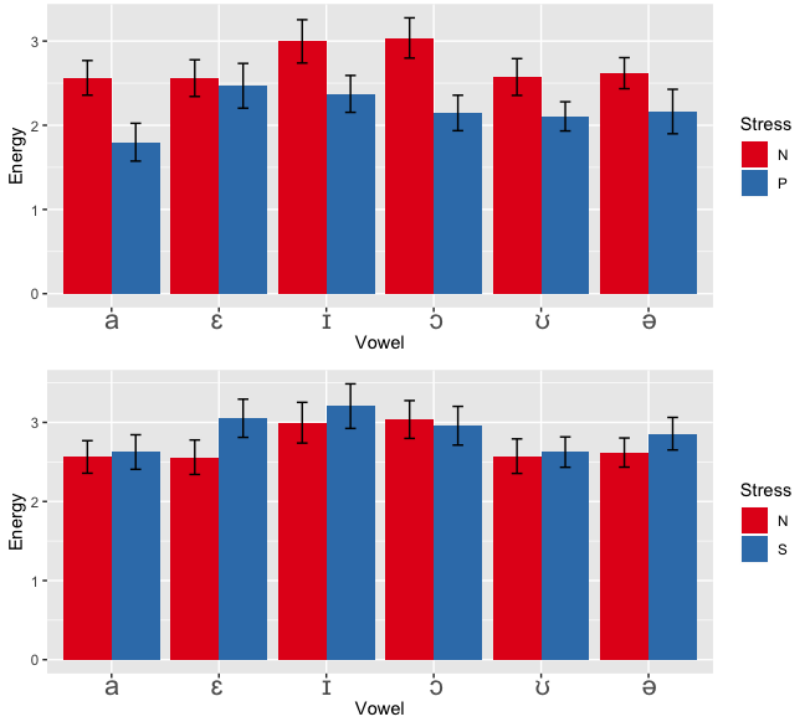


Figure 6: Mean RMS energy bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U - ultima).

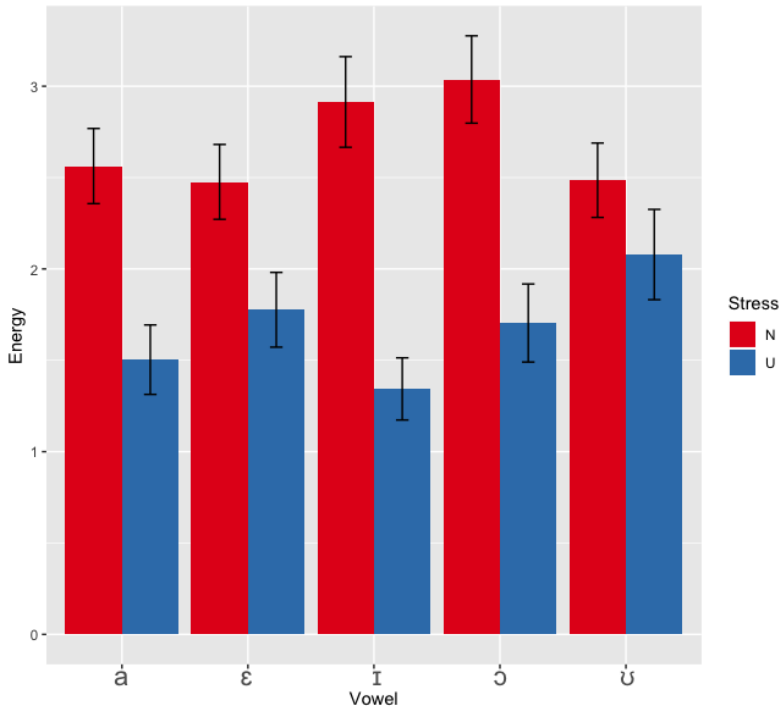


Table 6 Mean RMS energy for ultima vowels and unstressed vowels, *t*-values taken from linear mix effect model output, X^2 values and p-values adapted from likelihood ratio tests output (for standard deviation see parenthesis).

Vowels	Ultima	No stress	*t*-values	χ^2-values	*p*-values
/ɪ/	1.34(1.32)	2.91(1.86)	-2.51	$X^2(1) = 4.54$	<0.03*
/ɛ/	1.78(1.58)	2.48(1.56)	-3.61	$X^2(1) = 6.70$	<0.01**
/a/	1.50(1.45)	2.56(1.58)	-3.00	$X^2(1) = 5.55$	<0.02*
/ɔ/	1.70(1.64)	3.04(1.84)	-4.07	$X^2(1) = 7.50$	<0.006**
/ʊ/	2.08(1.91)	2.49(1.52)	-0.62	$X^2(1) = 0.47$	0.49
Overall	1.68(1.60)	2.70(1.68)	-2.89	$X^2(1) = 5.39$	<0.02*

Figure 5 demonstrates the mean RMS energy values of stressed (primary and secondary) and unstressed vowels. There was no significant effect for both primary and secondary stress found ($X^2(1) = 2.379$, $p= 0.12$, for primary stress) ($X^2(1) = 0.880$, $p= 0.35$, for secondary stress). Furthermore, figure 5 suggests contradictory effect between primary and secondary stress on RMS energy.

Figure 6 shows significant results when comparing unstressed and word ultima RMS energy across vowels ($X^2(1) = 5.389$, $p<0.02$*). A likelihood ratio test of this effect showed significant results with a vowel by word position interaction in the model ($X^2(4) = 19.184$, $p<0.0007$***) (see table 6). Likelihood ratio test for each vowel gave significant result, except for the vowel /ʊ/.

4.5 Formant heights (first and second formants)

Figure 7: Mean F1 (Hz) bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

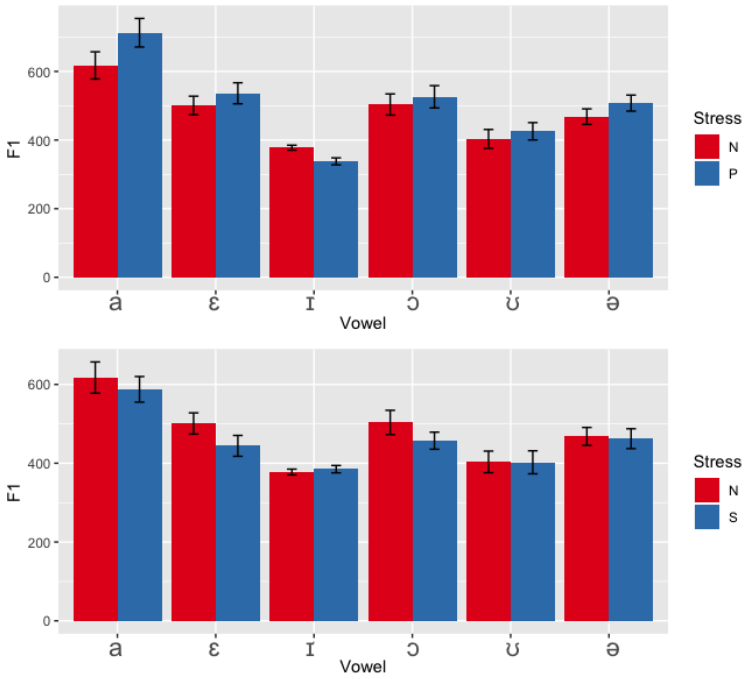


Figure 8: Mean F1 (Hz) bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U - ultima).

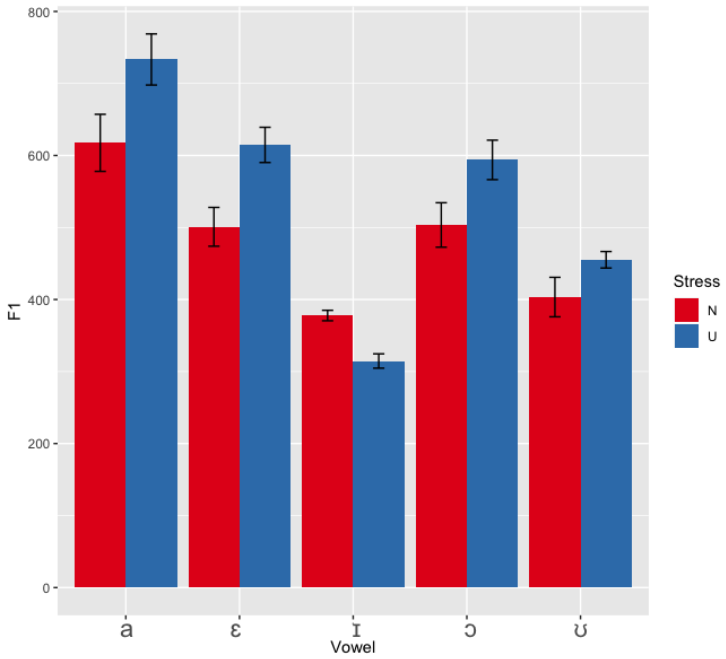


Figure 7 shows mean F1 (Hz) for the effect of stress between stressed and unstressed vowels. Overall, primary stressed vowels have higher F1 values in comparison to unstressed, and secondary stressed vowels have lower F1 values for stressed vowels. Vowel /ɪ/ showed opposite effect within different stress levels. However, likelihood ratio tests did not indicate significance for effect of stress for both stress levels in either direction ($X^2(1) = 0.67$, $p = 0.41$, for primary stress), ($X^2(1) = 0.44$, $p = 0.51$, for secondary stress). Moreover, models fitted with vowel by stress interactions did not improve model fit for both stress conditions ($X^2(5) = 4.34$, $p = 0.50$, for primary stress), ($X^2(5) = 1.70$, $p = 0.89$, for secondary stress).

Vowels at word ultima positions have overall higher F1 values than unstressed (similar tendency with primary stress, see figure 7 and 8). No significant improvement of model fit was achieved for potential effect of ultima position on F1 ($X^2(1) = 2.06$, $p = 0.15$).

Figure 9: Mean F2 (Hz) bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

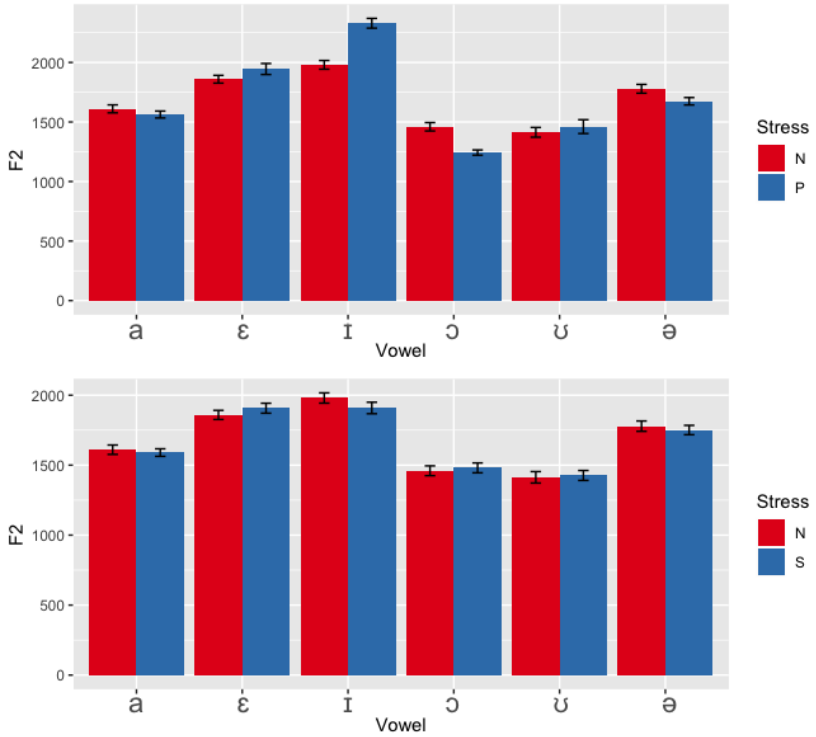


Figure 9 depicts mean F2 values for stressed and unstressed vowels. A likelihood ratio test did not find overall significance for the effect of stress for both primary and secondary stress ($X^2(1) = 0.004$, $p = 0.95$, for primary stress), ($X^2(1) = 0.12$, $p = 0.74$, for secondary stress). However, likelihood ratio test with vowel by stress interaction for primary stress significantly improved model fit, which suggests that there exists significant effect of stress on F2 for some vowel(s) ($X^2(5) = 25.46$, $p<0.0001$***). Therefore, within vowel comparisons were made for each vowel (see table 7). Contrarily, there was no significance by adding vowel by stress interaction for secondary stress ($X^2(5) = 1.28$, $p = 0.94$).

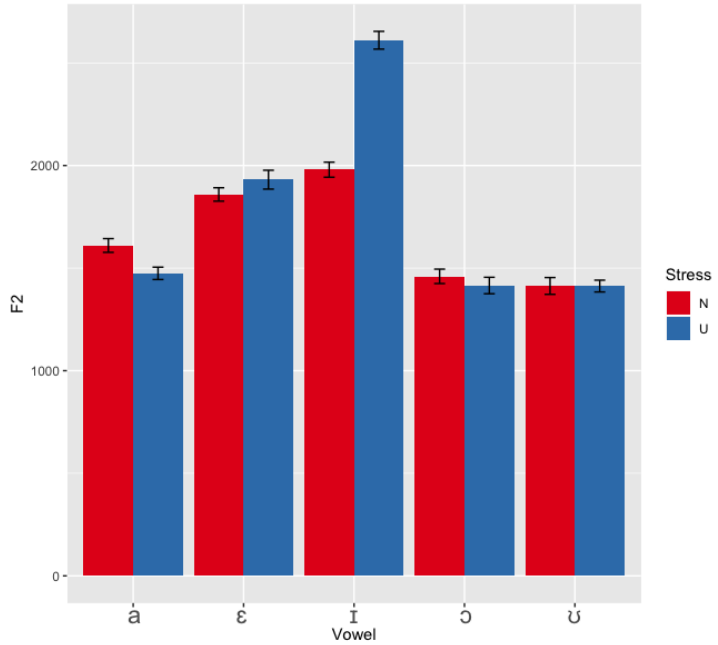
Table 7 Mean F2 (Hz) for vowels with primary and no stress, *t*-values taken from linear mix effect model output, X^2 values and p-values adapted from likelihood ratio tests output (for standard deviation see parenthesis).

Vowels	Primary stress	No stress	*t*-values	χ^2-values	*p*-values
/ɪ/	2329.02(317.84)	1979.75(283.85)	4.79	$X^2(1) = 8.63$	<0.003**
/ɛ/	1944.88(357.96)	1858.92(252.80)	1.27	$X^2(1) = 1.60$	0.21
/a/	1562.46(225.07)	1610.32(259.49)	-1.04	$X^2(1) = 1.12$	0.29
/ɔ/	1243.05(170.24)	1459.86(271.94)	-5.27	$X^2(1) = 9.16$	<0.002**
/ʊ/	1460.96(441.89)	1413.04(309.15)	0.51	$X^2(1) = 0.31$	0.58

/ə/	1674.13(240.60)	1778.69(285.82)	-2.26	$X^2(1) = 4.49$	<0.03*
Overall	1703.77(464.77)	1685.70(344.21)	-0.08	$X^2(1) = 0.004$	0.95

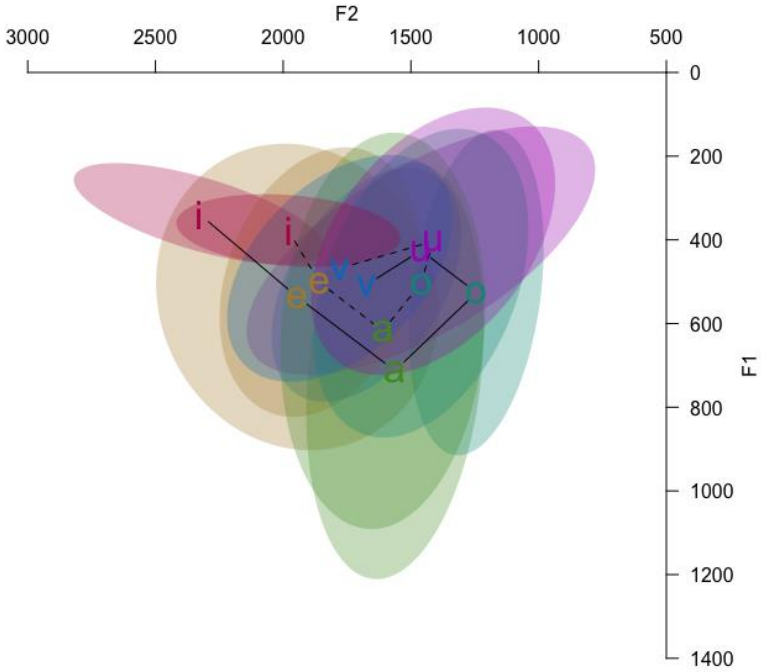
Within vowel comparison indicates when vowel /ɪ/ is primary stressed, its F2 is significantly higher; where vowel /ɔ/ and /ə/ showed significant lowering of F2 when primary stressed (see table 7).

Figure 10: Mean F2 (Hz) bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U - ultima).



Likelihood ratio test did not show improvement of model fit by effect of word ultima position on F2 ($X^2(1) = 3.07$, $p = 0.08$).

Figure 11: Vowel plot for primary and unstressed vowels (i- /ɪ/, e- /ɛ/, o- /ɔ/, u- /ʊ/, v- /ə/; Primary stress – solid line; Unstressed – dotted line).



Although there was only statistical significance for primary stress's effect on F2 for three vowels, figure 11 shows an overall consistent pattern of centralisation in vowel space for unstressed vowels (except for the vowel /ʊ/). Note that centralisation is most effective on more peripheral vowels according to figure 11, such as the vowels /ɪ/, /ɔ/ and /a/. A more comprehensive review of this centralising effect will be given in the discussion section (see section 5.5).

4.6 Voice quality (CPP and H1*-H2*)

Figure 12: Mean CPP bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

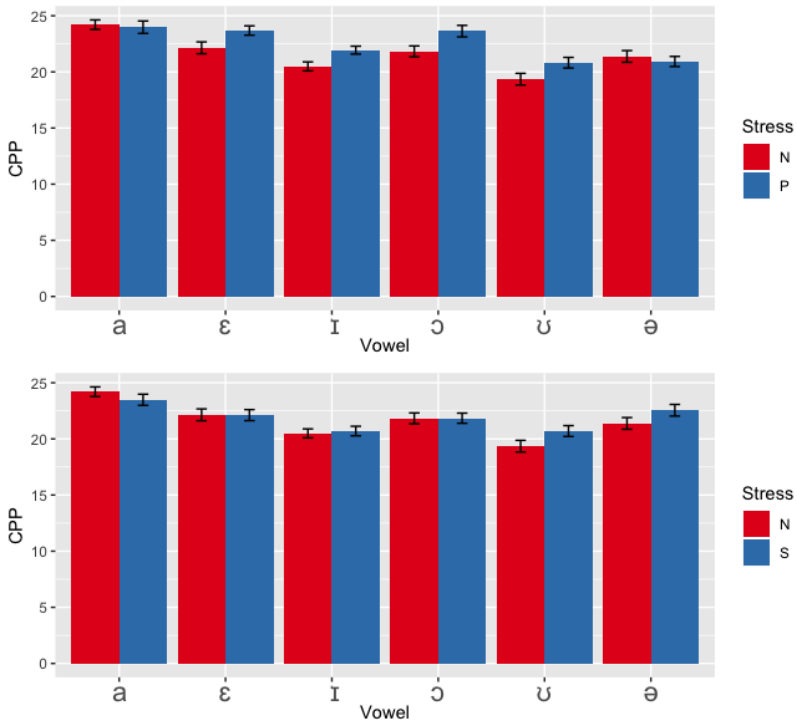


Figure 12 shows inconsistent effect of stress on CPP values. For primary stress, CPP values are higher for front and back vowels (/ɛ/, /ɪ/, /ɔ/ and /ʊ/) but not central vowels such as /a/ and /ə/ (see upper panel in figure 12). This indicates that vowels that bear primary stress are slightly noisier than when unstressed. No significance was found in the likelihood ratio test for stress as a fixed effect for primary stress ($X^2(1) = 2.98$, p= 0.08). Secondary stress showed less variations in CPP values between stressed and unstressed vowels, likelihood ratio test indicated no significance for the effect of stress ($X^2(1) = 3.53$, p= 0.06). Furthermore, adding a vowel by stress interaction in the model did not improve model fit for both stress levels ($X^2(5) = 7.45$, p= 0.19 for primary stress), ($X^2(5) = 3.12$, p= 0.68 for secondary stress). Figure 13 shows similar inconsistency for the effect of word position on CPP values, and likelihood ratio test indicated no significance for the effect of word ultima position on CPP measurements ($X^2(1) = 0.32$, p= 0.57).

Figure 13: Mean CPP bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U - ultima).

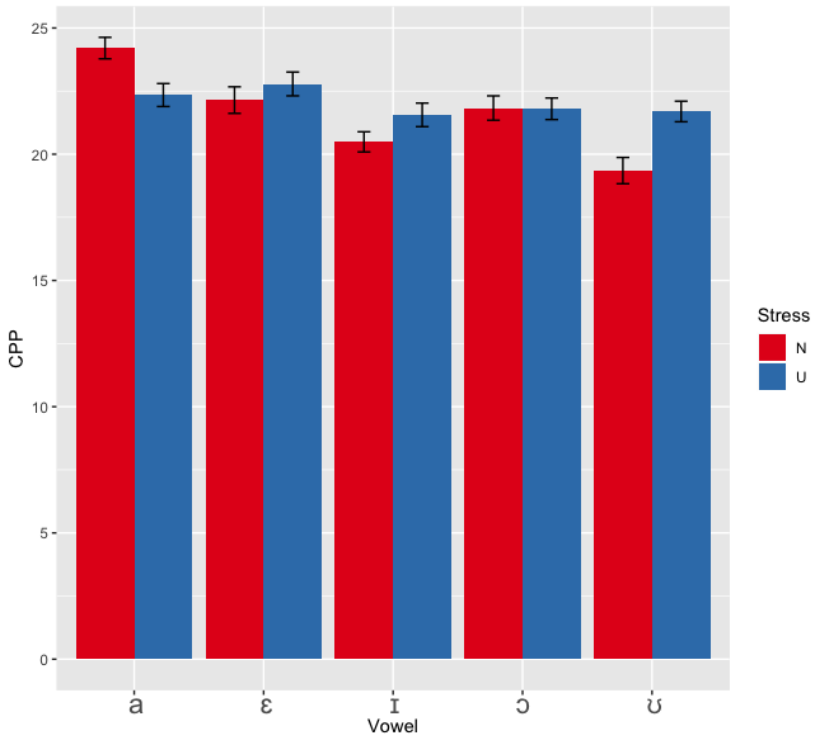


Figure 14: Mean H1*-H2* (dB) bar plot by vowel for primary (upper) and secondary (lower) stress. Error bars indicate standard error of the mean (N - no stress; P - primary stress; S - secondary stress).

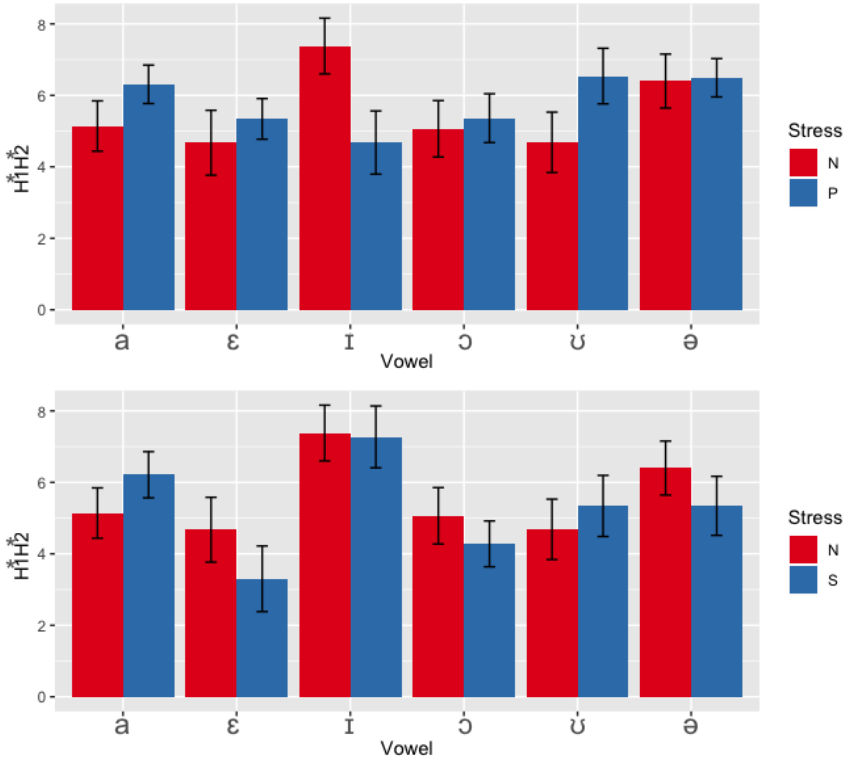


Figure 15: Mean H1*-H2* (dB) bar plot by vowel for ultima and unstressed vowels. Error bars indicate standard error of the mean (N - no stress; U - ultima).

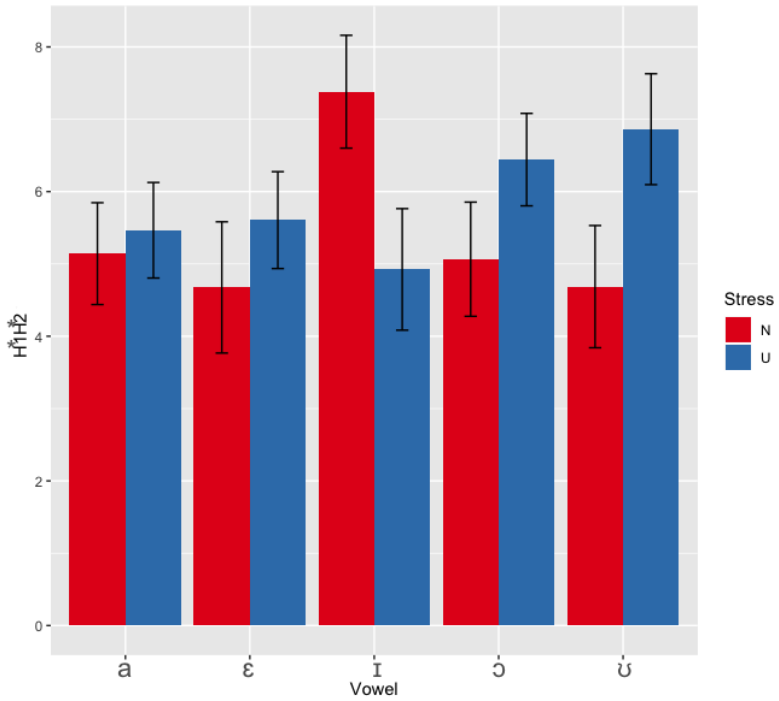


Figure 14 depicts mean values of H1*-H2* for each vowel under different stress conditions. There is more regular positive effect of stress on H1*-H2* values for primary stress (excluding the vowel /ɪ/) compare to secondary stress. However, no statistical significance was found for either stress level ($X^2(1) = 0.33$, $p= 0.57$ for primary stress), ($X^2(1) = 0.07$, $p= 0.78$ for secondary stress). Figure 15 shows mean values of H1*-H2* between word-final vowels and unstressed vowels. A parallel observation can be made between primary stress and ultima by looking at figure 14 and 15. Similarly, the function of word-final position did not have a significant effect on H1*-H2* measurements according to a likelihood ratio test ($X^2(1) = 0.17$, $p=$ 0.0.68).

The relatively large standard errors for H1*-H2* in this case may be due to considerable variations between speakers' voice quality, and complications from the carrier sentence chosen for this study (the later account for ultima only). There was noticeable difference in voice quality among speakers, which was observed in the spectrogram during labelling. Specifically, spectrogram of the raw data suggests that speaker two's voice quality was creakier overall, and speaker three's voice quality was categorically breathier.

5 Discussion

5.1 Duration as main effect of word stress in Southern Welsh

The present study investigates which acoustic parameters are used to encode word-level stress in Southern Welsh, as well as the acoustic characteristic of the ultima vowel in the interest of the Old Welsh Accent Shift. Results showed that duration serves as the most robust cue to primary stress in Southern Welsh. Such finding is consistent with most studies done on word stress cross linguistically, in that duration serves as a cue to stress. Extensive research shows that duration is used to signal stress in languages such as English (Fry, 1955), Dutch (Sluijter & van Heuven, 1996b), German (Aronov & Schweitzer, 2016), Tongan (Garellek & White, 2015),

Turkish Kabardian (Gordon & Applebaum, 2010), Spanish (Ortega-Llebaria & Prieto, 2010), Persian (Sadeghi, 2017), Catalan (Ortega-Llebaria & Prieto, 2010), and Uyghur (Yakup & Sereno , 2016). This effect was not significant for the vowel schwa, which corroborates with the findings of later research by Williams, it seems that duration of the schwa in Welsh does not vary significantly according to stress (Williams, 1999).

Interestingly, this result contradicts that of Williams's study on Welsh stress, in which she concluded that stressed penultimate vowels are marked by shorter duration (Williams, 1983). As discussed in earlier section, Williams compared stressed syllables to other syllables. Therefore, this observation most likely came from comparison of stressed vowels to vowels at word-edge positions. Indeed, when compared to unstressed vowels, primary stressed vowels are longer overall by around 39 ms and ultima vowels by 65 ms (see section 4.3). Since this study used the same data set for unstressed vowels for both comparisons, ultima vowels are longer than primary stressed vowels by about 26 ms.

However, longer duration in the ultima vowel is not unique to Welsh, final lengthening effects have been confirmed by a wide array of research such as Cambier-Langeveld (1997) for Dutch; Xu & Wang (2009) for Mandarin, Crystal & House (1988), Cooper, Paccia & Sorensen (1977), Byrd (2000), Cho (2006) and Nakatani, Aston & O'Connor (1981) for American English. Thus, longer duration in the ultima position in Welsh is most likely to be due to the effect of word-final lengthening.

A final note is that although there exists a length contrast in Welsh's vowel inventory, they are only contrastive in monosyllabic words (for details see section 2.1). This indicates that perceptual distinctiveness between long and short vowels is required only when they both bear primary stress. Thus, the use of duration to signal stress would not degrade perceptual distinctiveness, since there is no interaction between long and short vowels in stressed and unstressed conditions (i.e. instances where a short vowel is stressed, and a long vowel is unstressed).

5.2 F0 and stress in Southern Welsh

Surprisingly, fundamental frequency seems to show the opposite effect of stress when compared with research done on other languages – primary stressed vowels have significantly lower F0 overall when compared to unstressed vowels. Most literature and research suggest enlarged F0 excursions for stressed syllable, in other words, raising of pitch. Such languages include Indonesian (Adisasmito- Smith & Cohn 1996), Dutch (Sluijter & van Heuven 1996a), Turkish Kabardian (Gordon & Applebaum, 2010), Persian (Sadeghi, 2017), Tashlhiyt Berber (Gordon & Nafi, 2012) and English (Fry, 1958).

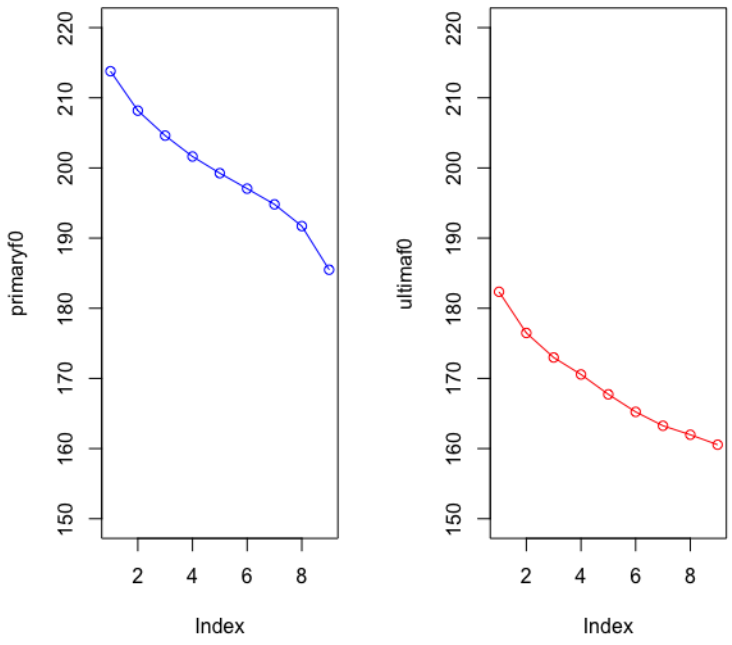
Unlike duration, cross linguistic research shows that correlation between F0 and stress is more inconsistent. Studies done in some languages suggest that F0 does not correlate with stress, or at least not strongly. For example, pitch does not seem to cue stress in British and Irish English (Kochanski, Grabe, Coleman & Rosner, 2005), Israeli Hebrew (Silber-Varod, Sagi & Amir, 2016), Kuot (Lindström & Remijsen, 2005), Uyghur (Yakup & Sereno , 2016) and Pirahã (Everett 1998). For Chickasaw, it was found that pitch is used to distinguish stress status between long vowels but not short vowels (Gordon, 2004). Moreover, change in F0 of the stressed syllable manifests differently according to sentential position (accented and unaccented). It is suggested that raising of pitch in stressed syllables is strongly associated with the on-focus word in a sentence. Huss (1978)'s study suggests that in English, significant

difference in pitch between syllables without and without stress only exists in words that are on focus. More recent research in Northern American English also found that F0 has a weak correlation with stress when unaccented (Plag, Kunter & Schramm, 2011).

The present study used words that are in nuclear position in the carrier sentence. Therefore, it is plausible that the overall lower F0 in stressed vowels may indicates a F0 lowering effect of stress in Welsh. Such finding is not contradictory to Williams's results – lack of F0 raise in stressed syllables (Williams, 1983). Lowering effect of pitch in stressed vowels would not be unique to Southern Welsh. Similar results have been found in Czech, where stressed syllables have lower pitch than unstressed, and are accompanied by a 'post-stress rise (L*-H)' (Volín, 2008; Volín & Weingartová, 2014, p.181).

This study also shows that mean F0 of ultima vowels is significantly lower than unstressed vowels, more so than their stressed counterparts. A vast array of literature on Welsh and Williams's research argue that the ultima in Welsh is accompanied by higher F0 (Williams & Ball, 2001).

Figure 16: F0 plot with each mean 1/9 measurements of the primary stressed vowels (left panel), and vowels at ultima positions (right panel).



To determine whether there exists a stress induced pitch lowering effect in the language, F0 contours of the vowel integral of the stressed penult and the ultima were plotted (see figure 16). Figure 16 shows consistent lowering of pitch from the onset of the stressed penultimate vowel to offset of the ultima vowel. Note that there are no visible peaks or valleys in the F0 trajectory for the stressed or ultima vowel. Thus, this study's finding indicates that perhaps there is little or no correlation between stress and F0 in Southern Welsh, and the ultima vowel does not seem to bear pitch prominence. In fact, such finding corresponds with results from Williams's research, in regard to F0 for primary stress. Specifically, it was found that a superimposed flat

F0 contour on the stressed nasal coda did not affect stress perception (Williams, 1983).

An alternative explanation to the later might be due to the carrier phrase used in this study - [dəuˈɛdʊχ ə ˈgai ___ ɪ ˈvɪ]. Recall that in order to avoid coda consonants' influence on the target vowels, target vowels were mostly in open syllables (except for the vowel /ɛ/ and /ʊ/ for ultima vowels). Consequently, around 60% of data reflects F0 in ultima vowels that directly precede the function word 'i' (IPA: /ɪ/) ('for' in English), and are subject to glottal epenthesis. Glottal epenthesis here refers to when a glottal stop/glottalisation is introduced between two successive vowels, which has been observed in English (Hayes, 2009). Studies found that with glottalisation, a drop of F0 is commonly present, as perturbation of pitch can efficiently signal glottalisation (Dilley, Shattuck-Hufnagel & Ostendorf, 1996; see figure 17).

Figure 17: lowering of f0 accompanied by glottalisation

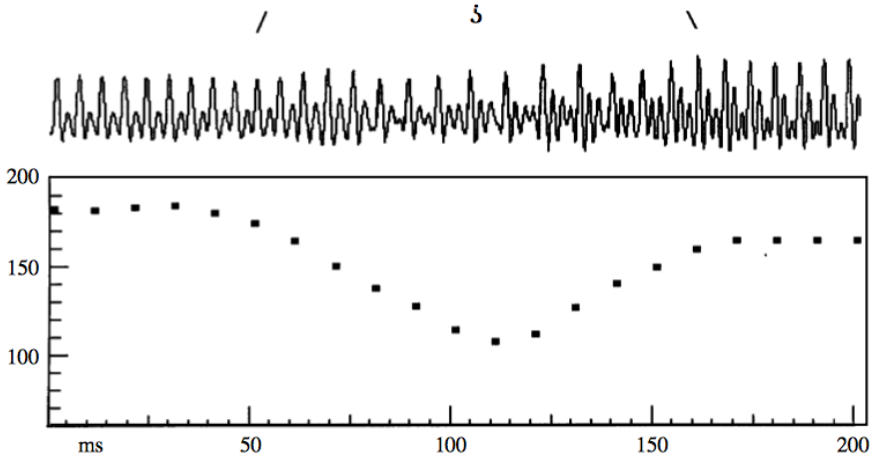


Figure 3. Dip in f_0 between two vowels results in perception of glottalization. Shown here is a portion of policy *ʒ is*, where "ʒ" indicates glottalization.

(Dilley, Shattuck-Hufnagel & Ostendorf, 1996, p.429)

5.3 Acoustic measures of secondary stress with linear discriminant analysis (LDA)

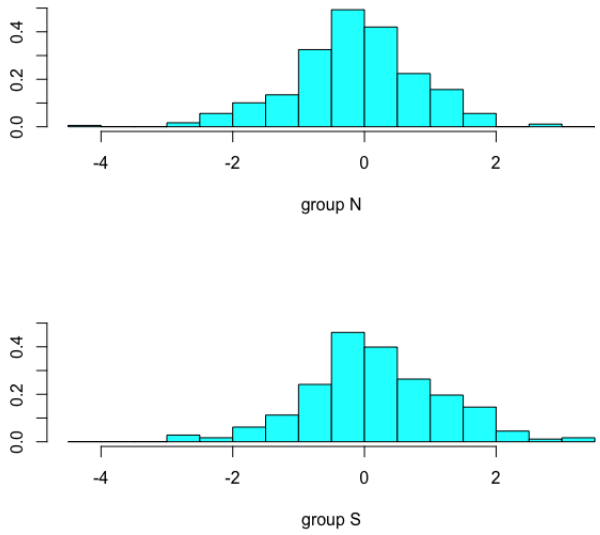
In this study, no statistical significance was reached in the measurements used for secondary stress. Therefore, in order to determine which acoustic measure best distinguishes secondary stressed and unstressed vowels, a linear discriminant analysis (LDA) was performed. As table 8 shows, although RMS energy has the highest value in comparison to other acoustic parameters, Figure 18 shows major overlapping of values for discriminant functions (acoustic measurements) between the secondary stress and no stress groups. Thus, it is possible that there is little to no phonetic signal for secondary stress in Southern Welsh. Similar discoveries were found for Turkish Kabardian (Gordon & Applebaum, 2010). Research in Indonesian also revealed varied phonetic manifestations in secondary stress across speakers (Adisasmito-Smith & Cohn, 1996).

Table 8 LDA output - coefficients of measurements as discriminant functions.

	Secondary stress
Duration	-0.008

F0	0.039
RMS energy	0.367
F1	-0.002
F2	-0.0004
CPP	0.100
H1*-H2*	0.037

Figure 18: Stacked histogram of LDA output between no stress (group N) and secondary stress (group S).



5.4 Welsh stress and intensity

It has been shown from previous research that intensity is often used to signal stress in many languages – such as Chickasaw (Gordon, 2004), English (Fry, 1955 &1958; Plag, Kunter &Schramm, 2011), Turkish Kabardian (Gordon & Applebaum, 2010), Indonesian (Adisasmito-Smith & Cohn, 1996) and Castilian Spanish (Ortega-Llebaria & Prieto, 2010). The absence of RMS energy as a function of primary stress seems unexpected at first (see section 4.4). Since research for the five languages mentioned above all indicate a positive correlation between stress and intensity. However, such findings may be related to how F0 is related/unrelated to stress in Southern Welsh. Particularly, Southern Welsh does not use F0 to encode stress, and pitch is consistently lower in primary stressed vowels than unstressed vowels (see section 4.2).

Alku, Vintturi & Vilkman (2002) investigated the relationship between raising of F0 and intensity in human speech. They found a positive linear relationship between pitch and intensity, specifically, speakers raise F0 while trying to increase loudness. This is because speakers enhance acoustic energy by increasing their sub-glottal pressure, which influences ‘individual glottal pulse’ (amplitude) and ‘the rate of repetition of consecutive glottal pulses’ (F0) (Alku, Vintturi & Vilkman, 2002,

p.322). Indeed, stress induced pitch raise and increased energy are commonly observed in tandem, such as in the aforementioned languages.

Volín & Weingartová (2014) suggested that Dutch speakers tend to produce stress in a L2 with pre-existence acoustic cues in their native language. They measured sound pressure level (SPL) in Dutch speaker's production of stressed syllables in English and found that there was little difference of SPL values between stressed and unstressed vowels. Recall that in Dutch, F0 of the stressed syllables is decreased in primary stressed vowels (Volín, 2008). The same rationale can be applied to why ultima vowels also have significantly lower energy values compared to unstressed vowels, more so than primary stressed vowels. Recall that F0 in ultima vowels are lower than that in primary stressed penult. Note also that although pitch and intensity are lower in stressed vowels for both Southern Welsh and Dutch, such observation is related to stress in Dutch and not in Welsh. Therefore, data in this study suggests that lower RMS energy values of primary stressed vowels may be a result of the irrelevance between F0 and stress in the language.

5.5 Centralisation of vowel space in Southern Welsh

Results in this study show that vowel space for unstressed vowels is subject to reduction in comparison to primary stressed vowels, especially regarding F2. Vowel reduction in unstressed syllables is a common phonological process in many languages (Crosswhite, 2001). Yet, if a language does not have a formal vowel reduction process phonologically, such as in Southern Welsh, a phonetic realisation of centralisation in unstressed vowels can still be expected (Flemming, 2005; Garellek & White, 2015). Such phenomenon is associated with what is called 'phonetic undershoot' (Garellek & White, 2015, p.26). There are many related theories which can explain the reason behind 'undershoot'. For example, the 'Hyper-and Hypoarticulation' theory mentioned previously, the 'Articulatory Phonology framework' and the 'Parallel encoding and target approximation model (PENTA)' (Garellek & White, 2015, p.26; Xu, 2005).

All three theories associate 'undershoot' of unstressed vowels with the decrease in duration of unstressed vowels. Duration of unstressed vowels in Southern Welsh is evidently shorter than primary stressed vowels (see section 4.3 and 5.1). It is believed that when duration is shortened, articulatory targets may not be entirely realised (Garellek & White, 2015). One of the crucial mechanisms in speech according to the PENTA model is temporal alignment of the articulation process with syllables as units, or in other words 'syllable-synchronised target approximation' (Xu, Prom-on & Liu, 2015, p.4). Therefore, when articulatory targets are assigned (in this case-formant heights), shorter duration would lead to premature termination of the target approximation process (Xu, Prom-on & Liu, 2015) – such as phonetic undershoot in the vowel space for unstressed vowels.

Figure 11: (i- /ɪ/, e- /ɛ/, o- /ɔ/, u- /ʊ/, v- /ə/; Primary stress – solid line; Unstressed – dotted line).

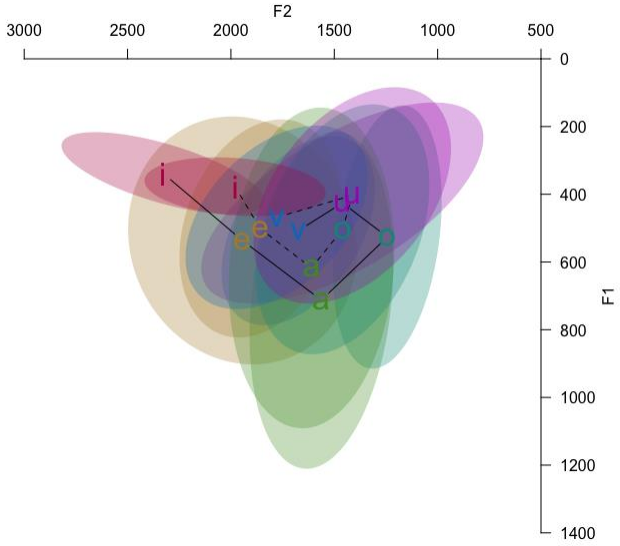


Figure 11 depicts the overall vowel space for all speakers under primary stressed and unstressed conditions (repeated here for convenience). Statistical analysis and visual inspection of figure 11 suggest a stronger horizontal reduction pattern then vertical (centralising for the second formant). Therefore, vowel reduction for unstressed vowels in Southern Welsh appears to merge contrasts in terms of frontness and backness. As section 1.1 shows, there is an additional contrast of roundness between front and back vowels in Welsh, which further lowers F2 values of the back vowels and enhances distinctiveness. This additional feature aids vowel dispersion in terms of back and front vowels. Such language specific typological characteristics could explain the reduction pattern at hand in Southern Welsh.

On the other hand, if the tongue height contrast of front and back vowels is reduced in unstressed vowels, perceptual distinctiveness may be compromised. Note that the unstressed vowel /a/ has been shifted upwards (in F1) more than other vowels in the language. Such observation further corroborates the rationale above, as there exists no open-mid vowels in Welsh's phonemic inventory. Therefore, raising in F1 for unstressed /a/ is less detrimental in regard to perceptual distinctiveness. Overall, in Southern Welsh, effect of vowel reduction as a function of stress is consistent with findings in other languages such as German (Mooshammer & Geng, 2008), Dutch (Bergem, 1993), Greek (Lengeris, 2012) and English (Crosswhite, 2001). However, such effect is not as potent as vowel reduction found in other languages. For example, Mooshammer and Geng (2008) found substantial reduction in vowel space (F1 and F2) for unstressed vowels (lax and tense) in German, although vowel inventory in Welsh is similar to that in German. This could be due to the fact that stress is non-contrastive in Welsh, and there is less incentive for an extensive reduction in vowel space to cue stress, similar of that for Turkish Kabardian (Gordon & Applebaum, 2010). Note that German also has non-contrastive stress. However, length (or lax and tense) contrasts serve as a distinctive feature not just in monosyllabic words, unlike in Welsh. This additional feature aids vowel dispersion, which may compensate for vowel reduction in the language.

5.6 Spectral-tilt and stress in Southern Welsh

According to Garellek & White (2015)'s paper on Tongan stress, CPP values can help interpret H1*-H2* results. If a higher H1*-H2* value is observed in conjunction with a high CPP value, a more modal voice quality can be presumed; if a high H1*-H2* value is observed with low CPP values, a breathier voice can be assumed. Additionally, low H1*-H2* values are typically associated with creaky voice.

Although Figure 12 and 14 show that primary stressed vowels have slightly higher values in CPP and H1*-H2* (except for vowel /ɪ/ and /ə/), no statistical significance was found for measurements of voice quality in this study. The use of spectral tilt to signal stress is controversial cross linguistically. In languages such as Persian (Sadeghi, 2017), British English (Kochanski et al, 2005), Swedish (Heldner, 2003), Spanish and Catalan (Ortega-Llebaria & Prieto, 2010), spectral tilt is said to be correlated with sentential accent instead of stress. Therefore, further research with different measurement method under different accentual conditions may help clarify the relationship between spectral balance and stress in Southern Welsh – such as comparing high and low frequency bands in the spectrum between stressed and unstressed vowels (used in Sluijter & van Heuven, 1996a for Dutch).

6 Conclusion

The aim of this study was to investigate which acoustic cues are used in the production of stressed vowels in Southern Welsh. In addition, this study attempted to verify some of the conventional beliefs with regard to vowels at the ultima position. The results suggest that primary stressed vowels in the language have longer duration, lower F0, lower energy and expanded vowel space when compared to unstressed vowels. However, the present study indicates that decrease in pitch and energy is not directly correlated with stress in Southern Welsh. For vowel reduction in unstressed vowels as a function of stress, there is a more significant horizontal reduction than vertical. The effect of F0 lowering is absent for secondary stressed vowels, which might have contributed to the finding of slightly higher energy in secondary stressed vowels. No significant effects of stress were observed for secondary stress. Perhaps there exists little phonetic evidence for secondary stress in the language.

Regarding ultima vowels, current results contradict with some previous research. Specifically, vowels at word final positions have lower F0 and energy. However, findings regarding the relationship between F0 and stress are consistent with results in the Williams (1983) study – little correlation between F0 and stress in the Welsh language. Although ultima vowels do have longer duration as earlier research indicates, it is difficult to determine whether it is due to language internal reasons or the cross linguistic phenomenon of word-edge/final lengthening.

Results in measurements for spectral tilt showed inconsistent patterns. Therefore, further research is needed to clarify the effect of stress on voice quality in the language. Moreover, this study focused on stress manifestation for sentential accented words. To better understand how stress is encoded in Welsh, further research is called for in order to disentangle acoustic effects associated with stress induced prominence with accent induced prominence.

Appendix: complete word list used for the experiment with IPA transcription

Primary	Gloss	Secondary	Gloss

/a/		**/a/**	
[ˌkaraˈvanav]	to rail	[arˌðaŋɔˈsɪðəl]	demonstrable
[ˌdɪvɛˈθadʊi]	Condemned to death	[ɛsˌgalaˈdɪrɔn]	escalator
[ˌgʊlɛˈðabɛrθ]	feast	[aˌrałʊˈladɔg]	foreign
[ˌɛsgaˈladɪr]	escalator	[pɛnˌdramʊˈnʊgləg]	headlong
[ˌkədʊˈladəl]	international	[əmˌðaŋɔˈsɪadɛ]	appearance
/ɛ/		**/ɛ/**	
[ˌgɔgɔˈnɛðʊχ]	glory	[pɛrˌχɛnɔˈgaiθɛ]	ownerships
[ˌtəŋɛdˈvɛnəl]	fateful	[prɛˌsɛnəlˈdɛbɛ]	attendances
[ˌəsgrɪˈvɛnɪð]	secretary	[kəˌfrɛdɪˈnəldɛb]	generality
[ˌkəvanˈhɛðʊχ]	friendship	[haˌnɛdɪˈvarɪs]	unrelenting
[ˌəmarˈvɛrɛð]	practice	[bɛˌnɛðɪˈgɛsɛ]	ladies
/ɪ/		**/ɪ/**	
[ˌdadanˈhɪðɔ]	to uncover	[amˌðɪfəˈnɛdɪg]	protected
[klaˈsɪrəl]	classical	[χʊrˌlɪgʊˈganəd]	Merry-go-round
[kəˈsɪlav]	advise	[kəvˌrɪvəlˈdɛbɛ]	responsibility
[ˌpɛntaˈfɪlən]	creeping cinquefoil	[əsˌgrɪvɛˈnɛdɪg]	written
[ˌbɛnɛˈðɪgɛs]	lady	[əsˌgrɪvɛˈnəðɛs]	female secretary
/ɔ/		**/ɔ/**	
[ˌkəvanˈsɔðɪ]	to compose	[anˌvɔnɛˈdɪgɪən]	missionary
[ˌpɛrχɛˈnɔgɪ]	to own	[əˌmɔsɔˈdɪadɛ]	attacks
[ˌarðəˈvɔdəl]	future	[aˌłɔraˈðɔlɪad]	alter-worship
[ˌpəθɛvˈnɔsəl]	fortnightly	[gɔˌsɔdɛˈdɪgəl]	enacted
[ˌarðaˈŋɔsʊr]	demonstrator	[prəˌfɔdɔˈlaiθɛ]	predictions
/ʊ/		**/ʊ/**	
[kasˈłʊχʊr]	Loughor	[kəˌdʊlaˈdəldɛb]	internationalism
[ˌχʊrlɪˈgʊgan]	Merry-go-round	[aˌmʊrɛˈgəsɛ]	griddles
[ˌaraˈłʊlad]	alien	[gɔˌrʊrɛˈgəsɛ]	bracing-griddles
[pɛnˌdramʊˈnʊgəl]	head-over-heels	[r̥əˌŋʊlaˈdəlav]	to internationalise
[kaˈrʊrɪaiθ]	friendship	[əˌmʊrɛˈgəsɪ]	to dress oneself
/ə/		**/ə/**	
[əˌmʊrɛˈgəsɪ]	to dress oneself	[anˌr̥ədɛˈðɪsəl]	honourable
[ˌləvrgɛˈłəðəl]	pertaining to a library	[gɔˌłəŋɛˈdɪgaiθ]	discharging
[łəŋˈðrəłɪad]	shipwreck	[prɪvˌləθəˈrɛnɛ]	capital letters
[ˌprɪvləˈθərɛn]	capital letter	[tɛˌlənɔˈrɛsɛ]	female harpists
[ˌpɛndɛrˈvənəl]	determined	[aˌmənɛðˈgarʊχ]	patience

Ultima	Gloss	Unstressed	Gloss
/a/		**/a/**	
[ˌəsgrɪˈvɛnva]	desk	[ˌhanvaˈnɛgəl]	unexpressed
[ˌəmðaˈŋɔsva]	to honour	[ˌəmðaˈŋɔsɪad]	appearance
[ˌgʊrθrəˈvɛla]	to rebel	[ˌgramaˈdɛgəl]	grammatical
[aˈłɔrva]	alter	[ˌarðaˈŋɔsʊr]	demonstrator
[gɔˈsɔdva]	station	[ˌaraˈłʊlad]	alien
/ɛ/		**/ɛ/**	
[ˌardaˈləðɛs]	marchioness	[ˌłɪsɛrˈnɔrsav]	lamp station
[ˌəmarˈvɛrɛð]	practice	[ˌprɛsɛˈnəldɛb]	attendance
[ˌɛkɔˈnɔmɛg]	economics	[ˌsɛrɛˈmənɪ]	ceremony
[ˌprɪvləˈθərɛn]	capital letter	[ˌpɛrχɛˈnɔgɪ]	to own
[ˌbɛnɛˈðɪgɛs]	lady	[ˌbɛnɛˈðɪgɛs]	lady
/ɪ/		**/ɪ/**	
[ˌanr̥əˈdɛðɪ]	to honour	[ˌamðɪˈfənva]	sanctuary

[ˌgɔgɔˈnɛðɪ̯]	magnify	[ˌkəvrɪ̯ˈvɔldɛb]	responsibility
[ˌpɛndɛrˈvənɪ̯]	conclude	[ˌəsgrɪ̯ˈvɛdɪg]	written
[ˌsɛrɛˈmənɪ̯]	ceremony	[ˌχʊrlɪ̯ˈgʊgan]	merry-go-round
[ˌkəvanˈsɔðɪ̯]	to compose	[ˌəsgrɪ̯ˈvɛnɪð]	secretary
/ɔ/		**/ə/**	
[ˌdadanˈhɪðɔ̯]	to uncover	[ˌanvɔ̯ˈnɛdɪg]	missionary
[gɔrˈfʊiɫɔ̯]	be mad	[ˌəmɔ̯ˈsɔdɪad]	attack
[ˌarðəˈmɪnɔ̯]	desire	[ˌgɔsɔ̯ˈdɛdɪg]	set
[takˈlɪsɔ̯]	make neat	[ˌprəfɔ̯ˈdɔlaiθ]	prediction
[ˌkədʊˈladɔ̯l]	international	[ˌamɔ̯ˈdɛdɪg]	subjunctive
/ʊ/		**/ʊ/**	
[ˌgɔgɔˈnɛðʊ̯χ]	glory	[ˌamʊ̯ˈrɛgɪs]	griddle
[ˌarðaˈŋɔsʊ̯r]	demonstrator	[ˌkədʊ̯ˈladɔl]	international
[ˌanr̥əˈdɛðʊ̯r]	honourer	[ˌgɔrʊ̯ˈrɛgɪs]	bracing-griddle
[ˌkəvanˈhɛðʊ̯χ]	friendship	[ˌɟəŋʊ̯ˈladɔl]	international
[maˌθəmaˈtɛgʊ̯r]	mathematician	[aˌrałʊ̯ˈladɔg]	foreign
		/ə/	
		[ˌanr̥əˈdɛðɪs]	honourable
		[ˌgɔɫəˈŋɛdɪg]	released
		[ˌtɛləˈnɔrɛs]	female harpist
		[ˌanr̥əˈdɛðʊr]	honourer
		[ˌprɪvləˈθərɛn]	capital letter

References

Adisasmito-Smith, N. and Cohn, A. C., 1996. *Phonetic correlates of primary and secondary stress in Indonesian: A preliminary study*. Working Papers of the Cornell Phonetics Laboratory 11, pp.1-16.

Alku, P., Vintturi, J. and Vilkman, E., 2002. Measuring the effect of fundamental frequency raising as a strategy for increasing vocal intensity in soft, normal and loud phonation. *Speech Communication*. 38, pp.321–334.

Aronov, G. and Schweitzer, A., 2016. *Acoustic correlates of word stress in German spontaneous speech*, in Proceedings of Tagung Phonetik und Phonologie im Deutschsprachigen Raum.

Baayen, R. H., 2008a. *Analyzing linguistic data: A practical introduction to statistics using R*. Cambridge: Cambridge University Press.

Barr, D. J., Levy, R., Scheepers, C., and Tily, H. J., 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), pp.1-43

Bickley, C., 1982. Acoustic analysis and perception of breathy vowels. *MIT Speech Communication Working Papers*, 1, pp.73–83.

Bloch, B. and Trager, G. L., 1942. *Outline of Linguistic Analysis*. Baltimore.

Bloomfield, L., 1933. *Languages*. New York.

Boersma, P. and Weenink, D., 2009. PRAAT: Doing phonetics by computer (version 5.1.14). http://www.praat.org/ (30 August 2009).

Byrd, D., 2000. Articulatory vowel lengthening and coordination at phrasal junctures. *Phonetica*, 57, pp.3–16.

Cambier-Langeveld, T. *The domain of final lengthening in the production of Dutch*; in Coerts, de Hoop, Linguistics in the Netherlands 1997, pp. 13–24 (John Benjamins, Amsterdam 1997).

Cho, T. and Keating, P. A., 2009. Effects of initial position versus prominence in English. *Journal of Phonetics*, 37, pp.466–485.

Cho, T., & McQueen, J., 2005. Prosodic influences on consonant production in Dutch: Effects of prosodic boundaries, phrasal accent and lexical stress. *Journal of Phonetics*, 33, pp.121–157.

Cho, T., 2006. Manifestation of prosodic structure in articulation: Evidence from lip kinematics in English. In L. M. Goldstein, D. H. Whalen, & C. T. Best (Eds.), *Laboratory phonology*, Vol. 8: Varieties of phonological competence. pp. 519–548. Berlin/New York: Mouton de Gruyter.

Cooper, W., Lapointe, S., and Paccia, J., 1977. Syntactic blocking of phonological rules in speech production. *Journal of the Acoustical Society of America*, 61, pp.1314–1320.

Crosswhite, K., 2001. *Vowel reduction in Optimality Theory*. New York: Routledge.

Crosswhite, K., 2003. Spectral tilt as a cue to stress in Polish, Macedonian and Bulgarian. In M.- J. Sole, D. Recasens, and J. Romero (eds.), *Proceedings of the XVth International Conference of Phonetic Sciences*, 2, pp.767-770. Barcelona: Causal Productions.

Czerniak, T., 2015. *Welsh Vowels - Element Distribution and Interaction*. Pp.133-153.

Dilley, L., Shattuck-Hufnagel, S. and Ostendorf, M., 1996. Glottalization of word-initial vowels as a function of prosodic structure. J. *Phonetics*, 24, pp. 423–444.

Everett, K., 1988. Acoustic correlates of stress in Piraha. *Journal of Amazonian Languages*, 1, pp.104–162.

Flemming, E., 2005. *A phonetically-based model of vowel reduction*. Ms., MIT.

Fry, D. B. 1955. Duration and intensity as physical correlates of linguistic stress. *Journal of the Acoustical Society of America*, 27, pp.765–768.

Fry, D., 1958. Experiments in the perception of stress. *Language and Speech*, 1(2), pp.126–152.

Gandour, J. Potisuk, S. and Harper, M., 1996. Acoustic Correlates of Stress in Thai. *Phonetica*, 53. pp.200-20.

Garellek, M. and Keating, P., 2011. The acoustic consequences of phonation and tone interactions in Mazatec. *Journal of the International Phonetic Association*, 41. pp.185-205.

Garellek, M. and White, J., 2015. Phonetics of Tongan stress. *Journal of the International Phonetic Association*, 45(1), pp.13-34.

Gordon, M. and Applebaum, A., 2010. Acoustic correlates of stress in Turkish Kabardian. *Journal of the International Phonetic Association*, 40, pp.35–58.

Gordon, M., 2004. A phonological and phonetic study of word-level stress in Chickasaw. *International Journal of American Linguistics*, 70, pp.1–32.

Gordon, M., Nafi, L., 2012. Acoustic correlates of stress and pitch accent in Tashlhiyt Berber, *Journal of Phonetics*, 40 (5), pp.706-724.

Griffen, T. D., 1991/1992. Epenthesis and the Old Welsh Accent Shift. *Studia Celtica*, 26/27, pp.163-174.

Hannahs, S. J. 2013. *The Phonology of Welsh*. Oxford: Oxford University Press.

Hayes, B., 2009. *Introductory Phonology*. UK: Blackwell Publishing.

Heldner, M., 2003. On the reliability of overall intensity and spectral emphasis as acoustic correlates of focal accents in Swedish. *Journal of Phonetics*, 31, pp.39–62.

Hillenbrand, J., Cleveland, R.A. and Erickson, R.L., 1994. Acoustic correlates of breathy vocal quality. *Speech Lang. Hear. Res*. (37) pp.769–778.

Huss, V., 1978. English word stress in the post-nuclear position. *Phonetica*, 35,m pp.86–105.

Jones, D. M., 1949. The accent in modern Welsh. *Bulletin of the Board of celtic Studies*, 13, pp.63-64.

Jones, D., 1949. *An Outline of English Phonetics*. Leipzig.

Kawahara, H., Masuda-Katsuse, I., and de Cheveigné, A., 1999. Restructuring speech representations using a pitch adaptive time-frequency smoothing and an instantaneous-frequency-based f0 extraction: Possible role of a repetitive structure in sounds. *Speech Communication*. (27). pp. 187-207.

Kochanski, G., Grabe, E., Coleman, J., & Rosner, B., 2005. Loudness predicts prominence: Fundamental frequency lends little. *Journal of the Acoustical Society of America*, 118(2), pp.1038–1054.

Lengeris, A., 2012. *Phonetic vowel reduction in Standard Modern Greek.* The 10th International Conference of Greek Linguistics.

Lindblom, B., 1990. Explaining phonetic variation: A sketch of the H&H theory. In Williams J. Hardcastle & Alain Marchal (eds), *Speech and speech modelling*. Dordrecht: Kluwer. pp.403-439.

Mooshammer, C. and Geng, C., 2008. Acoustic and articulatory manifestations of vowel reduction in German. *Journal of the International Phonetic Association*. 38(2). pp.117-136.

Morton, J., and Jassem, W., 1965. Acoustic correlates of stress. *Language and Speech*. (8). pp.159–181.

Nakatani, L.H., O'Connor, K.D. and Aston, C.H., 1981. Prosodic aspects of American English speech rhythm. *Phonetica* , 38. pp.84–106.

Nooteboom, S. G., 1972. *Production and perception of vowel duration. A study of duration properties of vowels in Dutch*. Ph.D. thesis. Utrecht University.

Ortega-Llebaria, M., and Prieto, P., 2010. Acoustic correlates of stress in Central Catalan and Castilian Spanish. *Journal of Language and Speech*, 54(1), pp.73–97.

Plag, I., Kunter, G. and Schramm, M., 2011. Acoustic correlates of primary and secondary stress in North American English. *Journal of Phonetics*, 39. pp.362–374.

R Development Core Team. 2008. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing. http://www.R-project.org (14 January 2009).

Sadeghi, V., 2011. *Acoustic correlates of lexical stress in Persian*. Proceedings of the 17th International Congress of Phonetic Sciences, HongKong, pp.1738-1741.

Shue, Y-L., Keating, P., Vicenik, C. and Yu, K., 2011. VoiceSauce: A program for voice analysis. 17th International Congress of Phonetic Sciences (ICPhS XVII), Hong Kong, pp.1846–1849.

Silber-Varod, V., Sagi, H., & Amir, N., 2016. The acoustic correlates of lexical stress in Israeli Hebrew. *Journal of Phonetics*, 56(1), pp.1–14.

Sjölander, K., 2004. The Snack Sound Toolkit [computer program], http://www.speech.kth.se/snack/ (retrieved 15 July 2018).

Sluijter, A. M. C., 1995. *Phonetic correlates of stress and accent*. PhD thesis. University of Leiden.

Leiden.

Sluijter, A. M., & van Heuven, V. J., 1996b. Spectral balance as an acoustic correlate of linguistic stress. *Journal of the Acoustical Society of America*, 100(4), pp.2471–2485.

Sluijter, A. M., and van Heuven, V. J., 1996a. *Acoustic correlates of linguistic stress and accent in Dutch and American English*. In Proceedings of the fourth international conference on spoken language processing (3). pp. 630–633. Philadelphia.

Thomas, A., 1984. "A lowering rule for vowels in a dialect of North Welsh". In Ball, M. J. and Jones, G. E. (eds), Welsh Phonology. A book of Readings. Cardiff: University of Wales press.

Thomas, C. H., 1967. Welsh intonation - A preliminary study. *Studia Celtica*, 2(8).

van Bergem, D. R., 1993. Acoustic vowel reduction as a function of sentence accent, word stress, and word class. *Speech Communication*, 12(1), pp.1–23.

Volín, J. 2008. Z intonace čtených zpravodajství: výška první slabiky v taktu [Intonation in newsreading: pitch of the first syllable in a stress group]. *Čeština doma a ve světě* 3(4). pp.89-96.

Volín, J. and Weingartová, L., 2014. Acoustic Correlates of Word Stress as a Cue to Accent Strength. *Research in Language*. 12(2). pp.175-183.

Watkins, T. A., 1993. "Welsh". In M. J. Ball and Fife, j. (eds), *the Celtic Languages*. London: Routledge.

Williams, B. 1983. *Stress in modern Welsh*. Ph.D thesis. University of Cambridge.

Williams, B. and Ball, M. J., 2001. *Welsh Phonetics*. Wales: The Edwin Mellen Press.

Williams, B., 1999. The phonetic manifestation of stress in Welsh. In Hulst, H. van der (ed.), Word Prosodic Systems in the Language of Europe. Berlin: Mouton de gruiter. pp. 311-326.

Willis, D., 2009. Old and Middle Welsh", in: Ball, Martin J., and Nicole Müller (eds.), The Celtic languages, Routledge Language Family Descriptions, 2nd ed. (1993), London, New York: Routledge. pp.117–160.

Xu, Y. and Wang, M., 2009. Organizing syllables into groups—Evidence from F0 and duration patterns in Mandarin. *Journal of Phonetics*, 37(4), pp.502-520.

Xu, Y., Prom-on, S. and Liu, F., 2015. Explaining the PENTA model: A reply to Arvaniti & Ladd. *Phonology*. 32(3). pp.505-535.

Yakup, M. and Sereno, J. A., 2016. Acoustic correlates of lexical stress in Uyghur. *Journal of the International Phonetic Association*. 46(1). pp.61-77.

No Country for Oldowan Men: Self-Domestication and Cranial Globularity as Factors in Language Evolution

Elliot Murphy

Abstract

Language evolution has long been researched. I will review a number of emerging research directions which arguably have the potential to provide a finer-grained and more structured picture of how and when the capacity for language emerged. In particular, human-specific levels of braincase globularity – and the broader process of self-domestication within which globularity seems capable of being encapsulated – will be argued to be the central pillars of any satisfactory and interdisciplinary model of language evolution.
Keywords: Domestication syndrome, molecular clock, genetic drift, globularity, language evolution, basicranial angle, birdsong

1 Introduction

In recent years, a number of models have been proposed to explain the implementational basis of hierarchical phrase structures (reviewed in Aboitiz, 2017; Friederici, 2017). A range of paleoanthropological, paleoneurological and genetic data has also been consulted in an effort to map out an accurate path that language evolution likely took (Beaudet, 2017; Benítez-Burraco & Boeckx, 2015; Murphy & Benítez-Burraco, 2018, In Press; Zollikofer & Ponce de León, 2013). My intention here is to examine some possible connections between these distinct modes of inquiry by exploring a specific set of phenotypic traits and evolutionary processes which have the potential to explain the emergence of core features of language such as syntactic complexity and unrestricted semantic combinatorics.

2 Gene Regulation

What is the likely *mutational profile* of the initial stages of language evolution? It has been proposed that there exist 1,241 primate-specific genes (Zhang et al., 2011), 280 of which are human-specific. 54% of these human-specific genes are upregulated in a brain area implicated in higher cognition, the prefrontal cortex. These new genes are significantly more likely to be involved in gene regulation (Diller & Cann, 2013, p. 256). It is not unlikely that the mutation of some regulatory gene reorganised the neuronal populations in the neocortex and its concomitant computational properties. This position seems reasonable given recent evidence that the complex syntax of Bengalese finch songs developed from simple neurological changes (Katahira et al., 2013). Given the level of regulatory complexity identified by Chakravarty, it is more likely that the neurocomputational properties required for language emerged after the mutation of multiple regulatory genes acting in concert, and not a singular mutational event as often claimed in the generative and biolinguistics literature (e.g. Chomsky, 2010): 'Genes and their products almost never act alone, but in networks with other genes and proteins and in [the] context of the environment' (Chakravarty, 2011, p. 15).

Relatedly, the transition from many fingers to only 5 was not the result of new genes, but rather of distinct regulations of existing genes, namely regulation of *Hoxa11* (Kherdjemil et al., 2016). A similar account may be application to core features of language, in particular given

that there exists no strong correlation between the total number of genes in a given species and the level of biological complexity it achieves (for instance, mice and humans have comparable numbers). Of relevance here is the finding that human evolution has slowed down, often called the 'hominoid slowdown': '[R]ates of occurrence of de novo mutations decreased as enhanced DNA repair mechanisms and larger generation times evolved' (Goodman, 1985, p. 10). Hominoids appear to have reached a certain mesa of complexity, with only slight tuning yielding novel benefits.

In summary, a slight epigenetic change could have produced an alteration in the human computational system yielding the capacity for constructing hierarchical phrase structures.

A separate question now concerns when this took place. Putting aside precise dates, and assuming that anatomically modern humans emerged around 150-300kya (kya: thousand years ago), it appears that the vast majority of complex forms of symbolic representation did not emerge until 60-100kya (Hurford, 2011). This time also correlates with the emergence of new migration patterns (Mellars, 2006), leading to the possibility that properties of the environment acted as release factors for language, as they also appear to do for the singing capacities of genetically identical finches subject to distinct environmental upbringings (see below). Encountering new forms of social organisation and environments may have served to prompt the basic combinatorics of mammalian cognition and encourage novel forms of (ultimately cyclic) conceptual combination. Bolender (2007) has suggested along these lines that an increased human population, leading to a greater complexity of inter-group communication, acted as a trigger for the use of syntactic word movement, hitherto dormant. If this is correct, then investigating syntactic phenomena from a purely computational perspective, not considering the influence of the development and emergence of the phenotype, would be missing a crucial part of any psychological or cognitive account. These hypotheses should be of great interest to a range of researchers given that archaeological evidence suggests that the emergence of language likely aligns with periods of significant demographic changes.

2 Human Evolution and Globularity

The human lineage began around 6 million years ago, when our common ancestor with chimpanzees split into separate lineages. Likely the closest we have to a last common ancestor was *Ardipithecus*, who lived in trees but was capable of bipedalism. Standing at 4 feet tall, their brains are estimated to have been at around 500 cubic centimetres. The oldest fossils ascribed to the genus *Homo* (our lineage, emerging around 2.5mya) are from Kenya, Ethiopia, Tanzania and South Africa, and include cranial and postcranial specimens. These are classified as *Homo erectus*. While there is some controversy about the earliest suggestive evidence of *Homo* in species such as *Homo habilis*, *Homo naledi* and *Homo erectus* (a fragmentary upper jaw with a partial dentition from Ethiopia, dated at 2.33mya), these cranial and postcranial specimens are the earliest fossils we can ascribe with confidence.

Skulls of subsequent members of *Homo* exhibit an increasingly high and globular morphology, forming the marked parietal bone eminences of anatomically modern humans. With respect to the development of the posterior inferior frontal gyrus, the general trend throughout hominin evolution appears to be a reduction in size on the left relative to the right, while the region more broadly projects more laterally and antero-posteriorly on the right side. Consequently, left Broca's area appears more globular (Balzeau et al., 2014). Recent re-evaluations of the fossil record have revealed a more complex picture of frontal lobe evolution than is typically assumed, such that the inferior frontal gyrus and Broca's cap have indeed assumed a more globular shape (Beaudet, 2017).

Building on these concerns of globularity, a recent review of 20 *Homo sapiens* endocasts from different time periods employing computed tomographic scans and geometric morphometric analyses was conducted by Neubauer et al. (2018). Endocasts approximate outer brain morphology very closely due to the fact that the brain, meninges and cranial bones interact during development. The authors showed that while modern human brain size was assumed as early as 300kya (hominin fossils from Jebel Irhoud, Morocco), it was not until 130-35kya that our modern, globularised brain shape emerged (that is to say, the Jebel Irhoud fossils were not globular). Crucially, Neubauer et al. (2018) note that this process 'paralleled the emergence of behavioral modernity as seen from the archeological record'. They add that 'the "human revolution" just marks the point in time when gradual changes reach full modern behavior and morphology and does not represent a rapid evolutionary event related to only one important genetic change' (see also Murphy, 2018 for a proposal that this process of globularisation granted 'travelling' neural oscillations the ability to migrate across new areas of the cortex and subcortex).

This suggests that while the capacity for cyclically constructing hierarchically organised objects (or phrase structure building involving labelling) was available before the final stages of globularisation, these documented changes in brain shape (and their concomitant neural re-wiring) likely allowed this computational system to gradually interface with other previously encapsulated cognitive systems. The labelling capacity came first, but did not achieve its full, modern reach until globularisation occurred. This suggests that language-music, language-mathematics and language-morality interfaces (assuming a common computational link between these capacities, à la Hauser & Watumull, 2017) emerged at different evolutionary timepoints and that it may be possible to plot a timeline for the emergence of these interfaces. For instance, we can date musical instruments to around 35kya (such as bone and ivory flutes; Conard et al., 2009); perhaps the language-mathematics interface emerged early in the globularisation process, then the language-morality interface, and finally the language-music interface.

Additionally, no CT data of the Herto skull (160kya) is available, and so it is possible that modern human-like globularisation was found as early as 160kya, possibly before. If this is the case, then a more saltationist model of language evolution may be accurate such that language interfaced with other cognitive systems rapidly. Regardless, what can be said with certainty is that modern humans exhibit a more acute basicranial angle than other Great Apes, achieving a much more extreme level of globularity.

Turning to the related theme of neurolinguistics, neuronal networks have been shown to obey Rent's law (a 'third factor' in language evolution), exhibiting hierarchical modularity that optimises a trade-off between physical cost and topological complexity, such that these networks are cost-efficiently wired. As Sengupta et al. (2013) summarise: 'A modular design balances the savings in metabolic costs, while preserving computational capacities'. A more globular braincase hosting a 'folded' brain (which, through gyrification, permits a large surface area to fit inside a smaller skull), in conjunction with Rent's law, maximises computational efficiency and large-scale circuit integration. The implications for cognitive evolution may be substantial.

Although these empirical discoveries are novel, the general themes supporting them remain classical. Ever since Broca (1861) and Dax (1863), human brain asymmetries have been documented, often being used to help differentiate between different species. Although the trend toward brain size increase has been well documented in hominin evolution (Sousa & Wood, 2007), there are some important exceptions such as *Homo floresiensis* (Kubo et al., 2013) and the size reduction in *Homo sapiens* since the Upper Paleolithic (Balzeau et al., 2014), a period lasting from 40-12kya. This makes lateralisation less likely to be the core modification at the centre of language evolution, in particular given Balzeau et al.'s (2014, p. 126) findings

that brain lateralisation is 'probably shared by all hominins'. Some other neural changes are likely to be responsible.

What are some other implications of neural reorganisation? Consider Australopithecines. These are assumed to lack the diverse behavioural and biological features exhibited by *Homo*, though the fossil record is far from complete. The oldest stone tools have been dated to around 2.6 million years ago, close to the likely appearance of the first *Homo*. This had led some to speculate whether the larger brains associated with early *Homo* specimens were required for the conceptualisation involved in using this type of tool (see Mann, 2011). Indeed, throughout the evolution of *Homo* brain size has almost tripled in volume. The earliest *Homo* had a braincase volume of 510-775cc, whereas modern *Homo sapiens* exhibit braincases with volumes ranging from 1200cc to over 1500cc. Influences of changing climate, environmental demands, and social competition are thought to be the major influences driving brain size change (Bailey & Geary, 2009).

Archaeologists studying the Paleolithic period have discovered the types of technology created by *Homo*. One such technology is composed of three types of basic stone tools: hammers, cores, and flakes. These are termed Oldowan tools, or Mode 1. These tools display substantial spatio-temporal uniformity with few modifications for more than 1 million years. Hominins used Mode 1 tools to kill and butcher medium- and large-sized mammals. Stone tools were also used to access bone marrow, and the surfaces of certain tools suggest that roots might also have been pounded (Wrangham, 2009). Upon the emergence of *Homo erectus*, Acheulean tools (Mode 2) emerged, which were effectively enhanced versions of Mode 1 tools with the addition of a 'biface'; namely, the margins of the tools were trimmed to either produce symmetrically sharp sides (as in the Acheulean hand axe) or a modified side meeting an unmodified side (as in cleavers). Acheulean tools were used to slice open animal skins, carve meat and break bones. Two examples of cutting tools typical of early Acheulean sites are pointed hand axes and picks, involving intentional shaping. Moreover, the intentional procurement of raw materials and the development of a multicomponent quarrying process was required to produce these tools. Mode 1 tools had no existence outside their conditions of use, but Mode 2 acquired a somewhat more abstract function. *Homo erectus* carried them around, using them for distinct purposes and to achieve different goals, participating in the cultural life of the species. In this sense they acquired a symbolic, memetic existence, helping *Homo erectus* consume the necessary amounts of meat needed to fuel its enlarged brain.

Indeed, it has often been suggested that because remains of one-million-year old campfires have been discovered and are thought to have been constructed by *Homo erectus*, the invention of cooking might have provided a new range of nutrients feeding brain growth in *Homo* (Aboitiz 2017, p. 452). DeCasien et al. (2017) provide novel statistical techniques to demonstrate that primate brain size is predicted by diet, not by degree of sociality, suggesting that studies of language evolution could benefit from a shift of attention towards ecological factors. The enlarged brain, in turn, seems to have been capable of coordinating spatial representations with shape recognition, necessary requirements for a biface; a process demanding an enlarged working memory for *Homo erectus* relative to earlier *Homo* (Gibson, 1993). After these advances in mentally manipulating three-dimensional Euclidean space, it is not at all clear whether substantial advances in spatial cognition were made until the present, or whether the spatial reasoning skills of modern humans are closely comparable to those of *Homo erectus*. One of the less controversial topics in human evolution involves the usefulness of dietary changes in providing the necessary nutrients and energy for sustaining hominin brain enlargement in early *Homo*. The modern human adult brain uses 20% of the body's metabolic energy, whereas new-borns use around 60% (Aiello et al., 2001), with growing brains needing a substantial range of foods (captured via sophisticated hunting tools) with high nutrient density. It is possible that these dietary (and, hence, social) changes had a selectional impact

on certain aspects of speech or babbling. Nutrition also may have impacted cognition in different and perhaps more significant ways than social life (DeCasien et al., 2017).

Soon after, Neanderthals appeared across Eurasia. This species has always suffered from something of a presentational problem: In the early 20th century, the discovery of a Neanderthal skeleton from La Chapelle-aux-Saints in France exposed deformities which were at the time thought to be indicative of their cognitive and cultural degeneracy, yet it is now known that these were simply a reflection of the old age of the particular individual. The Neanderthals in Eurasia were a population whose lineage split from that of *Homo sapiens* around 500kya, and who disappear from archaeological history around 30kya. They exhibited use of Mode 3 tools, namely Mode 2 tools with 'flake technology', producing intricate grooves along the sides of objects (surpassed only by Mode 4, or Solutrean tools; thin, sharp blades used by modern *Homo sapiens*). They also introduced hafting of stone points onto spears, and lived in small communities, enjoying little to no contact with other Neanderthal groups outside local territory. Neanderthal remains have been found across Europe, and consequently play a major role in discussions of human evolution given that both species appear to have trekked out of Africa. Relative to modern humans, Neanderthals possessed a low, flat braincase, sloping foreheads and large brow ridges. Their brains were slightly larger than those of humans. Their chests were barrel-like, indicating 'a body morphology adapted to the cold conditions of ice age Europe' (Mann 2011, p. 279). Since Neanderthals were one of a series of hominin populations dotted around Eurasia, different groups exhibited distinctive features: 'Fossil finds in northern Israel, such as those from the Tabun and Amud caves and the skeleton lacking a skull from the Kebara cave … possess features similar to other Israeli specimens, the Qafzeh and Skhul samples, which have been termed early modern humans' (Mann 2011, p. 280).

Neanderthals also appear to have been capable of pyrotechnology. Early Neanderthals from the late Middle Pleistocene site of Poggetti Vecchi, Italy, seem able to have appropriately selected timber to create 'digging sticks' (Aranguren et al., 2018; see also Hoffeckerl, 2018 for a review of Neanderthal technology). Kibblewhite et al. (2015) even propose a predictive framework for the preservation of materials (including bones, teeth, metals and organic materials) in soil across the European Union based on the chemical properties of discovered materials and the soil they were found in, allowing them to predict the most likely 'hot spots' for future discoveries relevant for cultural/cognitive research.

Moving forward to the time of modern *Homo sapiens*, the stone tools found at the Nubian Complex in the Dhofar region of Oman have been dated at 106kya (Rose et al., 2011), providing evidence for the existence of a northeast African Middle Stone Age technocomplex exhibiting the Levallois technique of stone knapping, a complex method involving the extraction of a small plane from a larger surface. Humans may well have been responsible for this, and if so they likely left Africa as early as 110kya. But Armitage et al. (2011) document how Levallois assemblages from Jebel Faya in the United Arab Emirates share close affinities with late Middle Stone Age assemblages from North East Africa. The authors date these Jebel Faya assemblages to 125kya, pushing the migration out of Africa even further back to around 130kya. Finally, the Lunadong hominin fossils discovered at Luna Cave in Guangxi, southern China, include one left upper second molar (M2) and one right lower second molar (m2). Bae et al. (2014) note that M2 is exclusively assigned to modern humans, while m2 is also likely to be. The teeth are dated between 127-70kya, in turn suggesting an early migration from Africa and Arabia. Bae et al. (2017) review recent results from hominin paleontology, geochronology and genetics, concluding that there must have been multiple dispersals from Africa into Eurasia, rather than a single exodus. The authors prefer a multiple-dispersal model and speculate that this began at the advent of the Late Pleistocene.

In summary, we can say with some confidence that the capacity for language emerged within the last 200kya, and we can say this thanks to the development of sophisticated tools,

cultural artefacts, complex trading relationships, and paintings. Indeed Miyagawa et al. (2018) draw a connection between cave paintings and 'archeoacoustics', noting that cave art is typically connected to the acoustic properties of the chambers they are located in. Being sensitive to the echoes generated in these chambers, Miyagawa et al. speculate that cave paintings may have been a form of cross-modality information transfer through which acoustic signals are transformed into visual representations. Although we will likely never know whether these complex cave paintings demanded the existence of language to produce, they are nevertheless part of a wider movement in cultural flourishing which are indicative of substantial cognitive advances.

Given the hunter-gatherer culture in which this capacity emerged, what can we say of the 'first words' (or units of semantic communication) which would have been externalised? Naturally we can only speculate, but it seems reasonable to assume that these words took the form of mimetic gestures or even sounds imitating whatever the shared object of attention was (likely food/carcasses or tools). As Studdert-Kennedy and Terrace (2017, p. 121) speculate, '[t]he vocal modality would have come to prevail, leaving hands and eyes free to go about their more important functions'. Before processes such as grammaticalization took control of complex morphology, initial vocalisations would have been simple linearizations relying on pragmatic procedures to derive the full meaning of expressions (Murphy, 2016b). Yet Cataldo et al. (2018) conducted the first assessment comparing the efficiency of speech (unaided by gesture) with gesture and also gesture-plus-speech as tool-making transmission aids. They demonstrated that subjects instructed by speech alone underperformed in stone tool-making compared to subjects instructed through either gesture alone or gesture-plus-speech. They conclude that 'gesture was likely to be selected over speech as a teaching aid in the earliest hominin tool-makers', and that 'speech could not have replaced gesturing as a tool-making teaching aid in later hominins, possibly explaining the functional retention of gesturing in the full language of modern humans'. They also suggest that speech may therefore have emerged for reasons unrelated to tool-making; it may have been a response to increased trade and more complex intra-group interactions bolstered by population increases.

3 Human Evolution

Closely tied to the theme of language evolution is the broader, and closely related (indeed, arguably identical) theme of *human evolution*. If we define *Homo sapiens* based on derived skeletal features, then the fossil record would place human origins somewhere in the African late middle Pleistocene. The relevant fossil data includes Omo Kibish 1 and the Levantine material from Skhul and Qafzek. Some of the oldest morphologically modern humans have been found at the Omo Kibish sites, and date to ~195kya (McDougall et al., 2005). Yet the genetic data indicates that both anatomically modern humans and *Homo neanderthalensis* shared a common ancestor in the middle Pleistocene (400-700kya), a date some 200kya earlier than the fossil-determined date. As Stringer (2016) notes, findings of this kind suggest that the morphology of *sapiens* exhibited no linear progression, and 'there was chronological overlap between different "archaic" and "modern" morphs' (2016, p. 1). Extant humans exhibit a number of shared traits, including a high neurocranium, a small face retracted under the frontal bone, small discontinuous supraorbital tori, and a narrow trunk and pelvis (Stringer, 2016). Anatomically speaking, it is possible to detect humans in the fossil record through focusing on these and broader features like cranial globularity and basicranial flexion (Arsuaga et al., 2015). Particularly relevant for language is a certain feature of the cranial vault: The parietal region is highly distinctive in humans, being expanded in certain areas (Bruner, 2010). Modulating and strengthening the connections of this expanded parietal region with other regions, such as

anterior temporal regions and subcortical structures like the thalamus, may have contributed to novel cross-modular communication.

4 The Cerebellum and Speech

Although left-frontal and parietal regions enjoy the most attention in discussions of language evolution, I would like to briefly address the potential importance of the *cerebellum*, which is increasingly being implicated in language processing.

The human cerebral cortex is approximately 3 millimetres in depth, while the cerebellum is considerably larger and contains 60 out of the brain's 86 billion neurons. Yet its role in higher cognition remains somewhat unclear. Pursuing the above line of inquiry, Ogihara et al. (2018) conducted a three-dimensional geometric morphometric analysis of reconstructed Neanderthal and early human endocasts. Their results indicated that ecto- and endocranial shapes are quantitatively different between the two species. The cranium of early humans displayed relative enlargement of the cerebellar region and a notable parietal expansion. This is perhaps the strongest evidence that the neuroanatomical organisation of the two species was significantly distinct. Following directly on from this documented cerebellum expansion, Tanabe et al. (2018) note that while the cerebellum has typically been seen as being involved largely in fine motor control, an emerging consensus is that this region is also involved in certain cognitive functions, including language. It exhibits a unique gross anatomy and microstructure, and the cerebellar cortex contains circuitry functioning as a learning system able to construct and store internal models of the world. Tanabe et al. (2018) show that the greater volume of the cerebellar cortex, the greater number of internal models it is able to construct and store. It seems likely that the cerebellum is therefore implicated in forms of long-term memory, with some of the complex representations it stores being constructed initially by the language system. In this sense, it may act as a post-linguistic long-term storage site, functionally distinct from parts of Broca's area (e.g. BA 44v, following standard sub-parcellation) which seem to act as a short-term memory 'buffer' site for phrase structures. Finally, cerebellar dysfunctions in humans lead to distinct speech motor deficits referred to as ataxic dysarthia (Ackermann, 2008; see also Murphy & Benítez-Burraco, 2017). The cerebellum is assumed to be involved in the control of coarticulation effects given its involvement in sequencing syllables into fast, rhythmically structured larger utterances. Nozaradan et al. (2017) also provide EEG evidence that the cerebellum and basal ganglia are involved in the neural representations of rhythmic sequences, in particular those demanding the encoding of precise sub-second events (see also Obleser et al., 2017).

More recently, Smaers et al. (2018) investigated the lateral cerebellum (a structure unique to mammals) across a range of species and mapped its evolutionary diversification, finding that relative volumetric changes of the lateral cerebellar hemispheres are correlated with measures of domain-general cognition in primates. These are furthermore characterised by a combination of parallel and convergent shifts towards similar levels of expansion in distantly related mammalian lineages. This suggests that increased behavioural complexity (for our purposes, of the kind found in the emergence of language) from a range of directions may be traced back to a common selection on a shared neural system, the cerebellum. This implies that this brain region aided certain other forms of higher cognition in a range of mammals, while in humans it seems to have aided rhythmicity and memory load, directly exploited by the language system.

Deepening these connections, Pidoux et al. (2018) show that the cerebellum provides a strong input to the song-related basal ganglia nucleus in zebra finches. Cerebellar signals are transmitted to the basal ganglia via a disynaptic connection through the thalamus, before being

conveyed to their cortical target and to the premotor nucleus controlling song production. These authors also showed that cerebellar lesions impair juvenile song learning.

As such, paleoneurological evidence bearing on the morphology of the cerebellum will likely inform our understanding of when certain language-related capacities emerged.

5 Genetic Drift

The most general distinction in the literature on language evolution is between theories which assume language emerged suddenly, and theories which assume it emerged gradually. What does the archaeological record have to say about this? Unfortunately, since the African middle Pleistocene hominin record is sparse, it is currently not possible to determine whether fossils like Omo Kibish 1 mark the earliest forms of the constellation of human features or whether older types exist. Another major question concerns whether human features emerged through natural selection or through random *genetic drift*. This occurs when the proportion of a gene variant in a population changes due to external events ('chance'). Coyne (2009, p. 14) notes that 'genetic drift may play some evolutionary role in small populations and probably accounts for some nonadaptive features of DNA'. Examining cranial measurements, Weaver et al. (2008) show that the differences between Neanderthals and anatomically modern humans could have emerged under drift over a period of around 400,000 years. Moreover, Weaver and Stringer (2015) show that these cranial differences emerged in a highly unconstrained way thanks to cultural buffering, relative to morphological divergences documented between crania of subspecies of *Pan troglodytes*.

While it is well known that only ~4% of the human genome differs at the nucleotide level from the chimpanzee genome (Varki & Altheide, 2005), the way that these genes are expressed is far from uniform. For instance, there is up to an 8% difference in splicing rates in the cortex between humans and chimpanzees (Calarco et al., 2007), with NDE1 (a gene involved in cortical neurogenesis) recently being shown to exhibit human-specific splicing patterns. Splicing consequently seems to be a major mechanism of brain evolution and cognitive development (Mosca et al., 2017).

Comparative genomics yields other fruitful insights into the likely origins of language. Gronau et al. (2011) analysed the whole-genome variation diversity patterns of six people from contemporary sub-populations: European, Yoruban, Han Chinese, Korean, Bantu, and San African. The final group (speakers of Khoisan) were discovered to have likely split from the rest of the human population around 108-157kya, and since they possess the ability to acquire language this indicates a likely timeline. Behar et al. (2008) report that mitochondrial DNA (mtDNA, transmitted through maternal inheritance) in the Khoisan peoples diverged from mtDNA in the human gene pool as early as 160kya years ago, remaining separate until around 40kya. The genetic isolation of the San people matches with the isolation of a core part of their language use. All Khoisan groups use clicks; Moisik and Dediu (2017) use a biomechanical model to show that a reduced alveolar ridge aids the production of clicks, and that this has been selected for amongst Khoisan groups. Clicks are complex obstruents externalised via a double closure in the oral cavity. Huybregts (2017) notes the intriguing possibility which follows from these findings. The common human population shared by the San and the rest of contemporary human societies must have had language but may not have solved the problem of externalisation, i.e. they may have exhibited labelling and the ability to recursively construct hierarchical representations, but not the ability to map this capacity to the sensorimotor system for externalisation via speech, gesture, and so forth. The San population and the non-San populations therefore solved the problem in different ways, indicating a clear timeline: the computational system of language evolved before it was linked to externalisation.

Nielsen et al. (2017) also discuss how 'genetic markers with uniparental inheritance and linguistic studies suggest that click-language-speaking hunter-gatherer populations may originally have been more widespread and were replaced in areas other than southern Africa or, alternatively, that they may have originated in eastern Africa and then migrated to southern Africa in the past 50 kyr'. Furthermore, 'other hunter-gatherer populations that speak languages that use clicks, including the Hadza people and the Sandawe people, currently reside in Tanzania in eastern Africa, although they display limited genomic affinity with the San people of southern African'.

Building on these developments, Murphy and Benítez-Burraco (In Press) argue that since we cannot track the neuronal oscillatory activity of the brain from extinct hominins, it is reasonable to use our current understanding of the language 'oscillogenome' (that is, the set of genes responsible for basic aspects of the oscillatory activity relevant for language; see Murphy & Benítez-Burraco, 2018) to infer some properties of the Neanderthal oscillatory profile. Several candidates for the language oscillogenome show differences in their methylation patterns between Neanderthals and humans, and Murphy and Benítez-Burraco (In Press) claim that differences in their expression levels could be informative of differences in cognitive functions important for language.

The importance of examining the brain in order to properly distinguish humans from Neanderthals is highlighted in recent work in paleoneurology. Mounier et al. (2016) document how endocranial features are more informative than features of the calvarium (supporting research efforts geared towards domestication; see below) and how human endocranial anatomy dramatically changed during the end of the Middle Pleistocene. Cultural development seems to have appeared alongside domesticated features like a smaller braincase, with a reorganisation of the cranium altering many neural features.

Lastly, despite the question of modern human origins in Africa remaining unsettled, a multiregional origin in which modern (domesticated) features evolved in a fragmented way in multiple areas connected by gene flow is a strong possibility. There is evidence, for instance, for the admixture of modern humans with archaic populations in Africa (Hammer et al., 2011). Statistical analyses of whole-genome sequencing data from geographically diverse hunter-gatherer populations also presents evidence of archaic human lineages that underwent introgression (i.e. exchanging genetic material via interbreeding) and diverged from modern human lineages anywhere between 1.3mya and 35kya, and so the extent of archaic admixture remains a point of controversy: 'Perhaps of greatest interest is genomic data from under-sampled regions of the world, which may help to refine evolutionary theories, including the question of whether there are further, as-yet uncharacterized, lineages of archaic humans' (Nielsen et al., 2017, p. 308).

6 Molecular Clock

Another topic which I would like to argue is relevant for language evolution research is the *molecular clock*, in particular given that many core hypotheses about the origin of recursive hierarchical phrase structure concern sudden and chance mutations. In recent research, the speed of the molecular clock has been calculated in terms of the number of mutational differences in matching segments of DNA between humans and primates based on the fossil record. Because it has typically been assumed that the speed was high, the 'Out of Africa' migration was thought to have occurred around 70kya (e.g. Gibbons, 2012). More recently, however, a new method of obtaining mutation rates has emerged which calculates the rate of the full genome of present-day humans through counting the number of new mutations in the

nuclear DNA of a newborn compared to its parents. Scally and Durbin (2012) cite the value at 0.5×10^{-9} $bp^{-1}year^{-1}$, which is around half of the previous fossil-calibrated rate (Ike-uchi, 2016).

As such, the molecular clock is much slower than previously believed. Adjusting for these new calculations, the migration from Africa is likely to have occurred around 130kya (as the fossil record above also suggests).

A possible scenario for language evolution in line with these findings is that the mutation(s) required for language occurred in an individual between 200-130kya in East Africa. This then spread through the community, and around 130kya years ago a group (composed of around ~450 individuals, according to estimates in Fagundes et al., 2007) migrated north across Arabia, passing the Bab al-Mandab Straits and progressing to Oman and the surrounding regions, eventually arriving in southern China and Indo-China. A separate group, much later (100-50kya) also left North Africa through a different route (the Nile Valley) and reached Eurasia. Of course, the hypothesis that a small number of mutations in a relatively short time window led to language is naturally compatible with whatever theory one adopts concerning the speed (fast or slow) of the molecular clock. But the notion of a slow clock nevertheless makes the standard generative picture of a *sudden, slight mutation* somewhat less appealing, and rather points to the validity of a series of mutations (echoing concerns raised above in Section 1). None of these discrete changes would have likely been sufficient to bring about the morphological and neurological characteristics of the anatomically modern human brain, but when spread throughout a community for extended periods they may have conspired to do so.

7 Domestication

It is increasingly becoming clear that the topic of *domestication* has a clear potential to inform our understanding of human brain evolution. The notion that anatomically modern humans are a fundamentally domesticated species has a long and rich history, dating back to Darwin (1871) and Boas (1938), with the latter commenting that '[m]an is not a wild form, but must be compared to the domesticated animals. He is a self-domesticated being' (Boas, 1938, p. 76). Concerning the general processes of self-domestication, Boas added that '[i]t is likely that changes of mental character go hand in hand with them' (1938, p. 140), and it is only very recently that researchers have been able to propose concrete hypotheses which expand on these speculations.

Domesticated species (including dogs, cats, foxes, pigs and sheep) are usually defined based on their shared phenotypic traits, referred to collectively as the 'domestication syndrome' (Zeder, 2012) and which include depigmentation, reduced ears, shorter muzzles, smaller teeth, smaller cranial capacities, and a reduction of sexual dimorphism (feminisation). Many of these features are exhibited by anatomically modern humans, and in fact distinguish humans from Neanderthals (Theofanopoulou et al., 2017), and they may also reflect a generalised deficit in the neural crest, an embryonic structure responsible for pigmentation and the cranial skeleton, amongst other things (Wilkins et al., 2014). Domesticated animals used to be regarded as entirely separate species but are now thought of as sub-species of their wild progenitors. Le Douarin (1980) discovered that transplanting neural crest cells from chicks to quails resulted in the chimeric hatchlings producing intermediate chick/quail vocalisations, suggesting that the process of self-domestication, involving the neural crest, contributed in some fashion to the emergence of vocal learning. Interestingly, Theofanopoulou et al. (2017, p. 4) document how interspecific domestication events suggest that 'the selective pressure for our self-domestication need not have been qualitatively different from those experienced by other species'. For instance, the silver fox (*Vulpes vulples*) was intentionally domesticated through a

project initiated by Belyaev (1979) based on a single criterion: tameness towards humans. After only twenty years of selection for tameness, a range of features typically associated with domestication emerged, suggesting a strong, causal link between the above noted phenotypic characteristics of domesticants.

It is therefore likely that selection for tameness, prosocial behaviour or related traits associated with the syndrome brought about human self-domestication after the split from our last common ancestor. Self-domestication can potentially explain – 'for free' – a number of human-specific traits, with the possible exception of the descended larynx, an explanation for which remains in relative obscurity. Speaking to this hypothesis, recent work suggests that humans, unlike monkeys, are adept at turning competitive situations into cooperative ones (Marquez, 2017). Tomasello et al. (2005, p. 685), discussing 'shared intentionality', note that 'it is almost unimaginable that two chimpanzees might spontaneously do something as simple as carry something together or help each other make a tool'. More generally, as Theofanopoulou et al. (2017, p. 12) note: 'It is also not unreasonable to suspect that byproducts of the domestication process, such as enhanced sensory-motor perceptual and learning pathways, may provide a foundation for more complex communicative abilities, including vocal learning abilities'.

Recent work has emphasised the potential for studies of dog vocal social perception to enhance our understanding of how linguistic and non-linguistic signals are represented in the mammalian brain in particular given that dogs have lived in anthropogenic environments for at least 16-32kya (Andics & Miklósi, 2018). This perspective goes somewhat beyond the standard focus on great apes, giving the study of vocal social perception a broader mammalian basis. It has been argued in the literature that dog domestication enabled this species to survive in small human groups (Serpell, 1995), fast becoming man's 'best friend', with this process selecting for dogs with the genetic potential to develop human-compatible behaviours. Dog brains also appear to have dedicated voice areas, preferring conspecific vocalisations over other sounds (Andics et al., 2014). These areas are located in anterior temporal regions, including the bilateral temporal poles. One possible interpretation of these findings, as Andics and Miklósi (2018, p. 60) note, is that 'conspecific preference in dogs and humans relies on homologous brain structures, implying that voice areas have been there in the last common ancestor of the two species, but convergent evolution provides an alternative interpretation that voice areas developed independently in the ancestors of dogs and humans, after their lineages split'.

Wrangham (2009) maintains that the cultural developments of anatomically modern humans are the result of self-domestication via inhibiting aggression and related traits. His line of research points to comparable developments within certain ape societies. For example, while chimpanzees display a range of cooperative traits their culture is typically plagued by aggression and violence (Hare et al., 2012). Bonobos (pygmy chimpanzees), in contrast, display a juvenile appearance (in line with domestication models) and live in far more peaceful societies (though, it should be noted, not as peaceful as stereotypes would suggest due to clear carnivorous tendencies). Like humans, bonobo societies are much larger than those of chimpanzees, with the rapidly increasing size of early human tribes likely playing a role in their domestication. As Aboitiz (2017, p. 452) summarises: 'As we domesticated other species, we adapted ourselves to the process of domestication, forming an evolutionary circle that maintained our genetic evolution and drags other species with it'. This cyclic process of self-domestication involved adapting to the needs of human groups while also domesticating a range of plants and animals in ways dynamically responding to such needs, with the newly-domesticated plants and animals in turn influencing the social structure of human societies (see also Murphy, 2019).

Turning to a related field of study, Okanoya (2012, 2013) reports that comparisons of the songs of wild finches (white-rumped munia) and domesticated finches (Bengalese finch) suggest that the latter produced songs of greater complexity, differing in acoustical morphology and the order of elements. Lansverk et al. (2018) replicate and expand on these results and also explore their genetic underpinnings. The sound density was also found to be 14dB higher in Bengalese finches than in white-rumped munias during recordings from identical settings. The most recent research in this direction has even suggested that domesticated birds have smaller brains but a larger cortex, in particular the forebrain (Olcowicz et al., 2016). As such, domestication seems broadly responsible for increases in syntactic complexity.

In summary, it appears from recent evidence that self-domestication helped lay the ground work for enhancing in modern humans some of the communicative, semantic and syntactic capacities of our ape ancestors.

8 Tool Use

In 1949, one of the most influential palaeontologists of the twentieth century, G.G. Simpson (1949, 291-292), wrote:

> Man arose as a result of the operation of organic evolution and his being and activities are also materialistic, but the human species has properties unique to itself among all form of life, superadded to the properties unique to life among all forms of matter and of action. Man's intellectual, social, and spiritual natures are altogether exceptional among animals in degree, but they arose by organic evolution.

It is common in the field for researchers to claim that because language is such a complex system – 'altogether exceptional' (Corballis 2017) – its evolutionary roots must extend very far back. As DeSalle and Tattersall (2017, p. 6) review, the first anatomical *Homo* exhibited 'little if any of the zeal for change and innovation, and none of the ability to reconceptualise the world, that so richly characterize their modern language-endowed descendants'. But these debates presuppose a clear understanding of what *language evolution* is, as distinct from the evolution of closely related capacities. When it comes to the relevance of the fossil record to questions of *speech evolution*, Wood and Bauernfeind (2011, p. 271) conclude their data review by claiming that 'the fossil evidence for archaic hominins contains little, or no, reliable evidence about the speech capabilities of these taxa'. But, going beyond fossils, what about the evolution of language and communication, distinct from speech? Assuming, as is commonly done, some form of relationship between symbolic communication and linguistic competence, there are a number of higher cognitive capacities that we share with our close relatives according to existing paleoanthropological accounts. Consider the Makapansgat manuport, a small stone (2 × 3 inches) found amongst Acheulean tools in South Africa in 1925 and putatively collected by *Australopithecus africanus* around 3mya (other Acheulean tools are dated somewhat later). It seems to closely resemble a human face, suggesting that Australopithecus could grasp connections between arbitrary symbolic forms and abstract meanings; otherwise known as iconicity. Since this semantic property appears so deeply rooted in hominin evolution, this might explain its prevalence amongst early religionists (see also Peterson, 1999, 2018).

Examining the neural basis of primitive tool technology, Hecht et al. (2015) compared brain responses while learning either the basic Oldowan technique or the more complex Acheulean technique. The latter exhibited increased activation in the right inferior frontal gyrus

and bilaterally in other regions, suggesting an increase in the requirement for cognitive control. Toolmaking typically involves the dominant hand making repetitive, rhythmic motions while the subordinate hand holds the object and occasionally rotates it (Uomini & Meyer, 2013). According to Uomini and Meyer (2013), hemispheric dominance arose due to the separation of competing neural processing strategies, one implicated in complex sequential behaviours like hand motions, and the other involved in coarse motor routines. Coordinating two different processes simultaneously (low-frequency and high-frequency motor commands) in what can arguably be described as a hierarchically organised form of behaviour (though of limited hierarchy; Stout & Chaminade, 2012) may well led to the selection for certain neural subroutines which the language system recruited when structuring the processing of units of different hierarchical complexity, i.e. when processing multiple syllables into a single word, and ultimately processing multiple words into a single phrase. Indeed, Morgan et al. (2015) discovered that students learned to make stone tools faster under verbal instruction, pointing to a potential co-evolution between toolmaking and speech (although it should be stressed that simply because verbal instruction enhances performance on a certain task, it does not follow that verbal abilities and this given task co-evolved). Note that this hypothesis does not lead to any causal explanation for language evolution (e.g. it does not commit one to the assumption that language evolved directly from toolmaking), it simply proposes that when the language faculty did emerge it was embedded within a sophisticated computational network.

Another related example comes from the Erfoud manuport, dated at around 300,000 years old and discovered in eastern Morocco. Seemingly collected by *Homo erectus*, the manuport is a cuttle fish bone shaped like a phallus (Everett, 2017). What is the possible relationship of these findings to language evolution? Conceiving of language as a recursive combinatorial system involving the construction of hierarchically organised syntactic objects, generative linguists such as Chomsky (2010) or Hornstein (2009) would likely not be too impressed with a penis-shaped cuttle fish bone. Yet clearly the capacity to bind bodily concepts either to concrete instantiations or more abstract symbolic representations in the form of manuports involves some form of impressive semantic mapping of the kind subsequently exploited by the language system in anatomically modern humans. Moreover, the development of the 300-400,000-year-old Schöningen spears point towards a sophisticated culture amongst *Homo heidelbergensis*, since not only do they act as tools but they also have symbolic cultural meaning, such that the spear can denote the act of hunting in abstraction, i.e. in the absence of any particular hunt. And unlike many other tools used throughout the animal kingdom, Everett (2017, p. 143) notes that these spears display aspects of Peircean signs in that 'only certain parts of the tools are meaningfully connected to their tasks, e.g. the edge of the tool'. This greater degree of abstraction seemingly came about shortly before the time that language would have emerged among anatomically modern humans (200-300kya), and so the generous and rapidly developing cognitive toolbox of *Homo heidelbergensis* (a variant of *Homo erectus*, or even identical according to some researchers) may well have been passed down to modern humans. *Homo heidelbergensis* additionally had a great number of nerves linking the brain and tongue than its predecessors, suggesting that it possessed the ability to refine and control vocalizations.

With this toolbox at the ready, the bow and arrow was used by humans as early as 71kya (McBrearty, 2012), a weapon which goes considerably beyond the complexity of the spear, likely involving a degree of sophisticated communication in order for it to be taught and implemented in a coordinated, strategic fashion. Likewise, most researchers concur that the capacity for complex symbolic thought (i.e. combining distinct symbolic representations in novel, 'imaginative' ways, of the kind found in polysemy; Falkum & Vicente, 2015; Murphy, Forthcoming; Pustejovsky, 1995, 2008) was needed to construct bodily ornaments such as

beads and decorative objects (Vanhaeren et al., 2006; Texier, 2010); both of which appeared around 100-60kya.

The capacity for complex orthography, and potentially also the ability to associate symbolic meaning with indentations, can also be found as far back as 540kya in the form of zigzag marks on a shell made by a member of *Homo erectus* and found in Java. Interestingly, a sea voyage was likely made by the creator (from mainland Asia to Java), who might have represented the sea through these patterns. The intentional act of creating marks to represent abstract icons also provided an important pre-linguistic trait for anatomically modern humans, who presumably would have been able to externalise their new Language of Thought after the emergence of human-specific syntax in precisely the same way as *Homo erectus*, with the exception of using such markings to represent more complex, composite representations, as opposed to simple concepts like SEA or FACE. Likewise, *Homo erectus* crafted a wide number of tools (including choppers and pounders). These could not have feasibly been created systematically from any random motor sequence, but require planning and imagination, as well as the ability to communicate to others the methods of production. The expanded cognitive power required for mastering these procedures, which soon became a necessary part of survival (in particular in the event of tribal warfare), may well have led to an important role for natural selection: namely, selection for expanded fronto-parietal circuits to satisfy the growing demand for cognitive control networks. Thus, we find the world's oldest piece of art, the 250kya Venus of Berekhat Ram, a rock carved in a female shape with evidence of intentional red ochre colouring for decoration, an object crafted with precision and imagination.

These ideas – of syntax ultimately being couched within pre-existing semantic properties – are quite distinct from the hypothesis proposed by Everett (2017). His claim is that 'with symbols + concatenation, there is language' (2017, p. 160). While a certain amount of compositionality might be derived from a semantic system relying on this architecture, hierarchically organised phrases plus long-distance dependencies cannot emerge from this. Combining representations of any format into syntactically hierarchical phrases is not a job for symbolism and concatenation alone (Murphy, 2015, 2016a). Likewise, the engraved ochre and bones found in Blombos Cave are suggestive of symbolic manipulations, yet as Botha (2011, p. 307) notes any links to syntactic language are highly questionable since 'beads, ochres, and engraved bones cannot stand as evidence for modern cognition, including language, unless it is specified what cognitive abilities these artefacts require'. Indeed, although the use of pigments pre-dates Blombos Cave and even implicates Neanderthals, these were non-symbolic and displayed little variation (Neanderthal pigments were generally black, for instance).

Finally, one of the core characteristics of the tools of early *Homo sapiens* is that they were crafted for durability just as much as immediate usefulness. This suggests a familiarity not only with symbolic behaviour, but with long-range planning. These planning and strategizing capabilities are neurologically and computationally separate from purely linguistic processes, suggesting that modern cognition demanded certain developments in executive reasoning skills as well as the evolution of language.

The general picture that emerges here is the following: The Oldowan tools dated around 3mya are suggestive of dexterity, motor control and intentional modifications of inanimate objects; the Acheulean tools dated slightly later (perhaps around 2mya) are suggested of hierarchical cognition and/or complex motor planning, along with complex emotions. The axes, cleaver and spears of *Homo heidelbergensis* dated around 400kya are suggestive of visual imagination, emotional control, symbolism, and possibly a sense of self. The Levallois method is generally dated around 300kya, and is suggestive of advanced hierarchical cognition, tuition, and an unusual degree of patience. Lastly, the technology of modern *Homo sapiens* dated around 200kya is suggestive of an improved memory, creativity, and an awareness of past and future.

9 DNA Sequencing

Developments in DNA sequencing recently resulted in sequence data covering much of the Neanderthal genome (Green et al., 2010). Shortly thereafter, a list of 87 genes with protein-coding differences between humans and Neanderthals was released (Prüfer et al., 2014). This allows hypotheses to be drawn up concerning the existence of certain language-relevant cognitive components in Neanderthals. The most famous (and notorious) candidate for a 'language gene' is *FOXP2*. This codes for a transcription factor (a protein able to bind DNA and modify the expression of other genes) connected to a large network of genes that can be up- or down-regulated (Vernes et al., 2007). In modern humans the gene exists in a species-specific allele, coding a protein differing from that of chimpanzees (Enard et al., 2002). *FOXP2* currently seems to have no variation that might have distinguished Neanderthals/Denisovans from humans. But as DeSalle and Tattersall (2017) note, this is an extremely weak basis from which to claim that Neanderthals/Denisovans had language. Prüfer et al. (2014) drew up a list of candidates for the Neanderthal genome and, as DeSalle and Tattersall (2017, p. 5) comment, these authors 'do not appear to have made any strong connections between language and any of the genes they determined as important in the differentiation of the Neanderthal/Denisovan genomes'. Of all the candidate genes for language summated via extensive review by DeSalle and Tattersall (2017), only one has a serious and promising connection to the Prüfer et al. (2014) database: CNTNAP2. This plays an important role in nervous system development and covers 1.5% of chromosome 7, although it currently remains unclear how it could causally relate to language evolution (see Mountford & Newbury, 2018 for further discussion). A regulatory region of FOXP2 was recently identified exclusively in modern humans at a binding site of the transcription factor POU3F2 (Maricic et al., 2013). This documented POU3F2 change that enhanced FOXP2 expression in the human brain was also not part of the gene flow from humans into Neanderthals that occurred in the Levant or Southern Arabia 125-100kya (Kuhlwilm et al., 2016). Since this likely resulted in improved speech, it is not unreasonable to associate linguistic externalisation with this POU3F2 haplotype at FOXP2, suggesting that externalisation was a late development occurring after the initial computational system had emerged. This research suggests that 'differences in gene regulation and expression may be involved in cognitive function, and that species differences are due to far more than just two variants in a single gene' (Mountford & Newbury, 2018, p. 55).

Exploring a broad topic such as the genetics of language will require a number of linking hypotheses between genes, neural anatomy and cognitive processes (of the kind proposed in Murphy & Benítez-Burraco, 2018, In Press). Without such linking hypotheses, it becomes extremely difficult to draw any substantial conclusions about the genetic foundations of language. For instance, the gene *SRGAP2* has often been invoked in discussions of language since it has been shown to be involved in cortical growth (Hillert, 2015). The occurrence of certain hominins correlates with copies of the genes, but also with the appearance of different artefacts, and so it is difficult to even generate any inferences let alone adjudicate between different hypotheses.

More broadly, Fisher (2013) makes the crucial point that genes do not specify behavioural outputs, and do not even code for specific cognitive 'modules'. Rather, gene products (usually proteins) interact with one another in complex networks to construct neural circuitry through modulating neuronal proliferation and migration, neurite outgrowth, axon pathfinding, synaptic strength, and so forth. Most genes, in particular regulatory genes, play multiple roles in the body ('pleiotropy'). In short, genes do not code for 'language' or 'speech', and an individual gene is rarely expressed in only one part of the central nervous system, with

FOXP2, for instance, being expressed in the cortex, basal ganglia, thalamus and cerebellum (Lai et al., 2003).

10 Future Directions

The unanswered questions emerging from this discussion cut across a range of domains: Which features of (self-)domestication have had an impact on the language architecture? How does the speed of the molecular clock impact either saltationist or adaptationist hypotheses concerning the emergence of language? What are the potential ways domestication can influence the externalisation component of a given species? Which factors (e.g. nutrition, climate) had the potential to impact features of human cognition relevant to language comprehension during the course of modern human evolution? To what extent could future studies of archaic hominin admixture provide insights into the evolution of language?

References

Aboitiz, F. (2017). *A Brain for Speech: A View from Evolutionary Neuroanatomy*. London: Palgrave Macmillan.

Ackermann, H. (2008). Cerebellar contributions to speech production and speech perception: psycholinguistic and neurobiological perspectives. *Trends in Neurosciences, 31*, 265-272.

Aiello, L.C., Bates, N., & Joffe, T. (2001). In defense of the extensive tissue hypothesis. In Falk, D., & Gibson, K.R. (Eds). *External Anatomy of the Primate Cerebral Cortex*. Cambridge: Cambridge University Press. 57-78.

Andics, A., & Miklósi, Á. (2018). Neural processes of vocal social perception: dog-human comparative fMRI studies. *Neuroscience and Biobehavioral Reviews, 85*, 54-64.

Andics, A., Gácsi, M., Faragó, T., Kis, A., & Miklósi, Á. (2014). Voice-sensitive regions in the dog and human brain are revealed by comparative fMRI. *Current Biology, 24*, 574-578.

Aranguren, B., Revedin, A., Amico, N., Cavulli, F., Giachi, G., Grimaldi, S., Macchioni, N.. & Santaniello, F. (2018). Wooden tools and fire technology in the early Neanderthal site of Poggetti Vecchi (Italy). *PNAS* https://doi.org/10.1073/pnas.1716068115.

Armitage, S., Jasim, S., Marks, A., Parker, A., Usik, V., Uerpmann, H-P. (2011). The southern route "Out of Africa": evidence for an early expansion of modern humans into Arabia. *Science, 331*, 453-456.

Arsuaga, J.L., Carretero, J.M., Lorenzo, C., Gomez-Olivencia, A., Pablos, A., Rodriguez, L., & Carbonell, E. (2015). Postcranial morphology of the middle Pleistocene humans from Sima de los Huesos, Spain. *PNAS, 112*, 11524-11529.

Bae, C.J., Douka, K., & Petraglia, M.D. (2017). On the origin of modern humans: Asian perspectives. *Science, 358(6368)*, eaai9067.

Bailey, D.H., & Geary, D.C. (2009). Hominid brain structure: testing climatic, ecological and social competition models. *Human Nature, 20*, 67-79.

Balzeau, A., Gilissen, E., Holloway, R.L., Prima, S., & Grimaud-Herve, D. (2014). Variations in size, shape and asymmetries of the third frontal convolution in hominids: Paleoneurological implications for hominin evolution and the origin of language. *Journal of Human Evolution, 76*, 116-128.

Beaudet, A. (2017). The emergence of language in the hominin lineage: perspectives from fossil endocasts. *Frontiers in Human Neuroscience, 11*, 427.

Behar, D.M., Villems, R., Soodyall, H., Blue-Smith, J., Pereira, L., Metspalu, E., Scozzari, R., & Makkan, H. et al. (2008). The dawn of human matrilineal diversity. *American Journal of Human Genetics, 82*, 1130-1140.

Belyaev, D.K. (1979). Destabilizing selection as a factor in domestication. *Journal of Heredity, 70(5)*, 301-308.

Benítez-Burraco, A. & Boeckx, C. (2015). Possible functional links among brain- and skull-related genes selected in modern humans. *Frontiers in Psychology, 6*, 794.

Boas, F. (1938). *The Mind of Primitive Man*. New York: Macmillan.

Bolender, J. (2007). Prehistoric cognition by description: a Russellian approach to the upper paleolithic. *Biology and Philosophy, 22*, 383-399.

Botha, R. (2011). Inferring modern language from ancient objects. In Gibson, K.R., & Tallerman, M. (Eds). *The Oxford Handbook of Language Evolution*. Oxford: Oxford University Press. 303-312.

Broca, P. (1861). Perte de la parole. Ramollissement chronique et destruction partielle du lobe anterieur gauche du cerveau. *Bulletin de la Société Anthropologique, 2*, 235-238.

Bruner, E. (2010). The evolution of the parietal cortical areas in the human genus: between structure and cognition. In Broadfield, D., Yuan, M., Schick, K., & Toth, N. (Eds). *The Human Brain Evolving: Palaeoneurological Studies in Honour of Ralph L. Holloway*. Gosport, IN: Stone Age Institute Press.

Calarco, J.A., Xing, Y., Caceres, M., Calarco, J.P., Xiao, X., Pan, Q., Lee, C., Preuss, T.M., & Blencowe, B.J. (2007). Global analysis of alternative splicing differences between humans and chimpanzees. *Genes & Development, 21*, 2963-2975.

Cataldo, D.M., Migliano, A.B., & Vinicius, L. (2018). Speech, stone tool-making and the evolution of language. *PLoS ONE, 13(1)*, e0191071.

Chakravarti, A. (2011). Genomics is not enough. *Science, 334(6052)*, 15.

Chomsky, N. (2010). Some simple evo devo theses: how true might they be for language? In Larson, R.K., Déprez, V., & Yamakido, H. (Eds). *The Evolution of Human Language: Biolinguistic Perspectives*. Cambridge: Cambridge University Press. 45-62.

Conard, N.J., Malina, M., & Münzel, S.C. (2009). New flutes document the earliest musical tradition in southwestern Germany. *Nature, 460*, 737-740.

Corballis, M. (2017). Language evolution: a changing perspective. *Trends in Cognitive Sciences* 21(4): 229-236.

Coyne, J.A. (2009). *Why Evolution is True*. Oxford: Oxford University Press.

Dax, G. (1863). Observations tendant a prouver la coïncidence constante des d'erangements de la parole avec une lesion de l'hemisphere gauche du cerveau. *C. R. Hebdomadaire des Séances Académie Science, 61*, 534.

Darwin, C. (1871). *The Descent of Man and Selection in Relation to Sex*. London: John Murray.

DeCasien, A.R., Williams, S.A., & Higham, J.P. (2017). Primate brain size is predicted by diet but not sociality. *Nature Ecology & Evolution, 1*, 0112.

DeSalle, R., & Tattersall, I. (2017). What aDNA can (and cannot) tell us about the emergence of language and speech. *Journal of Language Evolution* doi:10.1093/jole/lzx018.

Diller, K.C., & Cann, R.L. (2013). Genetics, evolution, and the innateness of language. In Botha, R., & Everaert, M. (Eds). *The Evolutionary Emergence of Language: Evidence and Inference*. Oxford: Oxford University Press. 244-258.

Enard, W., Przeworski, M., Fisher, S.E., Lai, C.S.L., Wiebe, V., Kitano, T., Monaco, A.P., & Pääbo, S. (2002). Molecular evolution of FOXP2, a gene involved in speech and language. *Nature, 418*, 869-872.

Everett, D.L. (2017). Grammar came later: triality of patterning and the gradual evolution of language. *Journal of Neurolinguistics, 43*, 133-165.

Fagundes, N., Ray, N., Beaumont, M., Neuenschwander, S., Salzano, F., Bonatto, S., & Excoffier, L. (2007). Statistical evaluation of alternative models of human evolution. *PNAS, 104*, 17614-17619.

Falkum, I.L., & Vicente, A. (2015). Polysemy: current perspectives and approaches. *Lingua, 157*, 1-16.

Fisher, S.E. (2013). Building bridges between genes, brains, and language. In Bolhuis, J.J., & Everaert, M. (Eds). *Birdsong, Speech, and Language: Exploring the Evolution of Mind and Brain*. Cambridge, MA: MIT Press. 425-454.

Friederici, A.D. (2017). *Language in Our Brain*. Cambridge, MA: MIT Press.

Gibbons, A. (2012). Turning back the clock: Slowing the pace of prehistory. *Science, 338*, 189-191.

Gibson, K.R. (1993). Tool use, language and social behavior in relationship to information processing capacities. In Gibson, K.R., & Ingold, T. (Eds). *Tools, Language and Cognition in Human Evolution*. Cambridge: Cambridge University Press. 251-269.

Goodman, M. (1985). Rates of molecular evolution: the hominoid slowdown. *BioEssays, 3(1)*, 9-14.

Green, R.E., Krause, J., Briggs, A.W., Maricic, T., Stenzel, U., Kircher, M. et al. (2010). A draft sequence of the Neandertal genome. *Science, 328(5979)*, 710-722.

Gronau, I., Hubisz, M.J., Gulko, B., Danko, C.G., & Siepel, A. (2011). Bayesian inference of ancient human demography from individual genome sequences. *Nature Genetics, 43*, 1031-1034.

Hammer, M.F., Woerner, A.E., Mendez, F.L., Watkins, J.C., & Wall, J.D. (2011). Genetic evidence for archaic admixture in Africa. *PNAS, 108*, 15123-15128.

Hare, B., Wobber, B., & Wrangham, R. (2012). The self-domestication hypothesis: evolution of bonobo psychology is due to selection against aggression. *Animal Behaviour, 83(3)*, 573-585.

Hauser, M., & Watumull, J. (2017). The Universal Generative Faculty: The source of our expressive power in language, mathematics, morality, and music. *Journal of Neurolinguistics, 43(B)*, 78-94.

Hecht, E.E., Gutman, D.A., Khreisheh, N., Taylor, S.V., Kilner, J., Faisal, A.A., Bradley, B.A., Chaminade, T., & Stout, D. (2015). Acquisition of Peleolithic toolmaking abilities involves structural remodelling to inferior frontoparietal regions. *Brain Structure and Function, 220*, 2315-2331.

Hillert, D. (2015). On the evolving biology of language. *Frontiers in Psychology, 6*, 1796.

Hoffecker, J.F. (2018). The complexity of Neanderthal technology. *PNAS* https://doi.org/10.1073/pnas.1800461115.

Hornstein, N. (2009). *A Theory of Syntax: Minimal Operations and Universal Grammar*. Cambridge: Cambridge University Press.

Hurford, J.R. (2011). *The Origins of Grammar*. Oxford: Oxford University Press.

Huybregts, M.A.C. (2017). Phonemic clicks and the mapping asymmetry: how language emerged and speech developed. *Neuroscience and Biobehavioral Reviews, 81*, 279-294.

Ike-uchi, M. (2016). Proposing the hypothesis of an earlier emergence of the human language faculty. In Fujita, K., & Boeckx, C. (Eds). *Advances in Biolinguistics: The Human Language Faculty and its Biological Basis*. London: Routledge. 291-305.

Katahira, K., Suzuki, K., Kagawa, H., & Okanoya, K. (2013). A simple explanation for the evolution of complex song syntax in Bengalese finches. *Biology Letters, 9(6)*, 20130842.

Kherdjemil, Y., Lalonde, R.L., Sheth, R., Dumouchel, A., de Martino, G., Pineault, K.M., Wellik, D.M., Scott Stadler, H., Akimenko, M.-A., & Kmita, M. (2016). Evolution of *Hoxa11* regulation in vertebrates is linked to the pentadactyl state. *Nature, 539*, 89-92.

Kibblewhite, M., Tóth, G., & Hermann, T. (2015). Predicting the preservation of cultural artefacts and buried materials in soil. *Science of the Total Environment, 529*, 249-263.

Kubo, D., Kono, R.T., & Kaifu, Y. (2013). Brain size of *Homo floresiensis* and its evolutionary implications. *Proceedings of the Royal Society B, 280*, 20130338.

Kuhlwilm, M., Gronau, I., Hubisz, M.J., de Filippo, C., Prado-Martinez, J., Kircher, M., Fu, Q., Burbano, H.A. et al. (2016). Ancient gene flow from early modern humans into Eastern Neanderthals. *Nature, 530*, 429-433.

Lai, C.S., Gerrelli, D., Monaco, A.P., Fisher, S.E., & Copp, A.J. (2003). FOXP2 expression during brain development coincides with adult sites of pathology in a severe speech and language disorder. *Brain, 126*, 2455-2462.

Lansverk, A.L., London, S.E., Griffith, S.C., Clayton, D.F., & Balakrishnan, C.N. (2018). The variability of song variability in wild and domesticated zebra finches *Taeniopygia guttata*. *bioRxiv* https://doi.org/10.1101/263913.

Le Douarin, N.M. (1980). The ontogeny of the neural crest in avian embryo chimaeras. *Nature, 286*, 663-669.

Mann, A. (2011). The *Homo* and the origins of 'humanness'. In Gibson, K.R., & Tallerman, M. (Eds). *The Oxford Handbook of Language Evolution*. Oxford: Oxford University Press. 273-281.

Maricic, T., Günther, V., Georgiev, O., Gehre, S., Ćurlin, M., Schreiweis, C., Naumann, R., & Burbano, H.A. (2013). A recent evolutionary change affects a regulatory element in the human FOXP2 gene. *Molecular Biology and Evolution, 30(4)*, 844-852.

Marquez, J.R. (2017). Humans, unlike monkeys, turn competitive situation into cooperative one. *Phys.org* https://phys.org/news/2017-12-humans-monkeys-competitive-situation-cooperative.html.

McBrearty, S. (2012). Sharpening the mind. *Nature, 491*, 531-532.

McDougall, I., Brown, F.H., & Fleagle, J.G. (2005). Stratigraphic placement and age of modern humans from Kibish, Ethiopia. *Nature, 433*, 733-736.

Mellars, P. (2006). Why did modern human populations disperse from Africa ca. 60,000 years ago? A new model. *PNAS, 103(25)*, 9381-6.

Miyagawa, S., Lesure, C., & Nóbrega, V.A. (2018). Cross-modality information transfer: a hypothesis about the relationship among prehistoric cave paintings, symbolic thinking, and the emergence of language. *Frontiers in Psychology* doi:10.3389/fpsyg.2018.00115.

Moisik, S.R., & Dediu, D. (2017). Anatomical biasing and clicks: evidence from biomechanical modelling. *Journal of Language Evolution, 2(1)*, 37-51.

Mounier, A., Balzeau, A., Caparros, M., & Grimaud-Hervé, D. (2016). Brain, calvarium, cladistics: a new approach to an old question, who are modern humans and Neanderthals? *Journal of Human Evolution, 92*, 22-36.

Mountford, H.S., & Newbury, D.F. (2018). The genomic landscape of language: insights into evolution. *Journal of Language Evolution, 3(1)*, 49-58.

Morgan, T.J., Uomini, N.T., Rendell, L.E., Chouinard-Thuly, L., Street, S.E., Lewis, H.M., Cross, C.P., Evans, C. et al. (2015). Experimental evidence for the co-evolution of hominin tool-making teaching and language. *Nature Communications, 6*, 6029.

Mosca, S., Raponi, M., Meneghello, A., Buratti, E., Woods, C.G., & Baralle, D. (2017). Human NDE1 splicing and mammalian brain development. *Scientific Reports, 7*, 43504.

Murphy, E. (2015). Labels, cognomes and cyclic computation: an ethological perspective. *Frontiers in Psychology, 6*, 715.

Murphy, E. (2016a). Evolutionary monkey oscillomics: generating linking hypotheses from preserved brain rhythms. *Theoretical Linguistics, 42*(1-2), 117-137.

Murphy, E. (2016b). Phasal eliminativism, anti-lexicalism, and the status of the unarticulated. *Biolinguistics* 10: 21-50.

Murphy, E. (2018). Interfaces (travelling oscillations) + recursion (delta-theta code) = language. Luef, E., & Manuela, M. (Eds). *The Talking Species: Perspectives on the Evolutionary, Neuronal and Cultural Foundations of Language.* Graz: Unipress Graz Verlag. 251-269.

Murphy, E. (2019). Anarchism and science. Levy, C., & Adams, M.S. (Eds). *The Palgrave Handbook of Anarchism*. London: Palgrave Macmillan. 193-209.

Murphy, E. (Forthcoming). Acceptability properties of abstract senses in copredication. Bolognesi, M., & Steen, G. (Eds). *Perspectives on Abstract Concepts: From Cognitive Processing to Semantic Representation and Linguistic Expression*. Human Cognitive Processing Series. Amsterdam: John Benjamins.

Murphy, E., & Benítez-Burraco, A. (2017). Language deficits in schizophrenia and autism as related oscillatory connectomopathies: an evolutionary account. *Neuroscience & Biobehavioral Reviews, 83*, 742-764.

Murphy, E., & Benítez-Burraco, A. (2018). Toward the language oscillogenome. *Frontiers in Psychology, 9*, 1999.

Murphy, E., & Benítez-Burraco, A. (In Press). Paleo-oscillomics: inferring aspects of Neanderthal language abilities from gene regulation of neural oscillations. *Journal of Anthropological Sciences, 96*.

Neubauer, S., Hublin, J-J., & Gunz, P. (2018). The evolution of modern human brain shape. *Science Advances, 4*, eaao5961.

Nielsen, R., Akey, J.M., Jakobsson, M., Pritchard, J.K., Tishkoff, S., & Willerslev, E. (2017). Tracing the peopling of the world through genomics. *Nature, 541*, 302-310.

Nozaradan, S., Schwartze, M., Obermeier, C., & Kotz, S.A. (2017). Specific contributions of basal ganglia and cerebellum to the neural tracking of rhythm. *Cortex, 95*, 156-168.

Obleser, J., Henry, M.J., & Lakatos, P. (2017). What do we talk about when we talk about rhythm? *PLoS ONE, 15(9)*, e2002794.

Ogihara, N., Amano, H., Kikuchi, T., Morita, Y., Suzuki, H., & Kondo, O. (2018). Digital Reconstruction of Neanderthal and Early *Homo sapiens* Endocasts. In Bruner, E., Ogihara, N., & Tanabe, H. (Eds). *Digital Endocasts: From Skulls to Brains*. Replacement of Neanderthals by Modern Humans Series. Tokyo: Springer.

Okanoya, K. (2012). Behavioural factors governing song complexity in Bengalese finches. *International Journal of Comparative Psychology, 25(1)*, 44-59.

Okanoya, K. (2013). Finite-state song syntax in Bengalese finches: sensorimotor evidence, developmental processes, and formal procedures for syntax extraction. In Bolhuis, J.J., & Everaert, M. (Eds). *Birdsong, Speech, and Language: Exploring the Evolution of Mind and Brain*. Cambridge, MA: MIT Press. 229-242.

Olkowicz, S., Kocourek, M., Lučan, R.K., Porteš, M., Fitch, W.T., Herculano-Houzel, S., & Němec, P. (2016). Birds have primate-like numbers of neurons in the forebrain. *PNAS, 113(26)*, 7255-7260.

Peterson, J.B. (1999). *Maps of Meaning: The Architecture of Belief.* New York: Routledge.

Peterson, J.B. (2018). *12 Rules for Life: An Antidote to Chaos.* Random House Canada.

Pidoux, L., Le Blanc, P., Levenes, C., & Leblois, A. (2018). A subcortical circuit linking the cerebellum to the basal ganglia engaged in vocal learning. *eLife, 7*, e32167.

Prüfer, K., Racimo, F., Patterson, N., Jay, F., Sankararaman, S., Sawyer, S., Heinze, A., Renaud, G. et al. (2014). The complete genome sequence of a Neanderthal from the Altai Mountains. *Nature, 505(7481)*, 43-49.

Pustejovsky, J. (1995). *The Generative Lexicon*. Cambridge, MA: MIT Press.

Pustejovsky, J. (2008). *From Concepts to Meaning*. Cambridge, MA: MIT Press.

Rose, J., Usik, V., Marks, A., Hilbert, Y., Galletti, C., Parton, A., Geiling, J.M., Černý, V., Worley, M., & Roberts, R. (2011). The Nubian Complex of Dhofar, Oman: An African Middle Stone Age industry in southern Arabia. *PLoS ONE, 6(11)*, e28239.

Scally, A., & Durbin, R. (2012). Revising the human mutation rate: implications for understanding human evolution. *Nature Reviews Genetics, 13*, 745-753.

Sengupta, B., Stemmler, M.B., & Friston, K.J. (2013). Information and efficiency in the nervous system – a synthesis. *PLoS Computational Biology, 9(7)*, e1003157.

Serpell, J. (1995). *The Domestic Dog: Its Evolution, Behaviour and Interactions with People*. Cambridge: Cambridge University Press.

Simpson, G.G. (1949). *The Meaning of Evolution*. Yale University Press.

Smaers, J.B., Turner, A.H., Gómez-Robles, A., & Sherwood, C.C. (2018). A cerebellar substrate for cognition evolved multiple times independently in mammals. *eLife, 7*, e35696.

Sousa de, A.A., & Wood, B. (2007). The hominin fossil record and the emergence of the modern human central nervous system. In Preuss, T.M., & Kaas, J.H. (Eds.). *The Evolution of Primate Nervous Systems. Evolution of Nervous Systems*. Vol. 4. Oxford: Academic Press. 291-336.

Stout, D., & Chaminade, T. (2012). Stone tools, language and the brain in human evolution. *Philosophical Transactions of the Royal Society B, 367*, 75-87.

Stringer, C. (2016). The origin and evolution of *Homo sapiens*. *Philosophical Transactions of the Royal Society B, 371*, 20150237.

Studdert-Kennedy, M., & Terrace, H. (2017). In the beginning: a review of Robert C. Berwick and Noam Chomsky's *Why Only Us*. *Journal of Language Evolution, 2(2)*, 114-125.

Tanabe, H.C., Kubo, D., Hasegawa, K., Kochiyama, T., & Kondo, O. (2018). Cerebellum: anatomy, physiology, function, and evolution. In Bruner, E., Ogihara, N., & Tanabe, H. (Eds). *Digital Endocasts: From Skulls to Brains*. Replacement of Neanderthals by Modern Humans Series. Tokyo: Springer.

Texier, P.-J., Porraz, G., Parkington, J., Rigaud, J.-P., Poggenpoel, C., Miller, C., Tribolo, C., Cartwright, C. et al. (2010). A Howiesons Poort tradition of engraving ostrich eggshell containers dated to 60,000 ago at Diepkloof Rock Shelter, South Africa. *PNAS, 107(4)*, 6180-6185.

Theofanopoulou, C., Gastaldon, S., O'Rourke, T., Samuels, B.D., Messner, A., Martins, P.T., Delogu, F., Alamri, S., & Boeckx, C. (2017). Self-domestication in *Homo sapiens*: insights from comparative genomics. *PLoS ONE, 12(10)*, e0185306.

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: the origins of cultural cognition. *Behavioral and Brain Sciences, 28*, 675-691.

Uomini, N.T., & Meyer, G.F. (2013). Shared brain lateralization patterns in language and Acheulean stone tool production: a functional transcranial Doppler ultrasound study. *PLoS ONE, 8*, e72693.

Vanhaeren, M., d'Errico, F., Stringer, C., James, S.L., Todd, J.A., & Mienis, H.K. (2006). Middle Paleolithic shell beads in Israel and Algeria. *Science, 312(5781)*, 1785-1788.

Varki, A., & Altheide, T.K. (2005). Comparing the human and chimpanzee genomes: searching for needles in a haystack. *Genome Research, 15(12)*, 1746-1758.

Vernes, S.C., Spiteri, E., Nicod, J., Groszer, M., Taylor, J.M., Davies, K.E., Geschwind, D.H., & Fisher, S.E. (2007). High-throughput analysis of promoter occupancy reveals direct neural targets of FOXP2, a gene mutated in speech and language disorders. *American Journal of Human Genetics, 81(6)*, 1232-1250.

Weaver, T.D., Roseman, C.C., & Stringer C.B. (2008). Close correspondence between quantitative- and molecular-genetic divergence times for Neandertals and modern humans. *PNAS, 105*, 4645-4649.

Weaver, T.D., & Stringer, C.B. (2015). Unconstrained cranial evolution in Neandertals and modern humans compared to common chimpanzees. *Proceedings of the Royal Society B, 282*, 20151519.

Wilkins, A.S., Wrangham, R.W., & Fitch, W.T. (2014). The "domestication syndrome" in mammals: a unified explanation based on neural crest cell behavior and genetics. *Genetics, 197*, 795-808.

Wood, B.A., & Bauernfeind, A.L. (2011). The fossil record: evidence for speech in early hominins. In Gibson, K.R., & Tallerman, M. (Eds). *The Oxford Handbook of Language Evolution*. Oxford: Oxford University Press. 258-272.

Wrangham, R. (2009). *Catching Fire: How Cooking Made Us Human*. New York: Basic Books.

Zeder, M.A. (2012). Pathways to animal domestication. In Gepts, P. et al. (Eds). *Biodiversity in Agriculture: Domestication, Evolution and Sustainability*. Cambridge: Cambridge University Press. 227-259.

Zhang, Y.E., Landback, P., Vibranovski, M.D., & Long, M. (2011). Accelerated recruitment of new brain development genes into the human genome. *PLoS Biology, 9(10)*, e1001179.

Zollikofer, C.P., & Ponce de León, M.S. (2013). Pandora's growing box: Inferring the evolution and development of hominin brains from endocasts. *Evolutionary Anthropology, 22*, 20-33.

Contrast, Contrastive Focus, and Focus Fronting*

Vieri Samek-Lodovici

Abstract

This paper compares the definitions of contrast in Krifka (2008) and Neeleman and Vermeulen (2012) carefully establishing whether they predict contrast to be present or absent across five types of conversational exchanges: open questions, closed questions, and corrective, confirmative, and additive exchanges. Using focus fronting in British English as a cue for the presence of contrast, it also shows that Neeleman and Vermeulen's definition better fits the distribution of contrast across the examined exchanges.

The paper also shows that focus à la Rooth (1992, 1995) plus contrast is sufficient to model focalization across the five exchange types examined here, thus arguing against treating separate focus-eliticing exchanges as corresponding to different types of focalization.

Keywords: Contrast, Focus, Fronting, Common Ground

1 Introduction

The distinction between contrastive and non-contrastive focalization plays a fundamental role in the study of information structure where contrastive foci are described as able to front while non-contrastive foci remain in-situ[1] (Rizzi, 1997, 2004; Belletti 2001, 2004; and much subsequent literature). Despite its importance, the definition of *contrast*, and the associated notion of *contrastive focus*, are still under debate; see amongst others Rooth (1992), Büring (1997, 2003), Kiss (1998), Molnár (2002), Kenesei (2006), Zimmerman (2007, 2008), Krifka (2008), Repp (2010, 2016), Horvath (2010), Krifka & Musan (2012), Neeleman & Vermeulen (2012). as well as the several articles in Molnár & Winkler (2006) and Repp & Cook (2010).

In order to progress, we need to systematically identify the linguistic domains where different analyses make divergent predictions, as this enables their testing. This paper takes a step in this direction by carefully comparing the definition of contrast in Krifka (2008), which requires contrast with propositions in the common ground, against the definition in Neeleman and Vermeulen (2012), which requires the intended denial by the speaker of one of the alternative propositions evoked by focalization. While the two definitions are clearly different, the original papers describing them do not discuss their differences in sufficient detail, leaving unclear their status relative to each other. Does one definition subsume the other? Or are they genuinely distinct? In the latter case, do we need both?

To answer these questions, this paper examines five distinct focus-eliciting conversational exchanges, several of them left undiscussed or only briefly touched in Krifka's and N&V's papers: open and closed questions, corrective exchanges, four types of

* I am very grateful to the students of my 2015, 2016, and 2017 "Reading in Syntax A" course at UCL Linguistics. They provided the informal judgements mentioned in the appendix and very kindly listened to the thoughts underlying this paper when it was still unclear where they would lead to. I am also grateful to the 2016 LAGB audience of a related talk.

[1] Whereto do contrastive foci front to is a separate issue. Many scholars would assume they move to the high left-peripheral focus projection posited by Rizzi (1997, 2004). Others disagree. For example, Samek-Lodovici (2015) provides several pieces of evidence showing that Italian contrastive foci stay in-situ except when forced into a fronted position by right-dislocation, while Abels (2017) calls into question the crosslinguistic evidence usually assumed to support the existence of a left-peripheral focus projection.

confirmative exchanges, and two types of additive exchanges (all exchange types are described in detail in later sections). For each exchange, the paper examines which definition predicts contrast to be present and which absent.

The main result of the paper is the detection of four exchanges where Krifka's and N&V's definitions make divergent predictions: closed question exchanges, two types of confirmative exchanges, and one type of affirmative exchanges. The detected exchanges also prove that the two definitions do not subsume each other since the two exchanges predicted to involve contrast by N&V's definition are expected to lack contrast under Krifka's definition, and vice versa for the other two exchanges.

These four exchanges also provide the ideal place for the empirically testing of the two definitions. Full experimental testing is beyond the scope of this paper, but I will discuss some observations that provide preliminary support for N&V's definition. The first concerns sentences where focalization is followed by continuation sentences that are consistent with just one definition, making a grammaticality assessment possible. The second concerns the examination of focus fronting as a proxy for the presence of contrast.

While this is not its immediate goal, this study also contributes to the issue of how many distinct types of focalization exist. The five main exchange types considered in this paper are shown to always involve focalization a la Rooth (1992), defined in terms of evoked alternative propositions. Contrast is independent. When it is present, focalization is also contrastive. Nothing else is necessary. Therefore, terms like 'corrective focus', 'confirmative focus', 'additive focus', etc, where focus is qualified in terms of the exchanges eliciting it, are misleading. They incorrectly suggest the existence of distinct types of focalization when focalization à la Rooth is sufficient. They also incorrectly suggest that contrast remains invariant within each exchange, whereas, as we will see, a single exchange type might involve focalization with or without contrast. This will be shown to be the case with confirmative and additive exchanges.

What this paper does not supply is a comprehensive comparison of all the existing alternative definitions of contrast available in the literature, although a few are briefly discussed in section 5 (see also Repp 2016). At the level of detail considered here, an exhaustive study of that type would quickly run into space restrictions and involve excessive complexity and clutter at the expense of clarity. Rather, the paper aims at taking a step in the direction of such a desired comprehensive comparison by spelling out the theoretical differences and predictions of Krifka's and N&V's notions of contrast in a reasonably short and self-contained paper.

Finally, in my experience many students, and even fellow scholars interested in the effects of focalization but not directly researching it, sometimes struggle with the notion of evoked propositions involved in Rooth's focalization. I want this paper to speak to these readers as well, and for this reason I made every reasoning step as explicit as possible. Apologies to any expert reader who might find some explanations a bit pedantic for them.

Section 2 introduces the notion of focalization à la Rooth as well as the definitions of contrast by N&V (2012) and Krifka (2008), illustrating all of them through corrective and open question exchanges. Section 3 deepens the comparison by examining the predictions of both definitions across closed questions, confirmative exchanges, and additive exchanges. Section 4 describes the preliminary observations supporting N&V's definition. Section 5 concludes with some brief reflections over the potential extension of these results to other notions of contrast, other focalization exchanges, and other languages.

2 Focus and Contrast according to Krifka (2008) and N&V (2012)

Krifka (2008) and N&V (2012) follow Rooth (1985, 1992) in maintaining that the distinctive property of focalization, here considered independently from the presence of contrast and hence even when focalization is non-contrastive, is the evocation of alternatives. The open question in (1) denotes the set of propositions in (2), where each proposition involves a different subject (Hamblin 1973). In turn, answer (1)B signals that it is an appropriate answer to question (1)A by focusing the subject "EDE" (stress is represented in capitals). Focalization of the subject ensures that (1)B, too, is associated to a set of alternative propositions – what Rooth defines as its 'focus value' – created by replacing the referent of the subject with suitable potential alternatives. While the ordinary meaning of (1)B is the single proposition *wants(Ede,coffee)*, its focus value is the set of propositions in (3).

(1) A: Who wants coffee? (Rooth, 1992)
B: EDE_F wants coffee.

(2) Set of propositions denoted by question A:
{wants(John,coffee), wants(Ede,coffee), wants(Bill,coffee), etc.}

(3) Set of propositions evoked by answer B via focalization (i.e. the focus value of B):
{wants(John,coffee), wants(Ede,coffee), wants(Bill,coffee), etc.}

Focalization, amongst other functions, governs the coherence of conversational exchanges by signalling that the current conversational move is appropriate under the explicit or implicit question that is being discussed. As Rooth showed, focalization executes this crucial function by evoking sets of propositions as the focus value of a sentence and then comparing this set with the set denoted by the explicit or implicit questions under discussion.

For example, as speakers, we intuitively assess that the question/answer exchange in (1) is felicitous because the set of propositions denoted by question (1)A is a subset of the set of propositions evoked through focalization by answer (1)B (Rooth 1992).[2] When this subset relation does not hold, the exchange becomes incongruous, and hence infelicitous. For example, if B placed main stress on the object, as in (4)B, focalization would have shifted to the object[3]. This affects the focus value of (4)B, which contains propositions involving different object-referents like 'Ede wants tea', 'Ede wants coffee', 'Ede wants milk', see (5). This set does not contain the set of propositions denoted by the question listed in (2) since the only proposition shared by both sets is 'Ede wants coffee'. Consequently, the exchange is assessed as infelicitous (as represented by the symbol '#').[4]

(4) A: Who wants coffee? (Rooth, 1992)
B: # Ede wants $COFFEE_F$.

[2] Not everyone agrees on the role of focalization in question/answer congruence. Krifka (2004) offers some countercases. See also section 7 in Kratzer & Selkirk (2018).

[3] Technically, answer (4) is ambiguous because focus could also fall on the entire sentence. I am leaving this case aside, as it adds nothing to the discussion.

[4] Students are often taught that in a question/answer exchange, the focused constituent in the answer is the constituent that corresponds to the wh-phrase in the corresponding question. Many scholars also use this rule of thumb as a quick and helpful definition of focus and I suspect I have committed the same sin myself. While extremely useful when teaching, this definition is misleading. It creates the impression that focus in the answer is determined by the question. Under Rooth's definition, though, focalization in the answer occurs independently from the question. As example (4) shows, B remains free to use stress to focus the subject or the object. Only after focus has been assigned we may determine whether B's statement is an appropriate, congruous, answer to the question under discussion, or not.

(5) Set of propositions evoked by (4)B via focalization (i.e. the focus value of B):
{wants(Ede,tea), wants(Ede,coffee), wants(Ede,milk), etc.}

Conversational exchanges eliciting focalization might or might not also involve contrast.[5] There are several very different notions of contrast in the literature, see the brief excellent introduction in Repp (2016). This paper only considers the definition of contrast provided in Krifka (2008) and N&V (2012). When contrast is absent, their analyses converge because, as mentioned, they share the same analysis of focalization, namely Rooth (1992). For example, open questions exchanges like (1) above are considered by both analyses as prototypically lacking contrast. Consequently, both converge in viewing the subject in (1)B as non-contrastively focused and evoking a set of alternative propositions via focalization à la Rooth as just described.[6]

Krifka (2008) and N&V (2012), however, diverge in their conception of contrast. Consider for example corrective conversational exchanges like (6), which both assume to prototypically involve contrast.

Following Molnár (2002) and Valduví & Vilkuna (1998) amongst others, N&V (2012, p.12) maintain that *contrast* is an information structure primitive with its own independent semantic content. Following similar insights in Kenesei (2006) and Repp (2010), N&V propose that contrast signals that at least one of the alternative propositions evoked by focalization does not hold (or,to put it in N&V's terms, that what holds is the negation of that proposition).

For example, in the corrective exchange in (6), the subject of (6)B is contrastively focused. Focus evokes a set of alternative propositions of the type *wants(x,coffee)* with *x* ranging over people known to A and B as in (7). Contrast entails that one of the alternative propositions evoked by focalization is denied. In corrective exchanges like (7), the denied proposition is the one being corrected, namely the proposition that John wants coffee.

(6) A: John wants coffee.
B: No. EDE_{F} wants coffee.

(7) Focus value of (6)B: {*wants(John,coffee)*, *wants(Ede,coffee)*, *wants(Bill,coffee)*, etc.}

---

[5] When contrast is absent, focus is said to be non-contrastive (a.k.a. 'presentational', and 'new-information' focus). When contrast is present, focus is said to be contrastive. Contrastive and non-contrastive focus are also often incorrectly referred to as *narrow* and *broad* focus. These latter terms are misleading because they refer to the size of the focused constituent, which does not perfectly correlate with its contrastive or non-contrastive nature. Instances of non-contrastive focus often involve large constituents, e.g. whole clauses, whereas instances of contrastive focus often involves short phrases, like DPs. These tendencies, however, have no theoretical import with respect to the definition of contrast because it is possible to contrastively focus large phrases and non-contrastively focus short ones, as is respectively the case in (1) and (2).

(1) A: You are $[_{\text{AP}}$ happy that John will visit you tomorrow].
B: No. I am $[_{\text{AP}}$ sad that Mary did not call me YESTERDAY$]_{\text{F}}$. *(Broad phrase, yet contrastively focused)*

(2) A: When did you meet Bill?
B: I met him $\text{YESTERDAY}_{\text{NewF}}$. (*Narrow phrase, yet non-contrastively focused*)

[6] To avoid any confusion, please note that for the two analyses considered in this paper the mere evocation of alternative propositions determined by Rooth's focalization has no bearance on the presence/absence of contrast, even if the evoked propositions might be described as contrasting with each other. This is worth stating, as some scholars do use the label 'contrast' as a description for the presence of focalization à la Rooth, see for example Kratzer & Selkirk (2018). Their notion of 'contrast' focus corresponds to focalization in absence of contrast in Krifka's and N&V's analyses.

The logical expression defining the semantic import of contrast for N&V is provided in (8). It departs slightly from N&V's original definition in its syntax, but not in its content. It states that whenever a sentence *s* undergoes contrastive focalization on some of its constituents, at least one alternative proposition *p* in the set of propositions evoked through focus by *s* (i.e. the focus value of *s*, expressed as $||s||^f$), does not hold. For N&V, contrast is added whenever a speaker wants to convey the semantic statement in (8), with context usually allowing the listeners to successfully identify which propositions are being denied.

(8) $\exists p \in ||s||^f$ such that $\neg p$
(At least one proposition *p* in the set $||s||^f$ evoked by focalization does not hold).

Krifka's definition of contrast (2008, p. 252, p. 259), instead, exploits the notion of common ground, which is defined as the information mutually known to be shared by all discourse participants. For Krifka contrast is present whenever the common ground contains at least one proposition from the focus value of the uttered sentence – i.e. one of its focus-evoked alternatives – and that proposition differs from the proposition denoted by the ordinary meaning of the uttered sentence.

For example, under Krifka's model, the focused subject of (6)B evokes the usual set of alternative propositions of the type *wants(x,coffee)* listed in (7). Contrast is present because the ordinary meaning of sentence (6)B, namely the proposition *wants(Ede,coffee)*, differs from the focus-evoked proposition *wants(John,coffee)* introduced into the common ground by (6)A.

It is worth adding that under Krifka's model only the ordinary meanings asserted in sentences (6)A and (6)B – i.e. the propositions *wants(John,coffee)* and *wants(Ede,coffee)* – become part of the common ground once they are uttered. The several propositions evoked by focalization do not enter the common ground, because being evoked via focalization is not sufficient to make a proposition shared knowledge. This is a necessary assumption for Krifka, or else his model would not be able to distinguish contrastive from non-contrastive focus, since the alternative propositions evoked by focalization would always enter the common ground and always contrast with the ordinary meaning of the uttered sentence.

The same assumption applies to questions, which are also banned from entering the propositions they denote into the common ground. This, too, is a necessary assumption, given Krifka's view that open question exchanges like (1), repeated in (9), lack contrast. The propositions denoted by the question must remain outside the common ground, otherwise they would inevitably contrast with the ordinary meaning of the answer, making open questions contrastive. Indeed, Krifka (2008, p. 246) explains that questions express the need for information but do not add factual information to the common ground; a point worth remembering since it will become relevant later on. For example, in (9), none of the propositions of the form *wants(x,coffee)* denoted by question (9)A enters the common ground, which remains empty. Consequently, the focalization of the subject in (9)B remains non-contrastive, because the ordinary meaning of (9)B, namely *wants(Ede,coffee*), does not contrast with any proposition in the (still empty) common ground.[7]

[7] In Krifka's own words, questions *manage* the common ground by calling for specific conversational moves that might update the common ground's content, even though questions never determine any update themselves. While generally agreeing with Krifka (2008), Repp (2010, p. 1336) identifies an interesting exception to Krifka's model. She notes that it should never be possible for answers to display contrast with questions, since the propositions denoted by questions do not enter the common ground. Yet, Repp points out, such cases exist. In (1), B's sentence is not Rooth-congruous with A's question and yet it is felicitous. It's felicity appears to emerge from the contrast with the proposition *drank(John,tea)* contained in the denotation of question (1)A, as

(9) A: Who wants coffee? (Rooth, 1992)
B: EDE_F wants coffee.

Summing up, Krifka and N&V define contrast differently. For N&V, contrast involves the denial of a focus-evoked alternative. For Krifka, it involves contrast with a focus-evoked proposition already in the common ground. These differences converge with respect to open questions and corrective exchanges, where contrast is predicted to be respectively absent and present by both Krifka's and N&V's definitions. They diverge, however, when we consider other types of exchanges.

3 Other types of conversational exchanges

This section examines whether contrast is predicted present or absent by either definition under closed questions, confirmative exchanges, and additive exchanges. I consider them in turn.

3.1 Closed question exchanges

Closed questions are like open questions except that the range of possible alternatives is expressed in the question itself, see (10). For Krifka (2008), closed and open questions are inevitably identical as far as contrast is concerned. Closed questions restrict the set of alternative propositions they denote through the overt alternatives they list, but otherwise they are questions, and therefore like open questions they do not add those propositions to the common ground. Consequently, no contrast ensues in exchanges like (10). Under Krifka's definition, focalization in out-of-the-blue closed questions always lack contrast.

(10) A: Who wants coffee, John or Ede?
B: EDE_F wants coffee.

N&V (2012, p. 8), instead, view closed questions as involving contrast. They describe example (11) below as similar to focalization in corrective exchanges, where focus is contrastive. Under their definition of contrast, this requires that sentence (11)B is uttered with the intention to deny the proposition *read(John,theExtendedPhenotype)*.

(11) A: What did John read? The Selfish Gene or The Extended Phenotype? (N&V, 2012)
B: He read [the Selfish GENE]$_F$.

N&V (2012, p. 9) wonder whether the denied proposition could be the result of an implicature drawn on the basis of Gricean reasoning rather than emerging from the presence of contrast. As they notice later in the paper while discussing corrective exchanges, Gricean implicatures are cancellable, whereas the semantic import of contrast as they define it is not. We can apply this observation to closed questions. If they genuinely involve contrast à la N&V, then the implied denial of one of the focus-evoked propositions should not be

---

if the question had affected the common ground contra Krifka's assumptions.

(1) A: Did John drink tea?
B: $PETER_F$ drank tea.

cancellable. The best way to see that this is indeed the case is by comparing open questions with closed ones. As (12) shows, with open questions, the potential Gricean implicature that John read the Bible and no other contextually salient book is easily cancelled by adding the underlined continuation sentence in (12)B stating that John did read other books as well.

(12) A: What did John read this summer?
B: He read [the BIBLE]$_F$. <u>He read everything he could lay his hands on, QURAN included</u>.

With closed questions, instead, the contrast-induced implied proposition that John did not read the Quran cannot be cancelled, making the underlined continuation sentence in (13)B infelicitous. It follows that closed questions do trigger contrast under N&V's model.

(13) A: What did John read this summer? The Bible or the Quran?
B: He read [the BIBLE]$_F$. # <u>He read everything he could lay his hands on, QURAN included</u>.

Summing up, on closed questions Krifka's and N&V's definitions diverge. Krifka's necessarily models them as lacking contrast. N&V models them as involving contrast. Closed questions thus provide a first exchange type where it is possible to assess which notion of contrast provides a better model. The observation that focus in-situ in (13)B is incompatible with a continuation sentence excluding the denial of focus-evoked alternative propositions provides some initial support for N&V's model.

3.2 Confirmative exchanges

Confirmative exchanges occur when a sentence confirms a previous statement as in (14) and (15). Under Krifka's definition, the presence of contrast depends on the content of the common ground at the time of B's reply, whereas under N&V's it depends on whether speaker B intends to deny one of the focus-evoked propositions. We need to distinguish the four confirmative cases *Confirmative I*, *II*, *III*, and *IV* discussed in detail below.

(14) A: John read the Quran.
B: Yes, JOHN$_F$ read the Quran.

(15) *A and B are parents commenting on the activity of children at the local primary school*.
A: Bill hit Jack, yesterday.
B: Yes, he hit JACK$_F$, yesterday.

Confirmative I – The first case lacks contrast under both models. It occurs when the common ground contains no propositions and B's utterance is not intended to deny any focus-evoked proposition. An example is provided in (16). Sentence (16)A introduces the proposition *hit(Bill,Jack)* in the previously empty common ground. Speaker B confirms that Bill hit Jack and then adds the assertion that Bill hit everybody. Crucially, this is new information for A, not yet present in the common ground.

(16) *The common ground contains no propositions concerning Bill*.
A: Bill hit Jack, yesterday.
B: Yes, he hit JACK$_F$, yesterday. <u>In fact, he's hit everybody</u>.

The focalization on 'JACK' in (16)B is non-contrastive under Krifka's model because the common ground contains no propositions for B's reply to contrast with.[8] Contrast is absent under N&V as well (2012, p. 12), because B believes that Bill has hit every child and therefore there cannot be any proposition of the type *hit(Bill,x)*, for some salient child *x*, that B intends to deny.

Confirmative II – In this second case, contrast is predicted present under both models. This case occurs when confirmative exchanges are used to implicitly deny one of the alternative propositions evoked by focalization and the denied alternative is also in the common ground. Consider a scenario where the parents of the pupils of the local school have heard the rumour that Bill, a pupil, hit Tom, another particularly vulnerable pupil. The proposition *hit(Bill,Tom)* is then already in the common ground when parents A and B engage in the confirmative exchange in (17). Speaker B, who is Bill's father, believes that his son has hit many children but definitely not little Tom. When speaker A states that Bill hit Jack, B's reply confirms it, but it also emphatically focalizes the object 'Jack' in order to implicitly deny that Bill hit Tom. By placing main stress on 'Jack', B implies that yes, Bill hit Jack, and possibly other kids like Jack, but definitely not little Tom.

(17) *A and B are parents commenting on the activity of children at the local primary school. The proposition 'hit(Bill,Tom)' is inthe common ground, but speaker B intends to deny it*.
A: Bill hit Jack, yesterday.
B: Yes, he hit $JACK_F$, yesterday. (*Implied: but not Tom, as some parents believe*).

Under this scenario, the ordinary meaning of (17)B, namely *hit(Bill,Jack)*, contrasts with the focus-evoked proposition *hit(Bill,Tom)* in the common ground, making contrast present under Krifka's model (2008, p. 251-252). Since the proposition *hit(Bill,Tom)* is also implicitly denied by speaker Bill, contrast is also predicted present under N&V's model.

Confirmative III – By manipulating the common ground and the speakers' intentions, we can build scenarios where contrast is absent under Krifka's model and present under N&V's, and vice versa. The former case occurs when the ordinary meaning of the sentence containing focus does not contrast with propositions in the common ground, yet the speaker intends to deny at least one focus-evoked propositions. Consider (18), again occurring under the 'parents chatting at the local school' scenario, but now assume that when the exchange takes place the common ground is empty, i.e. there have been no prior rumours that Bill hit any children at all. Since there is no contrast with propositions in the common ground, contrast is absent for Krifka. Parent B's reply, however, still intends to deny any focus-evoked propositions suggesting that his son Bill has hit other children, as his following sentences make clear. Under these circumstances, contrast is predicted present under N&V's model.

(18) *A and B are parents commenting on the activity of children at the local primary school. There are no propositions in the common ground about Bill's past actions*.

[8] This particular scenario is not contemplated by Krifka (2008). Krifka's (2008, p. 251-252) original discussion describes confirmative exchanges as exchanges where "the focus alternatives must include a proposition that has been discussed in the immediately preceding common ground. It is expressed that among the alternatives the ordinary meaning is the only one that holds." In other words, Krifka is considering cases where the common ground contains propositions that are denied, in which case confirmative exchanges might involve contrast. Confirmative exchanges of this kind do exist and are discussed under the labels confirmative II and IV later in this section.

A: Bill hit Jack, yesterday.
B: Yes, he hit JACK$_F$, yesterday. But it was a one-off. He's a lovely boy! He's never picked fights with the other children!

Together with closed questions, confirmative III exchanges thus provide a second case where Krifka's and N&V's definitions diverge with respect to the presence/absence of contrast.

Confirmative IV – For the final confirmative scenario, let's once more consider our talking parents at the local school scenario, but now assume that the fact that Bill hit Tom is shared knowledge, hence in the common ground, and that parent B has no intention to challenge either this fact or any other evoked propositions. Contrast is then predicted present under Krifka's model because the proposition *hit(Bill,Jack)* asserted in (19)B contrasts with the proposition *hit(Bill,Tom)* already in the common ground. Contrast is however predicted absent under N&V's definition because as the underlined continuation sentence in (19)B shows, speaker B does not intend to deny any focus-evoked proposition of the type *hit(Bill,x)* with *x* ranging on the contextually salient pupils.

(19) *A and B are parents commenting on the activity of children at the local primary school. The proposition 'hit(Bill,Tom)' is part of the common ground and speaker B does not intend to dispute it.*
A: Bill hit Jack, yesterday.
B: Yes, he hit JACK$_F$, yesterday. <u>In fact, he hit everybody</u>.

To wrap up, in confirmative exchanges contrast is present or absent depending on the content of the common ground for Krifka's model, and the intention to deny focus-evoked propositions under N&V's. As summarized in the table below, the two definitions make identical predictions for confirmative exchanges I and II and diverge on exchanges III and IV. The fact that under each model contrast might be either present or absent is worth noticing, since it is not mentioned in either Krifka (2008) or N&V (2012).[9]

(20) Table 1

Contrast predicted present/absent	**Krifka (2008)**	**N&V (2012)**
Confirmative I No contrast with proposition in CG No denial of evoked alternatives	Absent	Absent
Confirmative II Contrast with proposition in CG Denial of evoked alternative	Present	Present
Confirmative III No contrast with proposition in CG	Absent	Present

[9] Some exchanges might appear to be confirmative when actually they are not. The sentences below, from Birner and Ward's corpus study (2009, p. 1174), might at first look as a confirmative case, since the second underlined sentence supports the content of the first sentence by confirming that 'she' spent time 'here'. But the expression 'five semesters' actually contrasts with 'two years' because it does not refer to the same length of time. Focus on "five semesters" is used to specify that the time-period under discussion is five semesters, rather than just four semesters, which is what two years would correspond to when counted in semesters. The exchange thus is of the corrective type, hence involving contrast, which, in turn, triggers focus fronting.

(1) She's been here two years. <u>[Five SEMESTERS]$_F$, she's been here</u>.

Denial of evoked alternative		
Confirmative IV Contrast with proposition in CG No denial of evoked alternatives	Present	Absent

Cases III and IV are the interesting ones since they enable testing of the two models. In so far focus fronting is a proxy for the presence of contrast, it is predicted possible in cases II and IV by Krifka's model, and cases II and III by N&V's model. I discuss these predictions in section 4, where we will see how the available evidence supports N&V's model.

3.3 Additive exchanges

An exchange is additive when at least one of the focus-evoked alternatives of a sentence is already in the common ground. See (21) where speaker A introduces in the common ground the proposition *wants(Bill,coffee),* to which speaker B adds the proposition *wants(Mary,coffee).*

For Krifka (2008, p. 259), additive exchanges necessarily involve contrast because the proposition added through B's reply inevitably contrasts with the proposition introduced in the common ground by A's assertion. For example, in (21) the new proposition *wants(Mary,coffee)* stated by B contrasts with *wants(John,coffee)* introduced in the common ground by A. Since both propositions belong to the set of alternative propositions evoked through focalization in B's sentence, contrast is present.

(21) A: John wants coffee.
B: MARY_{F} wants coffee, TOO. (Krifka, 2008, p. 259)

N&V do not discuss additive exchanges, but their definition of contrast forces a distinction between a first case where contrast is absent and a second case where contrast is present. I discuss them in turn.

Additive I – As is always the case with N&V's definition, contrast is absent whenever the speaker has no intention to deny any focus-evoked alternative. Assume for example that A and B are a couple with three children, Bill, Jack, and Tom, and that no other children are contextually salient. In (22), speaker A mentions that Bill hit Jack, and B replies that Bill also hit Tom. Under Krifka's definition, focalization on 'Tom' in (22)B involves contrast because the asserted proposition *hit(Bill,Tom)* contrasts with the proposition *hit(Bill,Jack)* already introduced in the common ground by speaker A. Under N&V's definition, instead, contrast is absent because the provided context is designed to ensure that the focus value of B's utterance contains only two evoked propositions: *hit(Bill,Jack),* and *hit(Bill,Tom).*[10] Since both are asserted and accepted by both speakers, there is no focus-evoked proposition left for B to deny.

(22) *A and B are the parents of Bill, Jack, and Tom and are discussing their children.*
No other children are contextually salient at the time of their conversation.
A: Bill hit Jack, yesterday.
B: Yes, he hit TOM_{F}, TOO.

Another, possibly simpler, example is given in (23). The exchange occurs at a workshop

[10] I am assuming that the proposition *hit(Bill,Bill),* where Bill hits himself, is contextually excluded. The two parents are discussing typical sibling fights, not self-harming.

involving ten people, all of them contextually salient. B's utterance focuses the subject *Mary*. As B's continuation sentence makes clear, every focus-evoked proposition of the type *wants(x,coffee)*, with *x* ranging over the workshop's participants, is considered true by B. Since no focus-evoked alternative proposition is denied, contrast is necessarily absent.

(23) A: John wants coffee.
B: MARY_F wants coffee, TOO. EVERYbody wants coffee!

We thus have found a third exchange where Krifka and N&V make divergent predictions. Once again we can use focus fronting to test them. As we will see in section 4, preliminary testing supports N&V's definition.

Additive II – As mentioned, additive exchanges between two speakers A and B inevitably involve contrast under Krifka's definition because by definition B's proposition contrasts with A's proposition, which just entered the common ground. Additive exchanges may involve contrast under N&V's definition as well, provided the speaker intends to deny at least one focus-evoked proposition.

Consider again the previous context, but now assume that A and B have *four* children, Bill, Jack, Tom, and Sarah. The presence of an additional sibling enables parent B to mention that Bill also hit Tom with the intention to implicitly deny that Bill hit even Sarah. In this scenario, the focus value of B's utterance contains the three propositions *hit(Bill,Jack)*, *hit(Bill,Tom)*, and *hit(Bill,Sarah)*.[11] B's utterance focuses Tom by heavily stressing it with the intention to deny the proposition *hit(Bill,Sarah)*.

(24) *A and B are the parents of Bill, Jack, Tom, and Sarah and are discussing their children. No other children are contextually salient at the time of their conversation*.
A: Bill hit Jack, yesterday.
B: Yes, he hit TOM_F, TOO. (*Implied: Jack it even Tom, but not Sarah.*)

Summing up, additive exchanges provide another case where – at least under N&V's definition – contrast is either present or absent within the same type of exchange depending on other conditions, here the speaker's intentions. Furthermore, additive I exchanges add a fourth case where N&V's and Krifka's definitions make divergent predictions.

4 Testing for the presence of contrast

When we put all the predictions identified so far together, we obtain table 2. The table is informative in two ways. First, it shows the exact extent Krifka and N&V's definitions of contrast converge and diverge, enabling their testing. Second, it demonstrates that focalization à la Rooth, once combined with a precisely defined notion of contrast, is sufficient to model focalization across all of the examined exchange types. This is a welcome result showing that descriptively different exchange types do not correspond to distinct types of foci, each with their own separate properties.

(25) Table 2

Predicted presence/absence for contrast	**Krifka (2008)** Contrast occurs with focus-evoked alternatives	**N&V (2012)** Contrast occurs when at least one focus-evoked alternative

[11] As before, the described context is assumed to exclude the proposition *hit(Bill,Bill)* from the focus value.

	in the common ground.	is denied.
Open questions	Absent	Absent
Corrections	Present	Present
Closed questions	Absent	Present
Confirmative I No contrast with proposition in CG No denial of evoked alternatives	Absent	Absent
Confirmative II Contrast with proposition in CG Denial of evoked alternative	Present	Present
Confirmative III No contrast with proposition in CG Denial of evoked alternative	Absent	Present
Confirmative IV Contrast with proposition in CG No denial of evoked alternatives	Present	Absent
Additive I Contrast with proposition in CG No denial of evoked alternatives	Present	Absent
Additive II Contrast with proposition in CG Denial of evoked alternative	Present	Present

As far as testing is concerned, Krifka (2008) and N&V (2012) both maintain that in English contrast enables focus fronting.[12] We may thus use focus fronting as a proxy for contrast and test for each exchange type whether fronting is possible or not.[13] We may then examine to what extent the distribution of focus fronting matches the predictions about the presence of contrast in the above table.

4.1 Exchanges with convergent predictions

As a start – and as a check on the assumption that focus fronting does indeed rely on the presence of contrast – let us consider open questions and corrective exchanges, which both models assume to respectively lack vs. involve contrast. Consequently, focus fronting should be ungrammatical in open questions and grammatical in corrective exchanges. This prediction is usually considered borne out for British English. For example, N&V note that focus fronting is infelicitous in the open question (26) but grammatical in the corrective exchange (27).

(26) A: What did John read? (N&V, 2012, p. 9)

[12] N&V (2012, p. 20) root the assumption that contrast enables focus fronting in the quantificational nature that contrast possesses under their definition.

[13] Some instances of focus fronting are not easily analysed. As Ward (1985, p. 135) notices, in (1) below the phrase 'the poor man's paradise' is fronted. On one hand, constrat could be argued to be absent, since the focused DP constitutes the answer to the implicit open question "what was the place called?" and as we saw open questions do not involve contrast. On the other, the DP might contrast with the name 'Coney Island', although it is not clear how to reconcile this contrast with either Krifka's or N&V's definitions. Finally, fronting could here be unleashed by features other than constrat. I leave the analysis of these cases to further research.

(1) Once, 40 or 50 years ago, it was *the* summer place. A cool seaside resort for the price of a subway token. [then, only a nickel]. Everyone had heard of Coney Island. [The poor man's PARADISE]$_F$, they call it. [*Philadelphia Inquirer*, p. 4-C, 8/28/83, article "Trying to regain a paradise lost in urban renewal"]

(2)

B: # [The Selfish GENE]$_F$, he read.

(27) A: John read The Extended Phenotype. (Adapted from N&V 2012, p. 9)
B: No. [The Selfish GENE]$_F$, he read.

The distribution of focus fronting in British English also matches predictions on the other conversational exchanges where N&V and Krifka converge. For example, both models predict contrast, and hence focus fronting, to be present with confirmative II and additive II exchanges. As (28) and (29) show, this prediction is borne out.[14]

(28) *Confirmative II – A and B are parents commenting on the activity of children at the local primary school. The proposition 'hit(Bill,Tom)' is part of the common ground, but speaker B intends to deny it.*
A: Bill hit Jack, yesterday.
B: Yes, JACK$_F$, he hit, yesterday. (*Implied: but not Tom, as some parents believe.*)

(29) *Additive II – A and B are the parents of Bill, Jack, Tom, and Sarah and are discussing their children. No other children are contextually salient at the time of their conversation. There is contrast with the proposition hit(Bill,Jack) in the common ground, and speaker B intends to deny the focus-evoked proposition hit(Bill,Sarah).*
A: Bill hit Jack, yesterday.
B: Yes, TOM$_F$ he hit, TOO. (*Implied: Jack hit even Tom, but not Sarah.*)

Both models also converge in predicting the absence of contrast in confirmative I exchanges, where there is no contrast with propositions in the common ground, and speaker B does not intend to deny any focus-evoked proposition. Following a technique exploited in N&V and used in prior examples, we ensure that this latter property holds by adding a continuation sentence to B's utterance asserting every focus-evoked proposition, thus making their denial impossible. The relevant example is in (30). While focus in-situ is possible in (30)B, focus fronting in (30)B' makes the continuation sentence infelicitous, showing that fronting is not possible unless some focus-evoked alternative proposition is denied. Example (31) from N&V illustrates the same point (2012, p. 12).

(30) *Confirmative I - The common ground contains no propositions concerning Bill, nor does speaker B intend to deny any focus-evoked proposition.*
A: Bill hit Jack, yesterday.
B: Yes, he hit JACK$_F$, yesterday. <u>In fact, he's hit everybody</u>.
B': Yes, JACK$_F$ he hit, yesterday. # <u>In fact, he's hit everybody</u>.

[14] Example (1) below, from N&V (2012, p. 11-12), provides another case of fronting in confirmative II exchanges. The father implies that John has not read at least one of the books he had to read. See also the corpus-based example in (2) from Ward (1985, p. 136), where the fronted 'LIFE' implies the exclusion of any shorter jailing term.

(1) *Mum and Dad know that John must read five books to prepare for the exam; they are discussing which books he has read so far*.
Mum: John's read The Selfish Gene.
Dad: Yes, I know. [The Selfish GENE]$_F$ he's read. (*Implied: John did not read some of the other books*)

(2) Unlike the two prisoners released earlier on humanitarian ground, they say, Hess was condemned to life, and LIFE$_F$ it shall be. After all, they add, 20 million Soviet citizens perished at Nazi hands. [*Philadelphia Inquirer*, p. 10-A, 4/27/85, article "Lonely old man of Spandau is 91"]

(31) *Mum and Dad know that John must read five books to prepare for the exam; they are discussing which books he has read so far.*
Mum: John's read The Selfish Gene. (N&V, 2012, p. 12)
Dad: Yes, I know. [The Selfish GENE]$_F$ he's read. # In fact he's read all five books in the reading list.

Overall, the study of the exchanges with convergent predictions allows for two conclusions. First, the distribution of focus fronting matches Krifka's and N&V's predictions, making it a reliable diagnostics for testing the two models on the exchanges where their predictions diverge. Second, the impossibility of focus fronting in (30) and (31), where the denial of a focus-evoked alternative proposition is explicitly excluded, shows that contrast à la N&V is a necessary prerequisite to focus fronting in these cases. This, though, does not yet imply that contrast à la Krifka plays no role. To ascertain its import, we need to examine the exchanges where the two definitions make divergent predictions.

4.2 Exchanges with divergent predictions

N&V and Krifka's predictions diverge on closed questions, confirmative exchanges III and IV, and additive exchange I.

In closed questions and confirmative II exchanges, contrast is predicted present under N&V's definition and absent under Krifka's. The grammaticality of focus fronting in these two cases supports N&V's model. For example, in (32) the closed question can be answered with the fronted focus in (32)B. Yet this should not be possible if contrast were absent as expected under Krifka's definition. Furthermore, the fact that B's reply cannot be accompanied by a continuation sentence asserting that B read the Quran, as in (32)B$^{\prime}$, supports the claim that the proposition *read(B,Quran)* is denied as mandated by N&V's definition of contrast.

(32) A: What did John read this summer? The Bible or the Quran?
B: [The BIBLE]$_F$, he read.
B$^{\prime}$: [The BIBLE]$_F$, he read. # He read everything he could lay his hands on, QURAN included.

The same holds in confirmative III exchanges. As (33)B shows, focus fronting is possible as predicted by N&V's definition, whereas it should not be available if contrast were absent as expected under Krifka's definition. Furthermore, as (33)B$^{\prime}$ shows, fronting is not compatible with a continuation sentence preventing the denial of any focus-evoked propositions, providing further evidence that N&V's definition of contrast is the key factor enabling fronting.

(33) *A and B are parents commenting on the activity of children at the local primary school. There are no propositions in the common ground about Bill's past actions.*
A: Bill hit Jack, yesterday.
B: Yes, JACK$_F$ he hit, yesterday. But it was a one-off. He's a lovely boy! He's never picked fights with the other children!
B$^{\prime}$: Yes, JACK$_F$, he hit, yesterday. # In fact, he's hit everybody.

Predictions switch for confirmative IV and additive I exchanges, where contrast is expected present under Krifka's and absent under N&V's model. Starting with confirmative IV in (34),

if contrast with the proposition *hit(Bill,Tom)* already in the common ground were sufficient to trigger fronting, we would expect (34)B to be grammatical. Fronting should remain possible despite the added continuation sentence, which is necessary to ensure that contrast à la N&V's is absent but does not affect contrast à la Krifka. As the infelicitous status of the continuation sentence shows, this prediction is not borne out.

(34) *Confirmative IV – A and B are parents commenting on the activity of children at the local primary school. The proposition 'hit(Bill,Tom)' is part of the common ground and speaker B does not intend to dispute it*.
A: Bill hit Jack, yesterday.
B: Yes, JACK$_F$, he hit, yesterday. # <u>In fact, he's hit everybody</u>.

The same holds for additive I exchanges, where contrast is again predicted present under Krifka's model but not under N&V's. For example, in (35) B's assertion contrasts with the proposition *hit(Bill,Jack)* in the common ground, but no focus-evoked proposition is denied since *hit(Bill,Jack)* and *hit(Bill,Tom)* are the only evokable propositions (since there are no other contextually salient children) and they are both asserted. If Krifka's contrast could trigger fronting, focus fronting should be available, yet it is at best marginal.[15]

(35) *Additive I - A and B are the parents of Bill, Jack, and Tom and are discussing their children. No other children are contextually salient at the time of their conversation*.
A: Bill hit Jack, yesterday.
B: ?? Yes, TOM$_{F,}$ he hit, TOO.

Overall, the distribution of focus fronting across the four exchanges with divergent predictions supports N&V's definition of contrast. To be clear, Krifka's definition is not incorrect per se, since contrast with propositions in common ground is an inevitable property of grammar. It does or does not occur depending on the context in which exchanges occur and the assertions made in them. However, the above observation show that focus fronting in British English is insensitive to such contrast, whereas the presence of N&V's contrast is a prerequisite.

Before concluding this section, it is worth adding that the above observations were confirmed by the informal testing of 17 native speakers of British English. The involved sentences and judgements are provided in the appendix and involved all exchanges but for confirmative II and confirmative IV exchanges, which had not yet be considered at the time of the testing. Interestingly, these informants found in-situ focalization fully acceptable

[15] Ward (1985, p. 153) mentions an interesting corpus-based instance of focus fronting in additive exchanges, see (1) below. The speaker clearly intends to say that he does not enjoy any activity related to cab driving. The exchange appears to qualify as an additive I exchange, since on the one hand the fronted focus contrasts with the previous assertion "I don't enjoy [cab driving]" in the common ground, and on the other there is no intention to deny any focus-evoked proposition, since the speaker states that there is no activity related to cab driving that s/he enjoys. The underlined fronted focus thus challenges N&V's model. The sentence, however, involves a negative predicate. Before considering it as counter-evidence for N&V's model we would need to know exactly how sentential negation is assumed to affect their definition, and, specifically, whether it takes scope over the existential quantifier they posited, since in such case N&V's model would predict precisely the negation of every alternative proposition observed in this example.

(1) […] Listen to me, I sound like I'm always in cabs. Maybe two other times in my life. To tell the truth I don't even enjoy it. All the time I'm riding I'm watching the meter. Even [<u>the PLEASURES</u>]$_F$, I can't enjoy. [Roth, P. *Goodbye Columbus*, 1963, p. 83]

(2)

across all exchanges, including those where contrast is present for both Krifka and N&V. This tells us that focus fronting is always optional: contrast may enable fronting, but never force it (see also Horvath (2010)).

As for the focus fronting data, these informants mostly found fronting possible or only slightly marginal with corrective exchanges, closed questions, confirmative III exchanges, and, somewhat more marginally, additive II exchanges. Amongst the tested exchanges, these are thoses predicted to involve contrast by N&V's definition, and include the closed questions and confirmative III exchanges where contrast is predicted absent by Krifka's model. The same informants found focus fronting increasingly less acceptable with open questions, confirmative I, and additive I exchanges. These are the exchanges where contrast à la N&V is absent, and include the confirmative I exchange where contrast is present under Krifka's model. These results concern informal judgements and better controlled testing is necessary. Nevertheless, it is worth noticing how they, too, point toward N&V's notion of contrast as the necessary prerequisite for focus fronting.

5 Conclusions

This paper carefully compared the definitions of contrast in Krifka (2008) and N&V (2012), showing how N&V's definition better accounts for the distribution of focus fronting across the several types of exchanges here examined.

The paper also showed that focus à la Rooth (1992, 1995) and contrast à la N&V (2012) are sufficient to model focalization elicited by open and closed questions, as well as corrective, confirmative, and additive conversational exchanges. Treating them as if they elicited each their own distinct type of focalization is misleading and fails to capture the fact that confirmative and additive exchanges can give rise to both contrastive and non-contrastive focalization depending on the speaker's intentions.

These results suggest additional questions and directions for further research. The most obvious one concerns whether the same results carry over across other focus-eliciting exchanges, such as those reviewed in Gussenhoven (2008) (for a preliminary discussion see Perry (2016)).

Similarly, we need to examine whether other definitions of contrast or focalization here left unexamined might be as, or even more, successful than N&V's defnition in accounting for focus fronting. For example, Kiss (1998) maintains that only identificational focus obligatorily triggers movement to a higher functional projection. Kiss defines identificational focus as "the exhaustive subset [of the contextually or situationally given items for which the predicate phrase can potentially hold] for which the predicate phrase actually holds" (Kiss 1998, p. 245). In other words, identificational focus exhaustively identifies the items for which the predicate holds, excluding any other items. She does not discuss how identificational focus should be formalized in Rooth's alternative semantics, but her definition entails that only the asserted proposition holds, and all other focus-evoked alternative propositions do not.[16] Kiss' identificational focus thus effectively generalizes N&V's definition of contrast to all the propositions in the focus value of a sentence (see also

[16] According to Kiss, it is exhaustivity that triggers movement to a higher functional projection. Kiss also discusses 'contrast' (2012, p 267), but she does not consider it relevant for movement, which is why it is ignored in the above discussion. For the sake of completeness, once Kiss' definition of contrast is translated in Rooth's terms, identificational focus involves contrast when the set of focus-evoked propositions being denied is closed, and non-contrastive when the same set is open. In other words, contrast is present when the set of denied focus-evoked propositions is exhaustively identified.

Horvath (2010)): all evoked propositions must be denied, not just one as under N&V. Identificationa focus thus consttutes a stricter version of N&V's contrast. Whenever identificational focus holds, N&V's definition of contrast is necessarily satisfied, but not vice versa. For example, consider (36) and assume that there are four contextually salient children: Mary, Jack, Tom, and Bill. Under N&V's definition, contrast is present as soon as speaker B implies that one alternative – say *hit(Mary,Bill)* – does not hold. Identificational focus would instead require that all alternatives are denied, including the proposition *hit(Mary,Jack)* just asserted by A. This is inappropriate for additive exchanges, where prior propositions are not being questioned.

(36) A: Mary hit Jack, yesterday.
B: Yes, TOM_F she hit, TOO.

This shows that as far as focus fronting in British English is concerned, identificational focus cannot replace N&V's contrast. Indeed, Kiss herself views identificational focus as not relevant for English focus fronting on the basis of other independent tests (1998, p. 251).

Kiss' identificational focus, however, remains relevant for the Hungarian and English data she discussed. For example, she shows that English cleft-sentences satisfy the exhaustivity requirement intrinsic to identificational focus. This raises a second research question concerning the overall set of primitives necessary for information structure phenomena and contrast in particular. We have seen that as far as focus fronting is concerned, focus à la Rooth and contrast à la N&V (2012) are sufficient across several types of focus-eliciting exchanges. The issue is to what extent they can also explain any other focus-related phenomena. For example, should we consider N&V's contrast and Kiss' identificational focus, with its exhaustive nature, as independent primitives, or should identificational focus be modelled in terms of N&V's definition of contrast plus an exhaustivity operator extending it to all evoked propositions? If feasible, the second view provides a more principled model of grammar, since the presence of shared content across N&V's and Kiss' definitions would be inevitable rather than accidental.

A similar question applies to the fronting of mirative focus (Cruschina, 2006, 2012). Here too, we ought to investigate whether mirative focus can be decomposed into more elementary and independently necessary notions such as N&V's contrast. Bianchi et al's (2013, 2016) analysis goes in this direction, as it defines mirative focus as involving "at least one member of the set of alternative propositions which is *more likely* than the asserted proposition". Building on Grosz (2011) and Potts (2007, 2012), their analysis separates the import of focalization from the import attributed to mirativity, which is formalized as an implicature stating that a more likely alternative exists. The issue is whether the denial of this more likely alternative is implied by mirative foci, in which case N&V's contrast would be present. As Perry (2016) points out, this would allow us to explain the fronting of mirative foci through the same analysis used for contrastive foci in British English, because the presence of contrast à la N&V's would be sufficient for triggering fronting. Perry also observes that the same foci could remain non-contrastive under Krifka's model, since mirative expressions can be uttered out of the blue, presumably excluding the presence of any content in the common ground to contrast with. The issue here is whether expectations about likely alternatives are part of the common ground. If they are, then mirative foci would be contrastive for Krifka's as well. If they are not, then out-of-the-blue mirative foci would be non-contrastive and hence Krifka's contrast would not be able to trigger their fronting.

Last but not least, we need to research the crosslinguistic validity of the relation between contrast and focus fronting explored here for British English. At first sight, it does not appear to generalize to other languages. For example, my own very limited informal

testing of Italian, Mandarin Chinese, Korean, Spanish, and Galician shows a divergence between these languages and British English with respect to focus fronting across the exchanges examined in this paper. If confirmed by future studies, it would point to a variation in the crosslinguistic focus fronting data which is not yet captured.

This, in turn, raises the issue of whether it is possible to keep the fundamental primitives of information structure invariant across all languages. This might eventually require the parametrization of the association between contrast and fronting (with contrast triggering fronting in some languages but not others, see also Kiss 1998), with interesting ramifications for our understanding of the left periphery (for example, if a language lacks contrast-driven focus fronting, do we still posit a left-peripheral projection dedicated to contrastive foci?).

In conclusion, we need to investigate how the observational and theoretical richness recently attained in information structure studies can be rooted in a coherent and principled theoretical model. With this paper, I hope to have provided a small step in this direction.

6 References

Abels, K. (2017). *Beyond phrase-phrase interactions in the Left Periphery*.Talk presented at the Word Order in The Left Periphery - Workshop, Oslo. http://folk.uio.no/elenacal/wolp2017/pdf/KlausAbels_WOLP2017.pdf

Alboiu, G. (2004). Optionality at the Interface: Triggering Focus in Romanian. In H. van Riemsdijk, & A. Breitbarth (Eds.), *Triggers* (pp. 49–75). Berlin: Mouton de Gruyter.

Belletti, A. (2001). “Inversion” as focalization. In A. Hulk, & J.Y. Pollock (Eds.), *Subject Inversion in Romance and the Theory of Universal Grammar* (Oxford Studies in Comparative Syntax, pp. 60–90). Oxford: Oxford University Press.

Belletti, A. (2004). Aspects of the Low IP Area. In L. Rizzi (Ed.), *The Structure of CP and IP. The Cartography of Syntactic Structures* (Oxford Studies in Comparative Syntax, pp. 16–51). Oxford: Oxford University Press.

Bianchi, V., Bocci, G., & Cruschina, S. (2013). Focus Fronting and its Implicatures. In E. Aboh et al (Eds.), *Romance Languages and Linguistics Theory*. *Selected Papers from Going Romance*. Amsterdam: John Benjamins.

Bianchi, V., Bocci, G., & Cruschina, S. (2016). Focus Fronting, Unexpectedness, and the Evaluative Dimension. *Semantics and Pragmatics*, 9(0), 1-54.

Büring, D. (2003). On D-Trees, Beans, And B-Accents. *Linguistics and Philosophy*, 26, 511–545.

Büring, D. (1997). *The Meaning of Topic and Focus*. London: Routledge.

Costa, J., & Martins, A. M.. (2011). On Focus Movement in European Portuguese. *Probus*, 23(2), 217-245.

Cruschina, S. (2006). Informational focus in Sicilian and the left periphery. In M. Frascarelli (Ed.), *Phases of Interpretation* (pp. 363–386). Berlin, New York: Mouton de Gruyter.

Cruschina, S. (2012). *Discourse-Related Features and Functional Projections*. Oxford: Oxford University Press.

Grosz, P. (2011). *On the grammar of optative constructions*. MIT Dissertation. Cambridge, MA.

Gussenhoven, C. (2007). Types of Focus in English. In C. Lee, M. Gordon, & D. Büring (Eds.), *Topic and Focus: Cross-Linguistic Perspectives on Meaning and Intonation* (pp. 83–100). Dordrecht: Springer Netherlands.

Horvath, J. (2010). “Discourse Features”, Syntactic Displacement and the Status of Contrast. *Lingua*, 120(6), 1346–1369.

Kenesei, I. (2006). Focus as Identification. In Va Molnár, & S. Winkler (Eds.), *The Architecture of Focus* (pp. 137–168). Berlin: Mouton de Gruyter.

Kiss, K. É. (1998). Identificational Focus versus Information Focus. *Language*, 74(2), 245–273.

Kratzer, A., & Selkirk, E. (2018). Deconstructing Information Structure. Ms. UMASS and UCL.

Krifka, M. (2008). The Semantics of Questions and the Focusation of Answers. In C. Lee, M. Gordon, & D. Büring (Eds.), *Topic and Focus: Cross-Linguistic Perspectives on Meaning and Intonation* (Vol. 82, 139–150). Dordrecht: Springer.

Krifka, M. (2008). Basic Notions of Information Structure. *Acta Linguistica Hungarica*, 55(3), 243–276.

Krifka, M., & Musan, R. (2012). Information structure: Overview and linguistic issues. In M. Krifka, & R. Musan (Eds.), *The Expression of Information Structure* (The Expression of Cognitive Categories 5, pp. 1–44). Berlin/Boston: De Gruyter Mouton.

Molnár, V. (2002). Contrast - From a Contrastive Perspective. In H. Hasselgård, S. Johansson, B. Behrens, & C. Fabricius-Hansen, (Eds.), *Information Structure in a Crosslinguistic Perspective* (Language and Computers: Studies in Practical Linguistics 39, pp. 147–161). Amsterdam/New York: Rodopi.

Molnár, V., Winkler, S. (2006). *The Architecture of Focus*. Berlin: Mouton de Gruyter.

Neeleman, A., & Vermeulen, R.. (2012). The Syntactic Expression of Information Structure. In A. Neeleman, & R. Vermeulen (Eds.), *The Syntax of Topic, Focus, and Contrast* (Studies in Generative Grammar, pp. 1–38). Berlin/Boston: Mouton de Gruyter.

Perry, M. (2016). *PLIN3202: Readings in Syntax Assessing Krifka 2008 and Neeleman & Vermeulen 2012's treatment of contrastive focus*. Ms submitted for assessment within the undergraduate PLIN3202 course. University College London.

Poletto, C., & Bocci, G. (2016). Syntactic and Prosodic Effects of Information Structure in Romance. In C. Féry, & S. Ishihara, (Eds.), *The Oxford Handbook of Information Structure*. Oxford: Oxford University Press.

Potts, C. (2007). Conventional implicatures, a distinguished class of meanings. In G. Ramchand, & C. Reiss (Eds.), *The Oxford handbook of linguistic interfaces* (pp. 475–501). New York/Oxford: Oxford University Press.

Potts, C. (2012). Conventional implicature and expressive content. In C. Maienborn, K. von Heusinger, & P. Portner (Eds.), *Semantics: An international handbook of natural language meaning* (Vol 3, 2516-2536). Berlin: Mouton De Gruyter.

Repp, S. (2010). Defining "contrast" as an Information-Structural Notion in Grammar. *Lingua*, 120(6), 1333–1345.

Repp, S. (2016). Contrast. In C. Féry, & S. Ishihara (Eds.), *The Oxford Handbook of Information Structure* (pp. 270–289). Oxford: Oxford University Press.

Repp, S., & Cook, P. (2010). *Contrast as an Information-Structural Notion in Grammar*. Vol.120. Lingua, Special Issue.

Rizzi, L. (1997). The Fine Structure of the Left Periphery. In L. Haegeman (Ed.), *Elements of Grammar: Handbook in Generative Syntax* (pp. 281–337). Dordrecht: Kluwer.

Rizzi, L. (2004). Locality and the left periphery. In A. Belletti (Ed.), *Structures and Beyond: The Cartography of Syntactic Structures* (pp. 223–251). Oxford University Press, Oxford.

Rizzi, L., & Cinque, G. (2016). Functional Categories and Syntactic Theory. In M. Liberman, & B. H. Partee, (Eds.), *Annual Review of Linguistics* (Vol 2. pp. 139–163). Palo Alto: Annual Reviews.

Rooth, M. (1985). *Association with Focus*. PhD Thesis. University of Massachusetts at Amherst.

Rooth, M. (1992). A Theory of Focus Interpretation. *Natural Language Semantics*, 1(1), 75–116.

Samek-Lodovici, V. (2015). *The Interaction of Focus, Givenness, and Prosody. A Study of Italian Clause Structure, Oxford Studies in Theoretical Linguistics*. Oxford: Oxford University Press.

Vallduví, E., & Vilkuna, M. (1998). On Rheme and Kontrast. *Syntax and Semantics*, 29, 79–108.

Ward, G. (1985). *The Semantics and Pragmatics of Preposing*. University of Pennsylvania.

Ward, G., & Birner, B. J. (1994). A Unified Account fo English Fronting Constructions. *Penn Working Papers in Linguistics*, 1, 159–165.

Zimmermann, M. (2007). Contrastive Focus. In G. Fanselow, C. Féry, & M. Krifka (Eds.), *The Notions of Information Structure* (Working Papers of the SFB 632, Interdisciplinary Studies on Information Structure, pp. 147–160). Potsdam: Universitätverlag Potsdam.

Zimmermann, M. (2008). Contrastive Focus and Emphasis. *Acta Linguistica Hungarica*, 55(3), 347–360.

7 Appendix

The table below reports the judgements provided by 17 native speakers of British English enrolled in UG and MA linguistic courses and familiar with the notion of grammaticality and the practice of giving grammaticality judgements[17] They were all following a course of mine on focalization and were familiar with Krifka's and N&V's hypotheses on contrast, but at the time of testing they had no reasons to prefer a judgement over another. They were given a written questionnaire with the two-sentence dialogues in the table below, each involving one reply with focus in situ and one with focus fronting (with the text in bold and capitals as in the original questionnaire). Confirmative exchanges II and IV were missing, as their relevance had not been understood yet. The informants were encouraged to provide their judgements while at home, ideally in a room alone, giving themselves as much time as necessary.[18] For convenience, the last two columns list Krifka's and N&V's predictions on the availability of focus fronting.

(37) Table 3

Native speakers' judgements	Focus in situ	Fronted focus	Krifka	N&V
Open questions A: What did John eat? B1: He ate the COOkies$_F$. B2: The COOkies$_F$ he ate.	ok: 17 ?: none ??: none *: none	ok: 4 ?: 8 ??: 3 *: 2	no	no
Corrective exchanges A: John ate the COOkies. B1: No. He ate the CANdies$_F$ B2: No. The CANdies$_F$ he ate	ok: 17 ?: none ??: none *: none	ok: 10 ?: 5 ??: 1 *: 1	yes	yes
Closed questions A: What did John eat? The candies or the cookies? B1: He ate the COOkies$_F$. B2: The COOkies$_F$ he ate.	ok: 17 ?: none ??: none *: none	ok: 10 ?: 5 ??: 2 *: none	no	yes
Confirmative I – Bill and Jack are kids at the local school. The conversation is between two parents, none of them related to Jack. As his answers show, **parent B believes that Bill has hit every kid in the class**. A: Bill hit JACK yesterday. B1: Yes, he hit JACK$_F$. He hit EVery child in his class. B2: Yes. JACK$_F$ he hit. He hit EVery child in his class.	ok: 15 ?: 2 ??: none *: none	ok: 1 ?: 7 ??: 4 *: 5	no	no
Confirmative III – Bill and Jack are kids at the local school. The conversation is between parent A and parent B, **who is Bill's father**. As his answers show, Bill's father believes that other parents wrongly assume that Bill	ok: 14 ?: 1 ??: 1 *: 1	ok: 14 ?: 2 ??: 1 *: none	no	yes

[17] Many thanks to Patricia, Catherine, Chris, Jimmy, Ned, Margaret, Clare, Joshua, Helice, Gaby, Harriet, Oscar, Neelima, Tori, Marco, Julian, and Holly,

[18] Neeleman taught in the same institution of the informants. If Neeleman's presence in the same institution affected the English judgements, it should also have affected the judgements provided by the foreign informants about their own language, which should have resembled those of the Enligsh informants. This was not the case.

also hit Tom, a particularly small and vulnerable child. With his answer, Bill's father means to imply that this is not the case: he accepts that Bill hit Jack, **but not that Bill hit Tom.** The expression in parentheses lists this intention for your convenience, but it is never uttered by B. A: Bill hit JACK yesterday. B1: Yes, he hit $JACK_F$. (Not Tom.) B2: Yes. $JACK_F$ he hit. (Not Tom.)				
Additive I – A and B are the parents of THREE children: Bill, Jack, and Tom. **Crucially, they have no other children**. They are speaking about a brawl involving their children that happened in their home the day before. **No additional children are involved.** A: Bill hit JACK yesterday. B1: Yes. He hit TOM_F, TOO. B2: Yes. TOM_F he hit, TOO.	ok: 17 ?: none ??: none *: none	ok: 2 ?: 7 ??: 7 *: 1	yes	no
Additive II – A and B are the parents of FOUR children: Bill, Jack, Tom, and Mary. They are speaking about a brawl that happened in their home the day before, **when Bill hit Jack and Tom, but not Mary**. A: Bill hit JACK yesterday. B1: Yes. He hit TOM_F, TOO. B2: Yes. TOM_F he hit, TOO.	ok: 15 ?: 2 ??: none *: none	ok: 8 ?: 5 ??: 1 *: 2 (16 judgements: one informant omitted the judgement for this case)	yes	yes

Vowel and Consonant Alternations in the Bulgarian Verbal System

Jingyi Ye

Abstract

The aim of this paper is to explore the vowel and consonant alternations in the Bulgarian verbal system. With the target to achieve my aim of this study, I am undertaking the following tasks: 1) to go through the Bulgarian verb system 2) to define what is an alternation, and how does it carry out in the Bulgarian verb system. 3) to support my aim with clear, detailed examples and explanations.
Keywords: Slavonic Linguistics; Bulgarian Verb System; Vowel and Consonant Alternations; Verb Forms; Morphology

1 Introduction

The aim of my work is to explore the vowel and consonant alternations in the Bulgarian verbal system. With the target to achieve my aim of this study, I am undertaking the following tasks:

1. To go through the Bulgarian verb system, which includes the examining of verb forms, conjugations groups, verbal stems, etc.
2. To define what is an alternation, and how does it carry out in the Bulgarian verb system. This task includes drawing a clear idea about vowel and consonant alternations from the existing theories of different scholars and how it is carrying out in the Bulgarian verb form-formation. This task is set based on the fact that a learner of the Bulgarian language can come across vowel and consonant alternations not only in the verb system, but also in nouns, adjectives and other contents as well.
3. The key task of my dissertation is to support my aim with clear, detailed examples and explanations.
   Enabling to echo with the theory part, I first classify the examples by the stems – Present, Aorist and Imperfect stems; which means all the verb forms using the same type of stem for their form-formation are being put together. Under each stem type, there are sub-contents i.e. Present Tense, Past Passive Participle, etc. Under each sub-content, the examples are set out following the order of the three conjugation groups, i.e. first, second, third, if necessary.
   The selected examples are presented in the form of tables. Theoretically, only imperfective base verbs are being chosen, which means they don't have either prefixes or suffixes. However, there are still perfective verbs that don't have a base form (as their base imperfective verb has died out in the contemporary Bulgarian language) but do carry out alternations supporting my theory. In this case, the prefix of the verb would be put in brackets in the tables.
   The consonant and vowel alternations in this dissertation are based on the comparison of the verb form to its Base Form[1].

In order to work efficiently with the listed tasks, I synthesised the relevant theories mainly from the following scholars and their works: Ruselina Nicolova (*Bulgarian Grammar*), Kjetil Rå

[1] Defination of Base form is explained in the Theory Part.

Hauge (*A Short Grammar of Contemporary Bulgarian*), Petar Pashov (*Balgarska gramatika*) and Stoian Stouanov (*Gramatika na balgarski knizhoven ezik*), as well as the phonetic theory from the book *Gramatika na carvermenniya balgarski knizhoven ezik v tri toma*. The reason why I chose works that published several decades ago as well as the one released recently, is because I want to discover that within this duration of time, are there any changes taken place within the theoretical area of the Bulgarian verb system. Meanwhile, I also hope to find out whether alternations are still actively appearing in the contemporary Bulgarian language.

Majority examples in this dissertation are taken or adapted from the Bulgarian verb dictionary *Dzhobna gramatika na balgarski ezik, glagol* edited by Vladimir Zhobov and Georgi Kolev, and all the other works mentioned above.

2 The Bulgarian Verb System

The verb is a part of speech that includes a word (or group of words) that indicates an action, mental state or condition as a process in time. The action can be physical, as in such verbs as walk, run, jump, swim, or mental, as in such verbs as hope, dream, believe, etc. There are also verbs like be and become express a state or condition rather than an action.
The action, which has been represented by the verb, is always referred to a person or an object. However, not every word that means an action or a state is a verb. For example, in Bulgarian the word '*бяг (biag)*' is not a verb, but a noun, which means "running". This is because, although it means an action, the action is related to neither the person who carried out this action nor the implemental time duration of this action. The Bulgarian verb for "run" is "*бягам (biagam)*", since it denotes an action that is being done in the present by the speaker himself. In other words, the word (or tht verb form) contains within itself the meaning of the corresponding action, as well as the doer who committed this act and the time when this action has been carried out. Unlike the English verb, Bulgarian word "*бягам (biagam)*" equals to the sentence "*Аз бягам сега (Az biagam sega)*" - "I am running now". Therefore, in Ancient Greece, the verb is also being called the soul of the sentence.

3 Verb Forms
3.1 Overview

Linguist Ruselina Nocolova has listed the grammatical meaning expressed by the Bulgarian verb forms as following (Nokolova, 2017, p. 318):

1) Grammatical meanings characterising the object to which the dynamic property is ascribed: ***person***, ***number*** and ***gender***;
2) Grammatical meanings connected with dynamic (processual) property: ***tense*** and ***aspect***;
3) Grammatical meaning connected with the relation between the subject and the dynamic property ascribed to it: ***voice***;
4) Grammatical meanings connected with the relation of the speaker to the information about the dynamic property: ***mood***, ***evidentiality***, ***admirativety***.

Same as in English, the form that is used for listing a Bulgarian verb in dictionaries is the 1st Person Singular Present; for impersonal verbs the 3rd Person Singular Present. There are no infinitives in contemporary Bulgarian verb system, though once they have been existed in Old Bulgarian.

So what is an infinitive? In English, the infinitive is composed of two words: to + the dictionary form of the verb; this form, without the to, is sometimes called the bare infinitive in grammar books. Although it is the most basic form of the verb, the infinitive in English can never be used in a sentence without another verb. E.g. I need to read this book. In this case, "need" is the verb and "to read" is the infinitive. The same idea works in Bulgarian. *Трябва да прочета книга (Tryabva da procheta kniga)*. "*Трябва (Tryabva)*" is the verb and "*да прочета(da procheta)*" is the infinitive.

> "Since the infinitive is not a living category of the Bulgarian verb (there are vestigial old infinitive forms only), the Bulgarian linguistic tradition uses three main representative finite forms: first person singular present indicative form for verbs with normal paradigm, third person singular form for impersonal verb and third-person verbs, and first-person plural for pluralia tantum verbs." (Nokolova, 2017, p. 322)

However, from the point of view of the other linguists, "finite form" is a disputed term. Hence, in this dissertation, enable to differentiate with the 1st Person Singular Present, the base verb form used for paradigm will be called the base form.

3.2 Personal and Impersonal Verb Forms

In the nine Bulgarian tenses, only three of them, which are the Present, Past Aorist and Past Imperfective, are base tenses while other six are compound tenses. The dissertation has set the task to focus only on these three. Please be aware, that the verb forms related with *base tenses* are agreeing to *person* and *number*, but not to *gender*. That's why these verb forms are called Personal verb forms (bg) *Лични глаголни форми(lichni glagolni formi)*. They reflect the subject of the verb and the nature of the action, i.e., the subject of the sentence is the doer of the action. Most likely, the personal verb forms are used in active voice sentences, and they help to express an idea vigorously and concisely and is most often heard in conversational speech.
According to Stoianov:

> *"Значението на личната глаголна форма се съдържа представа за предмет или предметност и представа за признак като процес, действие или състояние на същия предмет или същата предметност. Представата за носителя на признака (процеса, деиствии то, състоянието) се нарича глаголно лице или субект на глаголаото действие. Личните глаголни форми могат да се изменят по лице и по число, т. е. могат да се спрягат, например: чета, четеш, чете, четем, четете, четат; четох, чете и пр. "* (Stoianov, 1993, p. 313)

The personal verb forms also include the Imperative verb forms (bg) *Повелително наклонение*(*Povelitelno naklonenie*).

We can learn from the formation of the nine tenses, that Bulgarian tenses consist not only three base forms but also participles. The participles (bg) *причастия*(*prichastiya*) use for the tenses are the Past Aorist Active participles (bg) *Минало Свършено Деятелно причастия*(*Minalo Cvarsheno Deyatelno prichastiya*), and there are still Present Active participles (bg) *Сегашно Деятелно причастия*(*Segashno Deyatelno prichastiya*), Past Imperfective Active participle (bg) *Минало Несвършено Деятелно причастия*(*Minalo*

Necvarsheno Deyatelno prichastiya) and Past Passive participles (bg) *Минало Страдателно причастия*(*Minalo Strdatelno prichastiya*). Participles are partly verb and partly adjective and change their endings like adjectives. They also carry our vowel and consonant alternations when having their form-formations. If we also need to put them within a verbal-form group, the participles, therefore, are belonging to the category of Impersonal verb forms (bg) *Нелични глаголни форми(nelichni glagolni formi)*. Referring to Nocolova's list (Nokolova, 2017, p. 318), when the verb forms characterising the object's gender and number, instead of person and number, the forms are called impersonal verb forms. Means they lack person in their grammar content.

Stoianov explains his definition for impersonal verb forms as

> "*Неличните глаголни форми се нарнчаттака, защата не се изменят по лице, а тога значи, че не притежават граматическа категория „глаголно лице". Неличните глаголни форми не могат да се спрягат.*" (Stoianov, 1993, p. 313)

Besides the participles; the impersonal verb forms also include Gerund (bg) *Деепричастие*(*Deeprichastie)* and verbal nouns (bg) *Отглаголни Съществителни*(*Otglagolni Sashtestvitelni*).

3.3 Person and Number

By considering Nokolova's list (Nokolova, 2017, p. 318) as a reference, the first two grammatical meanings of the verbs – *person* and *number*, are also the two most essential features that the learners of Bulgarian would first come across.
The grammatical categories for the person or the object, which the verbal action is referred to, are being called "*лице*(*litse*)" – "person" and "*число*(*chislo*)" – "number". Most often (but not always), this person is the one who committed the act. The person, which shows the relation between the agent(s) of the action on one hand and the participant(s) of the speech event on the other: agent and speaker coincide (first person); agent and hearer coincide (second person); agent coincides neither with speaker nor hearer (third person); and of number, which quantifies the agent as one (singular) or more than one (plural). (Hauge, 1999, p. 85) First person, denoting that the subject is identical with the speaker. Second person, denoting that the subject is identical with the hearer. Third person, denoting that the subject is non-participant in the act of speech. (Nokolova, 2017, p. 320)

3.4 Gender and Number

While lacking person, the impersonal verb forms (excluding gerunds and verbal nouns) have to agree with *gender* and *number*. The grammatical meaning of gender is expressed in participles, which are used either as part of analytic verb forms or independently. The impersonal verb form distinguishes the same three genders masculine, feminine and neuter (bg) *мъжки, женски и среден род*(*mazhki, zhenski i sreden rod*) inflectionally as nouns do, but while with nouns gender is an inherent, invariable category of predominantly classifying and selecting nature, with verb forms gender is the position of the subject. (Nokolova, 2017, p 320) They also need to consider number while conjugating. The three genders can be either singular or plural. When being plural, the three genders share the same ending for their verb forms.

4 Conjugation

4.1 Overview

If by chance you're not a native Bulgarian speaker, please take your time and try to remember your very first class when learning Bulgarian verbs. The first grammar most likely to be mentioned is the conjugation of the present tense, and this introduction also builds learners' knowledge of the term *"conjugation"*. The verb conjugation, from my understanding, is a list of six different forms of the verb, one for each of the subject pronouns – first, second and third persons, singular and plural. Textbooks always show the conjugation in a chart, in which each verb form is stated side by side with the matching pronoun. These pronouns, no doubt, are the indicators of *person* (or *gender*) and *number* shown in the conjugated verb forms.

4.2 Conjugation Groups

Before moving further into the following part, we must have a clear idea of what is a conjugation group (bg) *спрежение*(*sprezhenie*). All the Bulgarian linguistic sources, as well as the textbooks, explain every form-formation in the Bulgarian verb system by following the conjugation groups. Bulgarian verbs can be grouped into three conjugations groups, and the classification is based on the thematic vowel used when conjugating for Present tense. The thematic vowel is a single vowel that inserts after the verbal root morpheme and before the ending that agrees to the person and number, or the gender and number. The three conjugation groups are referring as the first, second and third conjugation group.

1) First Conjugation Group
   In this group, verbs use the thematic vowel *–е–*. E.g. *чета(cheta)* – "read"

1St Person Singular	чета	**1St Person Plural**	четем
2nd Person Singular	четеш	**2nd Person Plural**	четете
3rd Person Singular	чете	**3rd Person Plural**	четат

2) Second Conjugation Group
   In this group, verbs use the thematic vowel *–и–*. E.g. *говоря(govorya)* – "speak"

1St Person Singular	говоря	**1St Person Plural**	говорим
2nd Person Singular	говориш	**2nd Person Plural**	говорите
3rd Person Singular	говори	**3rd Person Plural**	говорят

3) Third Conjugation Group
   In this group, verbs use the thematic vowel *–а–*. E.g. *казвам(kazvam)* – "say"

1St Person Singular	казвам	**1St Person Plural**	казваме
2nd Person Singular	казваш	**2nd Person Plural**	казвате
3rd Person Singular	казва	**3rd Person Plural**	казват

5 Verbal Stem

According to contemporary Bulgarian grammar, a verbal stem means the part of a verb that is formed by a root morpheme (bg) *коренна морфема(korenna morfema)* and the thematic vowel (bg) *тематична гласна(tematichna glasna)*. Linguists, such as Stoianov (Stoianov, 1993, p. 438), Pashov (Pashov, 1999, p. 140) and Hauge (Hauge, 1999, p. 90) all believe that the Bulgarian verb has two stems – present and aorist. According to their theories, the Present tense, the Past Imperfective, the Imperative, the Present Active participle, the Past Imperfective

Active participle and the Gerund are formed from the *Present* stem; while the Past Aorist, the Past Aorist Active participle, the Past Passive participle and the Verbal Noun are formed from the *Aorist* stem.

In recent years, linguists including Nicolova (Nicolova, 2017, p. 382) support the idea that the Bulgarian verb can have three stems. She believes that the verbs of the first and second conjugations have three stems: *present*, *aorist* and *imperfect*; while the third conjugation verbs have only one stem – the *present* stem.

I support the idea that a Bulgarian verb has three stems – *present*, *aorist* and *imperfect*. However, I disagree with Nicolova's theory (Nicolova, 2017, p. 382) that the third conjugation verbs only have one stem. The third conjugation verbs also have three stems; the three stems are simply *identical*. Hence, unifying my firm belief of three verbal stems. According to the three-stem theory, the Present tense and the Gerund are formed from the *Present* stem; the Past Aorist, the Past Aorist Active participle, the Past Passive participle and the Verbal Noun are formed from the *Aorist* stem; and the Past Imperfect, the Present Active participle and the Past Imperfective Active participle are formed from the *Imperfect* stem.

The forming of Imperative is hard to group. That's why linguists debate there should be two verb stems instead of three. One can consider it is formed from either the *Present* stem, or the *Imperfect* stem. As we all know, the difference between the *Present* stem and the *Imperfect* stem is the *thematic vowel*. E.g. *чета(cheta)* it's Present stem is *четѐ*-(*chetѐ*-) and it's Imperfect stem is *четѝ-(chetyà-)*. But the forming of Imperative is based on the root morpheme of the *Present/Imperfect* stem plus the imperative thematic vowel and the ending agrees to person and number. As the root morpheme for the *Present* and *Imperfect* stems is identical, it is not possible to say precisely which stem the Imperative is formed from. In this dissertation, I decide to group the *Imperative* into the **Present stem**.

Nevertheless, I still support the theory that one verb should have three verbal stems. The examine that supports this theory can be delivered by the verbs *чета(cheta)* – "read" from the first conjugation group, *говоря(govorya)* – "speak" from the second conjugation group, and *казвам(kazvam)* – "say" from the third conjugation group through their verb forms in three tenses – Present tense, Past Aorist and Past Imperfect. The stress of the verb form is also indicated.

– First Conjugation Group: *чета(cheta)* – "read"

1) Present Tense

1St Person Singular	четà	**1St Person Plural**	четѐм
2nd Person Singular	четѐш	**2nd Person Plural**	четѐте
3rd Person Singular	четѐ	**3rd Person Plural**	четàт

2) Past Aorist

1St Person Singular	чѐтох	**1St Person Plural**	чѐтохме
2nd Person Singular	чѐте	**2nd Person Plural**	чѐтохте
3rd Person Singular	чѐте	**3rd Person Plural**	чѐтоха

3) Past Imperfective

1St Person Singular	четѝх	**1St Person Plural**	четѝхме
2nd Person Singular	четѐше	**2nd Person Plural**	четѝхте
3rd Person Singular	четѐше	**3rd Person Plural**	четѝха

The present stems for *чета(cheta)* is *четѐ*-(*chetѐ*-). Though the 1st Person Singular and 3rd Person Plural are different to the rest, it is not correct to think that there are two present stems for this verb. P. Pashov believed that this phenomenon exists because the 1st Person Singular and 3rd Person Plural forms for present tense have lost their thematic vowel. (Pashov, 1999, p. 140) K. Hauge also agrees to Pashov that the /-ə/ and /-ət/ parts of the 1st Person Singular and

3rd Person Plural Present Tense forms of the First and Second conjugation groups are endings, rather than compounds of thematic vowel and ending. (Hauge, 1999, p. 92) Therefore, the preferred way to find the present stem of the verb from all conjugation groups is to check it's 3rd Person Singular form, as it has the thematic vowel and zero personal ending.

The aorist stems for *чета(cheta)* are *чѐте-(chète-)* for 2nd Person and 3rd Person Singular, and *чѐто-(chèto-)* for remaining. *Twenty-four* imperfective base verbs [including *чета(cheta)*] from the first conjugation group have two aorist stems. For these verbs, the Aorist stem that is used for 2nd Person and 3rd Person Singular contains the thematic vowel *–е–*, and the other one contains the thematic vowel *–о–*. For imperfect stem, it is *четѝ-(chetyà-)* for all the forms.

- Second Conjugation Group: *говоря(govorya)* – "speak"

1) Present Tense

1St Person Singular	говòря	**1St Person Plural**	говòрим
2nd Person Singular	говòриш	**2nd Person Plural**	говòрит
3rd Person Singular	говòри	**3rd Person Plural**	говòрят

2) Past Aorist

1St Person Singular	говòрих	**1St Person Plural**	говòрихме
2nd Person Singular	говòри	**2nd Person Plural**	говòрихте
3rd Person Singular	говòри	**3rd Person Plural**	говòриха

3) Past Imperfect

1St Person Singular	говòрех	**1St Person Plural**	говòрехме
2nd Person Singular	говòреше	**2nd Person Plural**	говòрехте
3rd Person Singular	говòреше	**3rd Person Plural**	говòреха

The present stems for *говоря(govorya)* is *говòри*-(*govòryi*-). For aorist stem, it is *говòри*-(*govòri*-) for all the forms. And for imperfect stem, it is *говòре*-(*govòre*-). In this case, the Present stem and the Aorist stem are entirely identical.

- Third Conjugation Group: *казвам(kazvam)* – "say"

1) Present Tense

1St Person Singular	кàзвам	**1St Person Plural**	кàзваме
2nd Person Singular	кàзваш	**2nd Person Plural**	кàзвате
3rd Person Singular	кàзва	**3rd Person Plural**	кàзват

2) Past Aorist

1St Person Singular	кàзвах	**1St Person Plural**	кàзвахме
2nd Person Singular	кàзва	**2nd Person Plural**	кàзвахте
3rd Person Singular	кàзва	**3rd Person Plural**	кàзваха

3) Past Imperfect

1St Person Singular	кàзвах	**1St Person Plural**	кàзвахме
2nd Person Singular	кàзваше	**2nd Person Plural**	кàзвахте
3rd Person Singular	кàзваше	**3rd Person Plural**	кàзваха

As indicated before, the three stems are identical – they are all *кàзва*-(*kàzva*-).

However, there are some irregular conjugations happened when the verb *чета(cheta)* is formed into 2nd Person Singular and 3rd Person Singular for *Past Imperfect* tense. The *Imperfect* stem for *чета(cheta)* is *четѝ*-(*chetyà*-), but when the stem meets the ending -*ше*(-she), *четѝ*-(*chetyà*-) converts into *четѐ*-(*chetè*-). The alternation of *я*(*ya*) into *е*(*e*) is a vowel alternation.

6 Vowel and Consonant Alternations

The aim of this section is to draw a clear idea about vowel and consonant alternations, as they appear frequently in the contemporary Bulgarian language. The alternations are not only existed in the verb system, but also in all word aspects. Therefore, the examples provide in the following part will not only be verbal forms, but nouns, adjectives as well.

According to the linguistic definition, an alternation (bg) *редуване(reduvane)* means the variation that a morpheme exhibits in its phonological realisation (an alternant). A morpheme is the smallest part of a word that contains grammatical meaning. Theoretically, alternation can be caused by phonological, morphological, or other conditions, in which the morpheme finds itself. In the contemporary Bulgarian language, consonant and vowel alternations appear in both written and speech forms. Historical or modern phonetic laws may lead to these alternations. When a sound is under certain conditions, it has to carry out change to suit the particular phonetic position. Hence, it starts to alternate with another sound. When the change of sounds is regular and governed by phonetic rules, it is being called a phonetic law (bg) *звуков закон(zvukov zakon)*.

The historical phonetic law is the cause of many consonant alternations when they experience the word form-formation. Though this phonetic law is still present in the contemporary language, it is being called historical law because it follows a rule, which is no longer playing a vital role in the modern Bulgarian language. According to philologists[2], during the early period of the Bulgarian language it was not possible to form such syllables, i.e. *ге(ge)*, *ке(ke)*, *хе(he).* Referring to the vowel and consonant classifications, we can find out that *e* is a front vowel (bg) *предна гласна(predna glasna)*, and *k, g,* and *x* are velar consonants (bg) *задноезични съгласни(zadnoezichni caglacni).* Hence, we can realise that front vowels cannot be followed by velar consonants. Based on this rule, in order to be followed by the front vowel *e*, all the velar consonant *"г"*s will be alternated into *"ж"*s, all the *"к"*s into *"ч"*s, and all the *"х"*s into *"ш"*s. That's why in Bulgarian we have *влага(vlaga) — влажен(vlazhen)*, *юнак(iunak)— юначен(iunachen)*, *стомах(stomah) — стомашен(stomashen)* and etc. Enable to deliver a better understanding of this phonetic law we can also review it from a comparative-linguistic perspective. Because Old Church Slavonic (OCS) is closely related to the Old Bulgarian, that's why we can also find this phonological rule appears in OCS as well. S. C. Garner mentioned in his OCS grammar book: "Velar consonants —*k, g, x*. These cannot be followed by a front vowel"(Garner 1984, p. 19). Garner's statement strongly supports my theory.

P. Pashov believed that in the past the postalveolar consonants (bg) *небни съгласни(nebni caglacni) ж, ч* and *ш* are always being soft. (Pashov, 1998, p. 41) The replacement of *г, к, х* into *ж, ч, ш* when it is followed by front vowels, is, therefore, called the "palatalisation". Same as OCS, in the history of the Bulgarian language, the palatalisation also has happened twice. The alternation of *г, к, х* into *ж, ч, ш* happened in the first one, and during the second one *г, к* and *х* that in front of the front vowels were more often being alternated in to *з, ц* and *с*. *З, ц* and *с* are alveolar consultants (bg) *алвеодентални съгласни(alveodentalni caglacni)*. As a result of the second palatalisation, now in Bulgarian we have *съпруг(saprug) — съпрузи(sapruzi)*, *юнак(iunak) — юнаци(iunatsi)*, and *стомах(stonah) — стомаси(stomaci)*. Hence, three sets of alternations are established: *г — ж — з, к — ч — ц* and *х — ш — с*. Nowadays, we can also find that these alternations can, somehow, be interchangeable, i.e. *ж* alternate directly into *з*, or *ж* into *г* when it is not in front of a front vowel.

[2] Petar Pashov; *Balgarska gramatika*; Izdatelstka kashta "Khermes"; Sofia, 1999; p41

Due to these consonant alternations, vowel alternations will also take place enable to correspond to the phonetic law. Therefore, when we come across the alternations in the contemporary Bulgarian verbal system, we can notice that the consonant and vowel alternations may happen simultaneously. As mentioned before, velar consonants cannot be followed by front vowels, only when they alternate into postalveolar or alveolar consonants they can then be followed by front vowels. Meanwhile, there is another phonetic law that there can only be front vowel in front of a syllable containing front vowel. Because of this law, now in Bulgarian verbal system we have *(в-)ляза(v-liaza)*(base form) — *(в-)лезеш(v-lezesh)* (2nd Person Singular Present Tense). Consequently, when there is an alternation of postalveolar or alveolar consonant into velar consonant, the front vowel before or after the alternated consonant can also be changed. Hence, in the Bulgarian verb system we can find two alternations happen at the same time. I.e. *режа(resha)*(base form) — *рѝза(riaza)*(2nd Person Singular Past Aorist form).

The vowel alternation shows in the example above is *е — я*, it can also happen *vise versa*. The *я — е* alternation is known as the most frequent vowel alternation in the contemporary Bulgarian language. Historically this alternation is a result of different developments of the yat vowel (ѣ) (bg) ятова гласна (iatova glasna) that is lower than */e/* and more fronted than */a/*. (Hauge, 1999, p. 11) The yat vowel was once existed in Old Bulgarian and is extinct in modern days. This vowel alternation can also be referred as the yat-umlaut.

The yat-umlaut will **only happen** when meeting **as least one** of the following conditions:

1) The vowel is not in the stressed syllable. E.g. *сняг(snyag) — снегът(snegat)* , *място(myasto) - места(mesta)*
2) It is placed in front of a syllable containing *ж, ч, ш* (the palatal consonants) or й. E.g. *сняг(snyag) — снежен(snezhen)*, *мляко(mlyako) — млечен(mlechen)*, *грях(gryah) — грешка(greshka)*
3) It is in front of a syllable containing front vowels *е* or *и*. E.g. *бял(byal) — бели(beli)*, *пял(pyal) — пели(peli)*.
4) It is in front of a syllable containing a soft consonant that is indicated by ю, я or ьо. E.g. *място(myasto) — местя(mestya)*, *пяна (pyana)— пеня се(penya se)*.

But there are also exceptions to these rules

1) The yat-umlaut occurs to words that are borrowed from Russian (or Old Church Slavonic) and from Western Bulgarian dialect while not following the conditions. E.g. *зрял(zryal) — зрелост(zrelost)*, *лято(lyato) — дългoлетна(dalgoletna)*, *гняв(gnyav) — гневна(gnevna)*.
2) The yat-umlaut does not occur to the first and second person plural verb forms of the Past Aorist and the Past Imperfect of the first and second conjugation groups. E.g. *четяхме(chetyahme)*, *четяхте(chetyahte)*; *пяхме(pyahme)*, *пяхте(pyahte)*.
3) The yat-umlaut occurs to the perfective verbs from the first conjugation groups that are formed with the suffix *-на* while not following the conditions. E.g *клякам(klyakam) — клекна(klekna)*, *плясвам(glyasvam) — плесна(plesna)*. The alternations between imperfective and perfective verbs (as the examples show) are not going to be discussed in the following part of this dissertation, as the aim of my work is to focus only on the alternations appear in imperfective base verbs.
4) The yat-umlaout occurs inconsistently in the singular nouns ending in -ост. E.g. *престарялост(prestaryalost) — престарялостта(prestaryalostta)*
5) If the main stress is not on the vowel, the vowel is written as *е* in the subordinate basis of complex words. E.g. *беломорски(belomorski)*

As now we have established a more thorough understanding about the vowel and consonant alternations, we may continue and examine the alternations in the Bulgarian verbal system with detailed examples.

7 Vowel and Consonant Alternations: Present Stem

7 .1 Present Tense – First Conjugation Group

1) Consonant Alternation

– *К-Ч* Alternation

Base Form	**Present Stem**		**Singular**			**Plural**	
		1St Person	2nd Person	3rd person	1St Person	2nd Person	3rd person
пекà	печѐ-	пекà	печѐш	печѐ	печѐм	печѐте	пекàт
секà	сечѐ-	секà	сечѐш	сечѐ	сечѐм	сечѐте	секàт
рекà	речѐ-	рекà	речѐш	речѐ	речѐм	речѐте	рекàт
текà	течѐ-	текà	течѐш	течѐ	течѐм	течѐте	текàт
влекà	влечѐ-	влекà	влечѐш	влечѐ	влечѐм	влечѐте	влекàт
(съ-)блекà	(съ-)блечѐ-	(съ-)блекà	(съ-)блечѐш	(съ-)блечѐ	(съ-)блечѐм	(съ-)блечѐте	(съ-)блекàт

The listed verbs all have consonant alternations from the velar consonant *“к”* into the postalveolar consonant *“ч”*when forming their Present tense verb forms. These facts indicate that the alternations also appear in their Present stems. As mentioned previously, there is no thematic vowel inserted for the 1st Person Singular Preset tense, which at the same time, also matches the Base Form. We are able to tell the root morphemes of the listed verbs are *“пек(pek)”*, *“сек(sek)”*, *“рек(rek)”*, *“тек(tek)”*, *“влек(vlek)”* and *“(съ-)блек[(ca)blek]”*. For the First Conjugation Group, the thematic vowel attached to the root morphemes to form the present verbal stems is *–е–* (which is a front vowel). Hence, the velar consonant must follow the phonological rule and change into the postalveolar consonant, therefore, gain the right to be followed by a front vowel. These alternations also change their root morphemes from *“пек(pek)”*, *“сек(sek)”*, *“тек(tek)”*, *“влек(vlek)”* into *“nech(pech)”*, *“cech(sech)”*, *“mech(tech)”*, *“влech(vlech)”*. Though the base root morpheme and its alternant are different by form, but they carry out the same meaning. That’s why we can confirm the alternated root morphemes are the allomorphs of the base ones.

– *Г-Ж* Alternation

Base Form	**Present Stem**		**Singular**			**Plural**	
		1St Person	2nd Person	3rd person	1St Person	2nd Person	3rd person
мòга	мòже-	мòга	мòжеш	мòже	мòжем	мòжете	мòгат

Verb *мога(moga)* has the consonant alternation from the velar consonant*“г”* into the postalveolar consonant *“ж”* for its Present stem *“можѐ-(moshè)-”*, as well as all its Present tense verb forms. Its base root morpheme *“мог(mog)”* is ended in the velar consonant *“г”*; enable to be followed by the thematic vowel *–е–* (which is a front vowel) to form the Present stem, it has to be alternated into *“ж”*. The alternant root morpheme *“мож(mozh)”* is the allomorph of its base root morpheme *“мог(mog)”*.

2) Vowel Alternation: *Я-Е* Alternation (Yat-umlaut)

Base Form	**Present Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd person	1St Person	2nd Person	3rd person
(в-)ля̀за	(в-)лѐзе-	(в-)ля̀за	(в-)лѐзеш	(в-)лѐзе	(в-)лѐзем	(в-)лѐзете	(в-)ля̀зат

Verb *(в-)ляза[(v-)lyaza]* has the vowel alternation from the middle vowel *"я"* into the front vowel *"е"* for its Present stem *"(в-)лѐзе-[(v-)lèze-]"*, as well as all its Present tense verb forms. Its root morpheme *"(в-)ляза[(v-)lyaz]"* contains the vowel "*я*". According to the phonetic law, when the yat vowel is in front of a syllable containing front vowels *е* or *и*, the yat-umlaut will take place. Therefore, enable to be followed by the thematic vowel –*е*– to form the present stem "*я*" has to be alternated into *"е"*.

7.2 Gerund – First Conjugation Group

1) Consonant Alternation

– *К-Ч* Alternation

Base Form	**Present Stem**	**Gerund**
пекà	печѐ-	печѐйки
секà	сечѐ-	сечѐйки
текà	течѐ-	течѐйки
влекà	влечѐ-	влечѐйки

The listed verbs all have consonant alternations from the velar consonant *"к"* into the postalveolar consonant *"ч"* in their Present stems. Due to the fact that the Gerund forms are formed from the Present stems, therefore, the alternations appear again. (Please refer to the Present Tense part for detailed analysis.)

– *Г-Ж* Alternation

Base Form	**Present Stem**	**Gerund**
мòга	мòже-	мòжейки

Verb *мога(moga)* has the consonant alternation from the velar consonant *"г"* into the postalveolar consonant *"ж"* in its Present stem *"можѐ-(moshè)-"*. Due to the fact that the Gerund forms are formed from the Present stems, therefore, the alternation appears again. (Please refer to the Present Tense part for detailed analysis.)

7.3 Imperative – First Conjugation Group

1) Consonant Alternation: *К-Ч* Alternation

Base Form	Present Stem	Imperative
пекà	печѐ-	печѝ, печѐте
секà	сечѐ-	сечѝ, сечѐте
рекà	речѐ-	речѝ, речѐте
текà	течѐ-	течѝ, течѐте
влекà	влечѐ-	влечѝ, влечѐте
(съ-)блекà	(съ-)блечѐ-	(съ-)блечѝ, (съ-)блечѐте

The listed verbs all have consonant alternations from the velar consonant *"к"* into the postalveolar consonant *"ч"* in their Present stems. (Please refer to the Present Tense part for detailed analysis.) Due to the fact that the Imperative forms are formed from the Present stems, therefore, the alternations appear again.

2) Vowel Alternation: *Я-Е* Alternation (Yat-umlaut)

Base Form	Present Stem	Imperative
(в-)лѧ̀за	(в-)лѐзе-	(в-)лѐз, (в-)лѐзте

Verb *(в-)ляза[(v-)lyaza]* has the vowel alternation from the middle vowel *"я"* into the front vowel *"е"* in its Present stem *"(в-)лѐзе-[(v-)lèze-]*". (Please refer to the Present Tense part for detailed analysis.) Due to the fact that the Imperative forms are formed from the Present stems, therefore, the alternation appears again.

8 Vowel and Consonant Alternations: Aorist Stem
8.1 Past Aorist – First Conjugation

1) Consonant Alternation

– *Ж-З* Alternation

Base Form	Aorist Stem	Singular 1St Person	Singular 2nd Person	Singular 3rd Person	Plural 1St Person	Plural 2nd Person	Plural 3rd Person
блѝжа	блѝза-	блѝзах	блѝза	блѝза	блѝзахме	блѝзахте	блѝзаха
вѐржа	вѐрза-	вѐрзах	вѐрза	вѐрза	вѐрзахме	вѐрзахте	вѐрзаха
кà̀жа	кà̀за-	кà̀зах	кà̀за	кà̀за	кà̀захме	кà̀захте	кà̀заха
лѝжа	лѝза-	лѝзах	лѝза	лѝза	лѝзахме	лѝзахте	лѝзаха
мà̀жа	мà̀за-	мà̀зах	мà̀за	мà̀за	мà̀захме	мà̀захте	мà̀заха
нѝжа	нѝза-	нѝзах	нѝза	нѝза	нѝзахме	нѝзахте	нѝзаха
харѝжа	харѝза-	харѝзах	харѝза	харѝза	харѝзахме	харѝзахте	харѝзаха

The listed verbs all have consonant alternations from the postalveolar consonant *"ж"* into the alveolar consonant *"з"* when forming their Past Aorist verb forms. These facts indicate that the alternations also appear in their Aorist stems. What the meaning carries out by these

alternations is somewhat grammatical than phonetic. The alternation does not reveal any phonetic law but differentiates the Aorist stem from the other stems. We are able to tell that the Present and Imperfect stems for all the listed verbs are identical. They are *блѝже-(blìzhe-), въ̀рже-(vàrzhe-), ка̀же-(kàzhe-), лѝже-(lìzhe-), ма̀же-(màzhe-), нѝже-(nìzhe-),* and *харѝже-(harìzhe-).* Compare to the Aorist stems listed above, we can distinguish the difference. As mentioned before, only verbs from the Third Conjugation Group have three identical stems. Hence, the difference between the three stems for these verbs is presented by the *ж-з* consonant alternation together with the Aorist thematic vowel.

– *Ж-Г* Alternation

Base Form	**Aorist Stem**	**Singular** 1St Person	2nd Person	3rd Person	**Plural** 1St Person	2nd Person	3rd Person
лъ̀жа	лъ̀га-	лъ̀гах	лъ̀га	лъ̀га	лъ̀гахме	лъ̀гахте	лъ̀гаха
стрѝжа	стрѝга-	стрѝгах	стрѝга	стрѝга	стрѝгахме	стрѝгахте	стрѝгаха
стъ̀ржа	стъ̀рга-	стъ̀ргах	стъ̀рга	стъ̀рга	стъ̀ргахме	стъ̀ргахте	стъ̀ргаха

The listed verbs all have consonant alternations from the postalveolar consonant *"ж"* into the velar consonant *"г"* when forming their Past Aorist verb forms. These facts indicate that the alternations also appear in their Aorist stems. What the meaning carries out by these alternations is also grammatical. The alternation also differentiates the Aorist stem from the other stems. We are able to tell that the Present and Imperfect stems for all the listed verbs are also identical. They are *лъ̀же-(làzhe-), стрѝже-(strìzhe-)* and *стъ̀рже-(starzhe-).* The difference between the three stems for these verbs is presented by the *ж-г* alternation together with the Aorist thematic vowel.

– *Ч-К* Alternation

Base Form	**Aorist Stem**	**Singular** 1St Person	2nd Person	3rd Person	**Plural** 1St Person	2nd Person	3rd Person
дъ̀вча	дъ̀вка-	дъ̀вках	дъ̀вка	дъ̀вка	дъ̀вкахме	дъ̀вкахте	дъ̀вкаха
мяу̀ча	мяу̀ка-	мяу̀ках	мяу̀ка	мяу̀ка	мяу̀кахме	мяу̀кахте	мяу̀каха
пла̀ча	пла̀ка-	пла̀ках	пла̀ка	пла̀ка	пла̀кахме	пла̀кахте	пла̀каха
сму̀ча	сму̀ка-	сму̀ках	сму̀ка	сму̀ка	сму̀кахме	сму̀кахте	сму̀каха
су̀ча	су̀ка-	су̀ках	су̀ка	су̀ка	су̀кахме	су̀кахте	су̀каха
тъ̀пча	тъ̀пка-	тъ̀пках	тъ̀пка	тъ̀пка	тъ̀пкахме	тъ̀пкахте	тъ̀пкаха

The listed verbs all have consonant alternations from the postalveolar consonant *"ч"* into the velar consonant *"к"* when forming their Past Aorist verb forms. These facts indicate that the alternations also appear in their Aorist stems. What the meaning carries out by these alternations is also grammatical. The alternation also differentiates the Aorist stem from the other stems. We are able to tell that the Present and Imperfect stems for all the listed verbs are also identical. They are *дъ̀вче-(dàvche-), мяу̀че-(miaùche-), пла̀че-(plache-), сму̀че-(smùche-), су̀че-(sùche-),* and *тъ̀пче-(tàpche-).* The difference between the three stems for these verbs is presented by the *ч-к* alternation together with the Aorist thematic vowel.

– *Ш-С* Alternation

Base Form	Aorist Stem	Singular 1St Person	Singular 2nd Person	Singular 3rd Person	Plural 1St Person	Plural 2nd Person	Plural 3rd Person
бъ̀рша	бъ̀рса-	бъ̀рсах	бъ̀рса	бъ̀рса	бъ̀рсахме	бъ̀рсахте	бъ̀рсаха
пѝша	пѝса-	пѝсах	пѝса	пѝса	пѝсахме	пѝсахте	пѝсаха
чѐша	чѐса-	чѐсах	чѐса	чѐса	чѐсахме	чѐсахте	чѐсаха

The listed verbs all have consonant alternations from the postalveolar consonant *"ш"* into the alveolar consonant *"с"* when forming their Past Aorist verb forms. These facts indicate that the alternations also appear in their Aorist stems. What the meaning carries out by these alternations is also grammatical. The alternation also differentiates the Aorist stem from the other stems. We are able to tell that the Present and Imperfect stems for all the listed verbs are also identical. They are *бъ̀рше-(bàrshe-), пѝше-(pìshe-)* and *чѐше-(chèshe-).* The difference between the three stems for these verbs is presented by the *ш-с* alternation together with the Aorist thematic vowel.

– *Г-Ж* Alternation

Base Form	Aorist Stem	Singular 1St Person	Singular 2nd Person	Singular 3rd Person	Plural 1St Person	Plural 2nd Person	Plural 3rd Person
мòга	можà-	можàх	можà	можà	можàхме	можàхте	можàха

Verb *мога(moga)* has the consonant alternation from the velar consonant *"г"* into the postalveolar consonant *"ж"* when forming their Past Aorist verb forms. This fact indicates that the alternation also appears in its Aorist stem, which also occurs to its Present and Imperfect stems. The difference between the three stems for *мога(moga)* is presented by the Aorist thematic vowel. We may persume that this *"г"* -*"ж"* alternation is historically preserved from the first palatalisation[3].

2) Consonant Alternation: *К-Ч*

Base Form	Aorist Stem	Singular 1St Person	Singular 2nd Person	Singular 3rd Person	Plural 1St Person	Plural 2nd Person	Plural 3rd Person
пекà	пѐко-/ пѐче-	пѐкох	пѐче	пѐче	пѐкохме	пѐкохте	пѐкоха
рекà	рѐко-/ рѐче	рѐкох	рѐче	рѐче	рѐкохме	рѐкохте	рѐкоха
текà	тѐко-/ тѐче	тѐкох	тѐче	тѐче	тѐкохме	тѐкохте	тѐкоха

The listed verbs all from the 24 imperfective base verbs, which have two Aorist stems. The alternations all take place in the Aorist stem that contains the thematic vowel –*е*–. Because the velar consonant *"к"* cannot be followed by the front vowel *"е"*, therefore, it has alternated into the postalveolar consonant *"ч"*.

3) Consonant Alternation: *К-Ч* and Vowel Alternation: *Я-Е* (Yat-umlaut)

[3] As mentioned previously, in the history of the Bulgarian language, the palatalisation has happened twice. The alternation of *г, к, х* into *ж, ч, ш* happened frequently in the first one.

Base Form	**Aorist Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
(съ)блекà	(съ)бля̀ко-/(съ)блѐче-	(съ)бля̀кох	(съ)блѐче	(съ)блѐче	(съ)бля̀кохме	(съ)бля̀кохте	(съ)бля̀коха
влекà	вля̀ко-/влѐче-	вля̀кох	влѐче	влѐче	вля̀кохме	вля̀кохте	вля̀коха
секà	ся̀ко-/сѐче-	ся̀кох	сѐче	сѐче	ся̀кохме	ся̀кохте	ся̀коха

The listed verbs are also from the 24 imperfective base verbs, which have two Aorist stems. The alternations, too, take place in the Aorist stem that contains the thematic vowel *–е–*. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*. Meanwhile, because the velar consonant *"к"* cannot be followed by the front vowel *"е"*, therefore, it has alternated into the postalveolar consonant *"ч"*.

4) Vowel Alternation: *Я-Е* (Yat-umlaut)

Base Form	**Aorist Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
(в-)ля̀за	(в-)ля̀зо-/(в-)лѐзе	(в-)ля̀зох	(в-)лѐзе	(в-)лѐзе	(в-)ля̀зохме	(в-)ля̀зохте	(в-)ля̀зоха

Verb *(в-)ляза[(v-)liaza]* is also from the 24 imperfective base verbs, which have two Aorist stems. The alternation, too, take place in the Aorist stem that contains the thematic vowel *–е–*. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*.

5) Vowel Alternation: *Е-Я*

Base Form	**Aorist Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
пѐя	пя̀-	пя̀х	пя̀	пя̀	пя̀хме	пя̀хте	пя̀ха
лѐя	ля̀-	ля̀х	ля̀	ля̀	ля̀хме	ля̀хте	ля̀ха

The listed verbs all have vowel alternations from the front vowel *"е"* into the middle vowel *"я"* when forming their Past Aorist verb forms. These verbs have slightly different Aorist stems. There is no thematic vowel presents in the stems. Therefore, the alternation is taken place in their root morphemes. We are able to tell that the Present and Imperfect stems for all the listed verbs are also identical. They are *nèe--(pèe-)* and *лèе-(lèe-)*. Therefore, their root morphemes are *пе(pe)* and *ле(le)*. They alternate into *пя(pia)* and *ля(lia)* for the Aorist stems. The difference between the Aorist stem and other two stems for the listed verbs is presented by the vowel alternation.

6) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	**Aorist Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
рѐжа	ря̀за-	ря̀зах	ря̀за	ря̀за	ря̀захме	ря̀захте	ря̀заха

Verb *режа(resha)* has the consonant alternation from postalveolar consonant *"ж"* into the alveolar consonant *"з"*, as well as the vowel alternation from the front vowel *"е"* into the middle vowel *"я"* when forming their Past Aorist verb forms. This fact indicates that the alternations also appear in its Aorist stems. What the meaning carries out by these alternations is also grammatical. The difference between the Aorist stem and other two stems for *режа(resha)* is presented by the alterntaions.

8.2 Past Aorist – Second Conjugation

1) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	**Aorist Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
белѐжа	беля̀за-	беля̀зах	беля̀за	беля̀за	беля̀захме	беля̀захте	беля̀заха

Verb *бележа(belezha)* has the consonant alternation from postalveolar consonant *"ж"* into the alveolar consonant *"з"*, as well as the vowel alternation from the front vowel *"е"* into the middle vowel *"я"* when forming their Past Aorist verb forms. This fact indicates that the alternations also appear in its Aorist stems. What the meaning carries out by these alternations is also grammatical. The difference between the Aorist stem and other two stems for *бележа(belezha)* is presented by the alterntaions.

8.3 Past Active Aorist Participle – First Conjugation

1) Consonant Alternation

– *Ж-З* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
блѝжа	блѝза-	блѝзал	блѝзала	блѝзало	блѝзали
въ̀ржа	въ̀рза-	въ̀рзал	въ̀рзала	въ̀рзало	въ̀рзали
ка̀жа	ка̀за-	ка̀зал	ка̀зала	ка̀зало	ка̀зали
лѝжа	лѝза-	лѝзал	лѝзала	лѝзало	лѝзали
ма̀жа	ма̀за-	ма̀зал	ма̀зала	ма̀зало	ма̀зали
нѝжа	нѝза-	нѝзал	нѝзала	нѝзало	нѝзали
харѝжа	харѝза-	харѝзал	харѝзала	харѝзало	харѝзали

The listed verbs carry out the same consonant alternations as in the Past Aorist verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ж-Г* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
лъ̀жа	лъга-	лъ̀гал	лъ̀гала	лъ̀гало	лъ̀гали
стрѝжа	стрѝга-	стрѝгал	стрѝгала	стрѝгало	стрѝгали
стъ̀ржа	стъ̀рга-	стъ̀ргал	стъ̀ргала	стъ̀ргало	стъ̀ргали

The listed verbs carry out the same consonant alternations as in the Past Aorist verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ч-К* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
дъ̀вча	дъ̀вка-	дъ̀вкал	дъ̀вкала	дъ̀вкало	дъ̀вкали
мяу̀ча	мяу̀ка-	мяу̀кал	мяу̀кала	мяу̀кало	мяу̀кали
пла̀ча	пла̀ка-	пла̀кал	пла̀кала	пла̀кало	пла̀кали
му̀ча	му̀ка-	му̀кал	му̀кала	му̀ка	му̀кали
су̀ча	су̀ка-	су̀кал	су̀кала	су̀кало	мсу̀кали
тъ̀пча	тъ̀пка-	тъ̀пкал	тъ̀пкала	тъ̀пкало	тъ̀пкали

The listed verbs carry out the same consonant alternations as in the Past Aorist verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ш-С* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
бъ̀рша	бъ̀рса-	бъ̀рсал	бъ̀рсала	бъ̀рсало	бъ̀рсали
пѝша	пѝса-	пѝсал	пѝсала	пѝсало	пѝсали
чѐша	чѐса-	чѐсал	чѐсала	чѐсало	чѐсали

The listed verbs carry out the same consonant alternations as in the Past Aorist verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ж-Г* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
мо̀же	можà-	могъ̀л	моглà	моглò	моглѝ

Verb *мога(тоga)* carries out the same consonant alternation as in the Past Aorist verb forms. The alternation is occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

2) Vowel Alternation: *Я-Е* (Yat-umlaut)

Base Form	Aorist Stem	Past Active Aorist Participle			
		Masculine	Feminine	Neuter	Plural
влекà	вля̀ко-/влѐче-	вля̀кълъ	вля̀кла	вля̀кло	влѐкли
секà	ся̀ко-/ сѐче-	ся̀кълъ	ся̀кла	ся̀кло	сѐкли
(в-)лязà	(в-)ля̀зо-/(в-)лѐзе	(в-)ля̀зълъ	(в-)ля̀зла	(в-)ля̀зло	(в-)лѐзли

The listed verbs, as mentioned before, are from the 24 imperfective base verbs, which have two Aorist stems. When forming the Past Active Aorist Participle forms, they use the Aorist stems that have the thematic vowel *–о–*. However, there is an additional yat-umlaut occurs to their Plural forms. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*.

3) Vowel Alternation: *Я-Е* (Yat-umlaut)

Base Form	Aorist Stem	Past Active Aorist Participle			
		Masculine	Feminine	Neuter	Plural
пѐя	пя̀-	пя̀л	пя̀ла	пя̀ло	пѐли
лѐя	ля̀-	ля̀л	ля̀ла	ля̀ло	лѐли

The listed verbs carry out the same vowel alternation in its Aorist stem when forming its Past Active Aorist Participle forms. (Please refer to the Past Aorist part for detailed analysis.) But there is an additional yat-umlaut occurs to their Plural forms. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*.

4) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	Aorist Stem	Past Active Aorist Participle			
		Masculine	Feminine	Neuter	Plural
рѐжа	ря̀за-	ря̀зал	ря̀зала	ря̀зало	ря̀зали

Verb *режа(resha)* carries out the same consonant and vowel alternations as in the Past Aorist verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

8.4 Past Active Aorist Participle – Second Conjugation Group

1) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	Aorist Stem	Past Active Aorist Participle			
		Masculine	Feminine	Neuter	Plural
белѐжа	беля̀за-	беля̀зал	беля̀зала	беля̀зало	беля̀зали

Verb *бележа(belezha)* carries out the same consonant and vowel alternations as in the Past Aorist verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

8.5 Past Passive Participle – First Conjugation

1) Consonant Shift

– *Ж-З* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
блѝжа	блѝза-	блѝзан	блѝзана	блѝзано	блѝзани
вър̀жа	вър̀за-	вър̀зан	вър̀зана	вър̀зано	вър̀зани
ка̀жа	ка̀за-	ка̀зан	ка̀зана	ка̀зано	ка̀зани
лѝжа	лѝза-	лѝзан	лѝзана	лѝзано	лѝзани
ма̀жа	ма̀за-	ма̀зан	ма̀зана	ма̀зано	ма̀зани
нѝжа	нѝза-	нѝзан	нѝзана	нѝзано	нѝзани
харѝжа	харѝза-	харѝзан	харѝзана	харѝзано	харѝзани

The listed verbs carry out the same consonant alternations as in the Past Aorist and Past Active Aorist Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ж-Г* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
лъ̀жа	лъ̀га-	лъ̀ган	лъ̀гана	лъ̀гано	лъ̀гани
стрѝжа	стрѝга-	стрѝган	стрѝгана	стрѝгано	стрѝгани
стъ̀ржа	стъ̀рга-	стъ̀рган	стъ̀ргана	стъ̀ргано	стъ̀ргани

The listed verbs carry out the same consonant alternations as in the Past Aorist and Past Active Aorist Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ч-К* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
дъ̀вча	дъ̀вка-	дъ̀вкан	дъ̀вкана	дъ̀вкано	дъ̀вкани
тъ̀пча	тъ̀пка-	тъ̀пкан	тъ̀пкана	тъ̀пкано	тъ̀пкани

The listed verbs carry out the same consonant alternations as in the Past Aorist and Past Active Aorist Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ш-С* Alternation

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
бъ̀рша	бъ̀рса-	бъ̀рсан	бъ̀рсана	бъ̀рсано	бъ̀рсани
пѝша	пѝса-	пѝсан	пѝсана	пѝсано	пѝсани
чѐша	чѐса-	чѐсан	чѐсана	чѐсано	чѐсани

The listed verbs carry out the same consonant alternations as in the Past Aorist and Past Active Aorist Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *К-Ч* Alternation

Base Form	**Aorist Stem**	**Past Passive Participle**			
		Masculine	Feminine	Neuter	Plural
пекà	пѐко-/пѐче-	пѐчен	пѐчена	пѐчено	пѐчени
рекà	рѐко-/ рѐче	рѐчен	рѐчена	рѐчено	рѐчени
текà	тѐко-/ тѐче	тѐчен	тѐчена	тѐчено	тѐчени

The listed verbs, as mentioned before, are from the 24 imperfective base verbs, which have two Aorist stems. When forming the Past Passive Participle forms, they use the Aorist stems that have the thematic vowel *–е–*. The alternations all take place in their *–е–* Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

2) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	**Aorist Stem**	**Past Passive Participle**			
		Masculine	Feminine	Neuter	Plural
влекà	влѝко-/влѐче-	влечен	влечена	влечено	влечени
секà	сѝко-/ сѐче-	сечен	сечена	сечено	сечени

The listed verbs, as mentioned before, are from the 24 imperfective base verbs, which have two Aorist stems. When forming the Past Passive Participle forms, they use the Aorist stems that have the thematic vowel *–е–*. Both the consonant and vowel alternations take place in their *–е–* Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

3) Vowel Alternation: *Я-Е* (Yat-umlaut)

Base Form	**Aorist Stem**	**Past Passive Participle**			
		Masculine	Feminine	Neuter	Plural
пѐя	пѝ-	пѝт	пѝта	пѝто	пѐти
лѐя	лѝ-	лѝт	лѝта	лѝто	лѐти

The listed verbs carry out the same vowel alternation in its Aorist stem when forming its Past Passive Participle forms. (Please refer to the Past Aorist part for detailed analysis.) But there is an additional yat-umlaut occurs to their Plural forms. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*.

4) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	**Aorist Stem**	**Past Active Aorist Participle**			
		Masculine	Feminine	Neuter	Plural
рѐжа	рѝза-	рѝзан	рѝзана	рѝзано	рѝзани

Verb *режа(resha)* carries out the same consonant and vowel alternations as in the Past Aorist and Past Active Aorist Participle verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

Past Passive Participle – Second Conjugation

1) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	Stem	Past Passive Participle			
		Masculine	Feminine	Neuter	Plural
белѐжа	беля̀за-	беля̀зан	беля̀зана	беля̀зано	беля̀зани

Verb *бележа(belezha)* carries out the same consonant and vowel alternations as in the Past Aorist and Past Active Aorist Participle verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

8.6 Verbal Noun – First Conjugation

1) Consonant Shift

– *Ж-З* Alternation

Base Form	**Aorist Stem**	**Verbal Noun**
блѝжа	блѝза-	блѝзане
въ̀ржа	въ̀рза-	въ̀рзане
ка̀жа	ка̀за-	ка̀зане
лѝжа	лѝза-	лѝзане
ма̀жа	ма̀за-	ма̀зане
нѝжа	нѝза-	нѝзане
харѝжа	харѝза-	харѝзане

The listed verbs carry out the same consonant alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ж-Г* Alternation

Base Form	**Aorist Stem**	**Verbal Noun**
лъ̀жа	лъ̀га-	лъ̀гане
стрѝжа	стрѝга-	стрѝгане
стъ̀ржа	стъ̀рга-	стъ̀ргане

The listed verbs carry out the same consonant alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ч-К* Alternation

Base Form	**Aorist Stem**	**Verbal Noun**
дъ̀вча	дъ̀вка-	дъ̀вкане
тъ̀пча	тъ̀пка-	тъ̀пкане

The listed verbs carry out the same consonant alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *Ш-С* Alternation

Base Form	Aorist Stem	Verbal Noun
бъ̀рша	бъ̀рса-	бъ̀рсане
пѝша	пѝса-	пѝсане
чѐша	чѐса-	чѐсане

The listed verbs carry out the same consonant alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. These alternations are occurred to their Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

– *К-Ч* Alternation

Base Form	Aorist Stem	Verbal Noun
пекà	пѐко-/пѐче-	пѐчене
рекà	рѐко-/ рѐче	рѐчене
текà	тѐко-/ тѐче	тѐчене

The listed verbs, as mentioned before, are from the 24 imperfective base verbs, which have two Aorist stems. When forming the Verbal Noun forms, they use the Aorist stems that have the thematic vowel –*е*–. The alternations all take place in their –*е*– Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

2) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	Aorist Stem	Verbal Noun
влекà	вля̀ко-/влѐче-	влечене
секà	ся̀ко-/ сѐче-	сечене

The listed verbs, as mentioned before, are from the 24 imperfective base verbs, which have two Aorist stems. When forming the Verbal Noun forms, they use the Aorist stems that have the thematic vowel –*е*–. Both the consonant and vowel alternations take place in their –*е*– Aorist stems. (Please refer to the Past Aorist part for detailed analysis.)

3) Vowel Alternation: *Я-Е* (Yat-umlaut)

Base Form	Aorist Stem	Verbal Noun
пѐя	пя̀-	пѐене
лѐя	ля̀-	лѐене

The listed verbs carry out the same vowel alternation in its Aorist stem when forming its Verbal Noun forms. (Please refer to the Past Aorist part for detailed analysis.) However, unlike the other verbal forms formed from their Aorist stems, when forming the Verbal Noun forms the listed verbs need to add the thematic vowel –*е*– and the Verbal Noun ending –не. Hence, there is an additional yat-umlaut occurs to their Verbal Noun forms. According to phonetic law, when *"я"* is in front of a syllable containing front vowels *"е"* or *"и"*, it will alternate into *"е"*.

4) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*

Base Form	Aorist Stem	Verbal Noun
рѐжа	ря̀за-	ря̀зане

Verb *режа(resha)* carries out the same consonant and vowel alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

8.7 Verbal Noun – Second Conjugation

1) Consonant Alternation: *Ж-З* and Vowel Alternation: *Е-Я*
2)

Base Form	Aorist Stem	Verbal Noun
белѐжа	белѧ̀за-	белѧ̀зане

Verb *бележа(belezha)* carries out the same consonant and vowel alternations as in the Past Aorist, Past Active Aorist Participle and Past Passive Participle verb forms. The alternations are occurred to its Aorist stem. (Please refer to the Past Aorist part for detailed analysis.)

9 Vowel and Consonant Alternations: Imperfect Stem

9.1 Past Imperfect – First Conjugation

1) Consonant Shift

– *К-Ч* Alternation

Base Form	Imperfect Stem	Singular			Plural		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
пекà	печà-	печàх	печѐше	печѐше	печàхме	печàхте	печàха
секà	сечà-	сечàх	сечѐше	сечѐше	сечàхме	сечàте	сечàха
рекà	речà-	речàх	речѐше	речѐше	речàхме	речàхте	речàха
текà	течà-	течàх	течѐше	течѐше	течàхме	течàхте	течàха
влекà	влечà-	влечàх	влечѐше	влечѐше	влечàхме	влечàхте	влечàха
(съ)	(съ)	(съ)	(съ)	(съ)	(съ)	(съ)	(съ)
блекà	блечà-	блечàх	блечѐше	блечѐше	блечàхме	блечàхте	блечàха

The listed verbs all have consonant alternations from the velar consonant *"к"* into the postalveolar consonant *"ч"*when forming their Past Imperfect verb forms. These facts indicate that the alternations also appear in their Imperfect stems. What the meaning carries out by these alternations is somewhat grammatical than phonetic. The alternation does not reveal any phonetic law but differentiates the Imperfect stem from the other stems. The difference between the Imperfect stem and other two stems for these verbs is presented by the *к-ч* consonant alternation together with the Imperfect thematic vowel.

– *Г-Ж* Alternation

Base Form	Imperfect Stem	Singular			Plural		
		1St Person	2nd Person	3rd Person	1St Person	2nd Person	3rd Person
мòга	мòже-	мòжех	мòжеше	мòжеше	мòжехме	мòжехте	мòжеха

Verb *мога(moga)* has the consonant alternation from the velar consonant*"г"* into the postalveolar consonant *"ж"* for its Imperfect stem *"можѐ-(moshè)-"*, as well as all its Past Imperfect verb forms. What the meaning carries out by these alternations is also grammatical.

Its base root morpheme *"мог(mog)"* is ended in the velar consonant *"г"*; enable to be followed by the thematic vowel *–е–* (which is a front vowel) to form the Imperfect stem, it has to be alternated into *"ж"*. The alternant root morpheme *"мож(mozh)"* is the allomorph of its base root morpheme *"мог(mog)"*. Also, we are able to tell that the Present and Imperfect stems for *мога(moga)* are identical, because they all use the same thematic vowel *–е–*.

2) Vowel Alternation: *Я-Е* Alternation (Yat-umlaut)

Base Form	**Imperfect Stem**	**Singular**			**Plural**		
		1St Person	2nd Person	3rd person	1St Person	2nd Person	3rd person
(в-)ля̀за	(в-)лѐзе-	(в-)лѐзех	(в-)лѐзеше	(в-)лѐзеше	(в-)лѐзехме	(в-)лѐзехте	(в-)лѐзеха

Verb *(в-)ляза[(v-)lyaza]* has the vowel alternation from the middle vowel *"я"* into the front vowel *"е"* for its Imperfect stem *"(в-)лѐзе-[(v-)lèze-]"*, as well as all its Past Imperfect verb forms. Its root morpheme *"(в-)ляза[(v-)lyaz]"* contains the middle vowel "*я*". According to the phonetic law, when the yat vowel is in front of a syllable containing front vowels *е* or *и*, the yat-umlaut will take place. Therefore, enable to be followed by the thematic vowel *–е–* to form the present stem "*я*" has to be alternated into *"е"*. Also, we are able to tell that the Present and Imperfect stems for *(в-)ляза[(v-)lyaza]* are identical, because they all use the same thematic vowel *–е–*.

9.2 Present Active Participle – First Conjugation

1) Consonant Shift

– *К-Ч* Alternation

Base Form	**Imperfect Stem**	**Present Active Participle**			
		Masculine	Feminine	Neuter	Plural
пекà	печà-	печàщ	печàща	печàщо	печàщи
секà	сечà-	сечàщ	сечàща	сечàщо	сечàщи
рекà	речà-	речàщ	речàща	речàщо	речàщи
текà	течà-	течàщ	течàща	течàщо	течàщи
влекà	влечà-	влечàщ	влечàща	влечàщо	влечàщи
(съ) блекà	(съ) блечà-	(съ) блечàщ	(съ) блечàща	(съ) блечàщо	(съ) блечàщи

The listed verbs all have consonant alternations from the velar consonant *"к"* into the postalveolar consonant *"ч"* for their Imperfect stems. Due to the fact that the Present Active Participle forms are formed from the Imperfect stems, therefore, the alternations appear again. (Please refer to the Past Imperfect part for detailed analysis.)

– *Г-Ж* Alternation

Base Form	**Imperfect Stem**	**Present Active Participle**			
		Masculine	Feminine	Neuter	Plural
мòга	мòже-	мòжещ	мòжеща	мòжещо	мòжещи

Verb *мога(moga)* has the consonant alternation from the velar consonant *"г"* into the postalveolar consonant *"ж"* for its Imperfect stem *"можѐ-(moshè)-"*. Due to the fact that the

Present Active Participle forms are formed from the Imperfect stems, therefore, the alternation appears again. (Please refer to the Past Imperfect part for detailed analysis.)

9.3 Past Active Imperfect Participle – First Conjugation

1) Consonant Shift

– *К-Ч* Alternation

Base Form	**Imperfect Stem**	**Present Active Participle**			
		Masculine	Feminine	Neuter	Plural
пекà	печà-	печàл	печàла	печàло	печàли
секà	сечà-	сечàл	сечàла	сечàло	сечàли
рекà	речà-	речàл	речàла	речàло	речàли
текà	течà-	течàл	течàла	течàло	течàли
влекà	влечà-	влечàл	влечàла	влечàло	влечàли
(съ) блекà	(съ) блечà-	(съ) блечàл	(съ) блечàла	(съ) блечàло	(съ) блечàли

The listed verbs all have consonant alternations from the velar consonant *"к"* into the postalveolar consonant *"ч"* for their Imperfect stems. Due to the fact that the Past Active Imperfect Participle forms are formed from the Imperfect stems, therefore, the alternations appear again. (Please refer to the Past Imperfect part for detailed analysis.)

– *Г-Ж* Alternation

Base Form	**Imperfect Stem**	**Present Active Participle**			
		Masculine	Feminine	Neuter	Plural
мòга	мòже-	мòжел	мòжела	мòжело	мòжели

Verb *мога(moga)* has the consonant alternation from the velar consonant *"г"* into the postalveolar consonant *"ж"* for its Imperfect stem *"можѐ-(moshè)-"*. Due to the fact that the Past Active Imperfect Participle forms are formed from the Imperfect stems, therefore, the alternation appears again. (Please refer to the Past Imperfect part for detailed analysis.)

2) Vowel Alternation: *Я-Е* Alternation (Yat-umlaut)

Base Form	**Imperfect Stem**	**Present Active Participle**			
		Masculine	Feminine	Neuter	Plural
(в-)лѝза	(в-)лѐзе-	(в-)лѐзел	(в-)лѐзела	(в-)лѐзело	(в-)лѐзели

Verb *(в-)ляза[(v-)lyaza* has the vowel alternation from the middle vowel *"я"* into the front vowel *"е"* for its Imperfect stem *"(в-)лѐзе-[(v-)lèze-]*". Due to the fact that the Past Active Imperfect Participle forms are formed from the Imperfect stems, therefore, the alternation appears again. (Please refer to the Past Imperfect part for detailed analysis.)

10 Conclusion

The dissertation examined the vowel and consonant alternations in Contemporary Bulgarian verbal system in detail, with the additional analysis of verb forms, verb stems and alternations. Hence, echoing the main theme.

The dissertation also reveals that alternations are still actively appearing in the contemporary Bulgarian language. In addition to the existed linguistic knowledge, the new established three-stem theory provides learners with a more comprehensive approach to the thorough understanding of alternation.

With sincerity, I hope my work can be recognised by the academic scholars as a readworthy reference for the learners of Bulgarian language, and further studies can be based on this piece of work.

References

Comrie, B., Corbett, G.(2002), *The Slavonic Languages*; London: Routledge

Gardiner, S.C. (1984); *Old Church Slavonic: an Elementary Grammar*; Cambridge: Cambridge University Press; Cambridge

Ghinina,S., Nikolova, Ts., Sakazova, L. (1972), *A Bulgarian Textbook for Foreigners*; Sofia: Naouka i Izkoustvo

Khadzhieva, E., Vlakhova, R., Velkova, Y., Shushlina, V. (2014); *Lesnoto v trudhiyabalgarski ezik*; Sofia: Izdatelstka kashta "Gutenberg"

Maslov, Iu.(1982), *Gramatika na balgarski ezik*; Sofia: Nauka i izkustvo

Mirchev, K. (1982), *Istoricheska gramatika na balgarski ezik*; Sofia: Darzhabno izdatelstvo "Nauka i izkustvo"

Nicolova, R. 2017; *Bulgarian Grammar*; Berlin: Frank & Timme GmbH

Pashov, P. (1999); *Balgarska gramatika*; Sofia: Izdatelstka kashta "Khermes"

Pashov, P. (1994); *Prakticheska balgarska gramatika*; Sofia: Prosneta

Pashov, P., Purvev, C., Radeva, V. (1989), *Learning Bulgarian*; Sofia: Universitetcko izdatelstvo "SV. Kliment Ohridcki";

Popov, K., Stoyanov, S., Yanakiev, M. (1980); *Balgarski ezik: Uchebnik za institutite za nachalni uchiteli*; Sofia: Narodna prosveta

Stoianov, S., Ivanova, K., Pashov, P., Stankov, V.(1983); *Gramatika na carvermenniya balgarski knizhoven ezik v tri toma*; Sofia: Izdatelstvo na balgarskata akademiya na naukite

Stoianov, S.(1993) ; *Gramatika na balgarski knizhoven ezik*; Sofia: Universitetcko izdatelstvo "SV. Kliment Ohridcki"

Sussex, R., Cubberley, P. (2006); *The Slavic Languages*; Cambridge: Cambridge University Press

Zhobov, V., Kolev, G. (2005); *Dzhobna gramatika na balgarski ezik, glagol*; Sofia: IK"SemaRSHA"