Abstract

The Phonetics and Phonology of Abkhaz Word Stress

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Previous work on phonological theories of prosody has argued that word stress is universally a property of the syllable (Hayes 1995, Hyman 2006). Although segmental and suprasegmental phonology may interact, such interactions are mediated by prosodic units: vowel reduction may apply in unstressed syllables, or voiceless stops may become aspirated in the onsets of stressed syllables. In this dissertation I show that the lexical stress system of the Northwest Caucasian language Abkhaz challenges these assumptions about prosody. I argue that all segments in Abkhaz, whether low vowels or voiceless stops, can carry lexical accents underlyingly. Both stress and the prosodically-conditioned segmental phonology of the language are computed over these segmental accents without any mediation by prosodic units like syllables or moras. In this sense, Abkhaz displays a segmental stress system. I argue that it must be parameterized on a language-specific basis whether a stress system operates over syllables, moras or segments, and that once such parameterization is allowed, Abkhaz word stress can be successfully analyzed with familiar theoretical tools.

I develop a grid-based analysis of Abkhaz word stress following Idsardi (1992), including the assignment of primary and secondary stress as well as a stress-conditioned segmental process of schwa epenthesis. I use new data to argue that schwa is not a phoneme in Abkhaz at all, and that it is always predictably epenthesized. This analysis predicts not only the main patterns of stress assignment, but also many classes of

morpho(phono)logical exceptions and even exceptions to those exceptions. All of this is accomplished within a single rule-based grammar without lexically specific phonology and where the morphosyntax is never directly visible to the phonology.

The phonological data come mainly from an Abkhaz dictionary (Yanagisawa 2010), which I compile into two new corpora of stress alternations. The corpora contain 990 noun, adjective and verb stems in several inflected forms, for a total of 4,205 words. I have conducted the first phonetic study of Abkhaz word stress, and report preliminary data on the acoustics of primary and secondary stress from four speakers. I rely on poetic evidence from scansion and native speaker intuitions to study Abkhaz syllabification.

Methodologically a recurring theme of the dissertation is the use of computer-guided analyses. I use programming tools to uncover exceptionless phonotactic restrictions on Abkhaz vowels, and the corpora were both built and analyzed in a semi-automated fashion. This allows for automatic empirical evaluations of the coverage of different theories of stress assignment at a scale which would be impossible to achieve by hand. When combined with traditional theoretical argumentation, this allows me to develop a theory of Abkhaz prosody which correctly predicts stress on 98.89% of the inflected noun and adjective forms I study, and on 95.70% of the inflected verb forms. The combination of several different methodologies and sources of data places the empirical generalizations and the theoretical conclusions in this dissertation on a more solid foundation.

I hope that this dissertation contributes empirically to the documentation of a complex stress system, methodologically to the use of computer-aided phonological analysis, and theoretically to our understanding of prosodic phonology.

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Аҧсуаа рзы

Abbreviations

1	first-person
2	second-person
3	third-person
A	absolutive case
A.REL	absolutive relativizer
ADJZ	adjectivizer
ADVZ	adverbalizer
BEN	benefactive
CAUS	causative
COM	comitative
COND1	conditional 1, ‘would VERB’ (see Hewitt 2010: 166-168)
COND2	conditional 2, ‘would VERB’ (see Hewitt 2010: 168-170)
DAT	dative
DEF	definite
DYN	dynamic (denoting an event rather than a state)
DYN.FIN	dynamic finite (here I use the Abkhaz-specific meaning of ‘finite’ = ‘not in a relative clause’, see footnote 9)
E	ergative case
E.REL	ergative relativizer
H	human
H.PL	human plural
INDF	indefinite

INF	infinitive
M	masculine
n.	noun
N.PL	non-human plural
NEG	negative
NEG.IMP	negative imperative
NEG.PST.ABS	negative past absolute, 'not having VERBed'
NEG.STAT.IMPF	negative stative imperfect
NMLZ	nominalizer
O	oblique case
P	plural
POSS	possessive
PREV	preverb
PRF	perfective
PST	past
PST.ABS	past absolute, 'having VERBed'
Q	question
QUOT	quotative
S	singular
STAT	stative
STAT.PRES	stative present
TAME	tense-aspect-mood-evidentiality
VBLZ	verbalizer

Less commonly used grammatical categories are spelled out in full, e.g. NUMERAL, INTENSIFIER. Person prefixes show person, number, gender/animacy, and case in that order, without periods. For example, 3SNO = third-person singular non-human oblique, 2SFE = second-person singular feminine ergative.

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Chapter 1: Introduction

In this dissertation I argue that the Northwest Caucasian language Abkhaz has a segmental stress system. The underlying lexical accents of the language attach directly to segments — individual vowels and consonants, independently of their sonority — and the whole stress assignment computation from underlying to surface representation operates directly over these segmental accents without any mediation of prosodic units like syllables or moras. This challenges prosodic theories where stress is universally a syllable-level property, raising the question of whether there are any exceptionless universal properties which separate stress from tone and pitch accent. The existence of a segmental prosodic system also calls into question how strict the binary division between segmental and suprasegmental phonology really is.

This requires modifications to prosodic theory, but I argue that these modifications are smaller than one might imagine. Specifically, I suggest that the unit relevant to stress systems is parameterized on a language-by-language basis. This idea was already present in Halle & Vergnaud (1987) who discuss moraic stress systems among their case studies (see also Kager & Martínez-Paricio 2018 for more recent discussion of moraic stress), but I suggest that there are three possible phonological units which languages may use for stress: syllables, moras, and segments. (Other prosodic phenomena, like reduplication, may make use of additional units.) Once this parameterization option is allowed, an analysis of Abkhaz stress in the metrical grid framework of Idsardi (1992) becomes possible without making any further modifications to the theory. Abkhaz stress assignment involves typologically familiar processes like clash resolution, with the only difference that the rule removes accents on adjacent *segments* rather than on adjacent *syllables*. I predict that segmentally defined counterparts of other prosodic phenomena, such as rhythmicity and window restrictions, should also be possible in human language.

I arrive at these theoretical conclusions by studying both the phonetics and phonology of Abkhaz word stress and the Abkhaz vowel system using several different methodologies (surveyed in Chapter 2). I report on acoustic experiments on primary and secondary stress, which are the first studies of their kind on Abkhaz (Chapters 3 and 4). The phonetic data resolve unanswered questions from previous work about the vowel system and its interaction with stress, and I argue that schwa is not a phoneme in Abkhaz, but is always epenthesized in predictable environments (Chapter 4).

Using dictionary data from Yanagisawa (2010), I compile two corpora of stress alternations in 990 noun, adjective, and verb stems (total 4,205 words), and use computer programming to investigate generalizations in the corpora and to test phonological theories empirically (Chapter 6). I also make use of scansion evidence from poetry and native speaker intuitions, as well as traditional theoretical phonological argumentation (Chapters 5, 7 and 8). In Chapter 9 I briefly review diachronic data showing that the Abkhaz stress system has remained stable over many centuries, suggesting that it is learnable and not a brief transitional state in an ongoing change from one stress system to another. The use of multiple methodologies and multiple sources of data helps alleviate concerns about data reliability and representativeness, which are issues in theoretical phonology generally but especially in studies of stress. I hope that the computer-aided methods I use can also clarify phonological issues in other languages, and that theoretical phonology in general will continue to move towards newer methodologies and richer sources of data.

In Section 1.1 below, I first present an overview of the dissertation, focusing on introducing some important data patterns relating to Abkhaz stress. Section 1.2 discusses the theoretical, empirical, and methodological contributions. In Section 1.3 I give background language information on Abkhaz, including a brief overview of its phonology and morphology. Finally Section 1.4 gives a brief outline of the structure of the dissertation.

As Chirikba (2003: 17) states, the "present-day centre of Abkhaz studies is the Abkhaz capital Sukhum". Although valuable studies have appeared in Western European languages, the vast majority of the rich linguistic tradition of Abkhaz is written in Abkhaz and Russian. I hope this dissertation can introduce some of this language to a wider readership of linguists.

1.1 Overview of the dissertation

Abkhaz has perfect minimal pairs for stress, which come from underlying binary accentual contrasts (accented vs. unaccented) such as that between accented /la/ 'dog' and unaccented /la/ 'eye'. Throughout this dissertation I use 'accent' to refer to an abstract or underlying property, and 'stress' to the corresponding surface property and its phonetic realization (Abercrombie 1991, van der Hulst 1996, Bogomolets 2020). Because the analysis of Abkhaz that I develop in this dissertation is segmental, I do not use the (syllabic) IPA diacritics ˈ and ˌ for stress. Primary stress is indicated with an acute accent ´ over the stressed segment, and secondary stress is indicated with a grave accent `.

(1) A minimal pair for stress (Arstaa et al. 2014: 95)

a. Accented stem
аԓа
[a-lá]
DEF-dog
'dog'

b. Unaccented stem
аԓа
[á-la]
DEF-eye
'eye'

There are no window restrictions (Kager 2012) where stress must be close to a word edge, no sonority restrictions on stress assignment (de Lacy 2007), and there is no weight sensitivity (Gordon 2006). See Chapter 3 for a detailed introduction to Abkhaz stress The placement of surface stress depends *only* on the prosodic properties of the constituent morphemes in a word, as determined by Dybo's Rule (Dybo 1977): stress falls on the leftmost underlying accent not immediately followed by an accent. In Chapter 5 I present new data supporting this rule, and argue that if there are no underlying accents, default stress is stem-final.

This means that depending on which affixes are present, and what their accentual properties are, stress can fall on a prefix, stem or suffix. This is illustrated below with inflected forms of the unaccented stem /fa/ 'eat'. Underlying accents are shown with +, the absence of an accent with -, and the location of stress as predicted by Dybo's Rule with ↑.

(2) Stress alternations on /fa/ ‘eat’ (Yanagisawa 2010: 433)

a. афара

[á-	fa	-ra]
+	-	+
↑		
DEF-	eat	-INF

‘eat’

b. Ишәфа!

[ji-	ʃʷ-	fá]
-	-	-
		↑
3NA-	2PE-	eat

‘Eat it/them!’

d. бысфахьеит

[bə-	s-	fa	-χʲé	-j	t’]
-	-	-	+	-	-
			↑		
2SFA-	1SE-	eat	-PRF	-DYN.FIN	

‘I have already eaten you’

Abkhaz has long words without underlying vowels. Stress in such words is assigned in exactly the same way as in words with vowels: segments like /a/ and /p’/ are treated identically in stress assignment in that both can carry underlying accents and both can therefore be assigned stress. However, in the Abzhywa dialect I study, surface stress always falls on a vowel because of a rule epenthesizing a schwa when there is no vowel to carry stress. Schwa is also epenthesized in long consonant clusters. It is typologically unusual to have stressed epenthetic vowels, since in many languages epenthetic vowels are invisible to stress assignment (see Chapter 4 for the vowel system of Abkhaz).

An example word illustrating some of the properties above is shown below. Notice that the stem /pʰʂ/ ‘wait’ has two accents, one for each segment. I argue in Chapter 7 that this is true in general in Abkhaz: each segment is either accented or unaccented.

Stress ought to fall on the /ʂ/ of the stem, so a schwa is epenthesized after this consonant to carry that stress. The phonotactically illicit resulting sequence *[əj] has been changed to [ij] by productive rules of so-called vowel coloring (Section 1.3.2 below). Several unstressed schwas break up what would otherwise be a long consonant cluster. All epenthetic vowels are bolded.

(3) A consonant-only word (Yanagisawa 2010: 138)

[s**ə**-b-z**ə**-l-m**ə**-r-p^{h}ʂ**í**-jt’]

/s-	b-	z-	l-	m-	r-	p^{h}	ʂ	-j	t’/
-	+	+	+	+	+	+	+	-	-
							↑		
1SA-	2SFO-	BEN-	3SFE-	NEG-	CAUS-	wait		-DYN.FIN	

‘she did not make me wait for you’

I show in the corpus study in Chapter 6 that stems without vowels like /χ^{j}ʃ/ ‘hawk’ systematically show the same patterns of stress alternation as stems with vowels like /laħ^{w}a/ ‘raven’.

The forms above are only a small sample to illustrate some of the generalizations underlying Abkhaz prosody. In this dissertation I discuss stress placement and vowel epenthesis as well as their interaction in greater detail. In the course of studying the principles of Abkhaz stress assignment I make theoretical, empirical, and methodological contributions, which I discuss in this order immediately below.

1.2 Contributions of the dissertation

1.2.1 Theoretical contributions

Theoretically the main contribution of this dissertation is to prosodic typology. I argue that the accent-bearing unit is not universally the vowel or syllable, but that there is parametric variation with language-by-language variation between syllables, moras and segments as the units relevant to the stress system. Abkhaz has a segmental stress system. I rely on a metrical grid framework (Idsardi 1992) and in Chapter 7 I show that Abkhaz can be analyzed using the exact same type of stress assignment rules which are well established for other languages, with the one crucial difference that gridmarks in Abkhaz represent segments rather than syllables. The stability of the stress system over hundreds of years (Chapter 9, Section 9.3) suggests that this is a learnable grammar which phonological theories must account for.

By removing syllable dependency as a necessary property of stress systems (as argued by Hayes 1995, Hyman 2006 among others), Abkhaz calls into question whether a sharp boundary separating stress from tone and pitch accent can really be drawn. Abkhaz also blurs the boundary between segmental and suprasegmental phonology since stress is assigned directly to segments without any mediation by prosodic units such as syllables or moras. This has important typological consequences. I analyze Abkhaz using a segmental clash resolution rule, but the parameterization of accent-bearing units predicts a range of other segmental counterparts to prosodic rules, including segmental window restrictions and segmentally rhythmic stress. I predict such prosodic systems are attest*able*, even if they are currently unattest*ed*.

I argue for the possibility of segmental stress systems through a detailed phonological analysis of Abkhaz stress assignment (Chapter 7) which predicts not only the main patterns, but also many exceptions, and even exceptions to those exceptions. Some patterns of stress assignment, such as pre-accentuation where stress falls immediately before the stem, are sensitive to complex interactions of morphosyntactic properties (such as ergative person markers and causatives) and phonological properties (such as the length and accentual properties of the stem). Despite this I use only a single grammar of stress assignment, without lexically specific rules or constraints and without the phonology being able to directly 'see' the syntax or morphology.

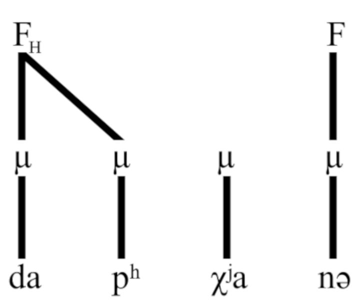
Below I show the surface representation of the Abkhaz word [dápʰχʲanə̀] 'him/her having read it' (Yanagisawa 2010: 342) in the grid-based analysis I argue for. The height of each line of grid marks represents the level of prominence. Note that Line 0 of the metrical grid has a grid mark for every segment, not for every mora or syllable. For comparison I also show the same word as represented in the alternative analysis developed in Chapter 8, with moraic feet. Moras are shown as μ, feet as F, and head foot of the word is marked additionally by a subscript $_{H}$.

(4) дапхьаны [dápʰχʲanə̀] 'him/her having read it' (Yanagisawa 2010: 342)

a.

Line 2		*					
Line 1		(*					*
Line 0	*	*	*	*	*	*	*
Segments	d	a	pʰ	χʲ	a	n	ə

b.



I argue that the Abkhaz data favor a grid-based analysis over a purely foot-based alternative. The latter struggles with syllable integrity (Prince 1976), a constraint which requires foot and syllable boundaries to be aligned. A conflict between footing and syllabification arises in Abkhaz because the stress system is built on segments rather than syllables. Several other prosodic universals to do with the relationship between moras and syllables are also violated by a foot-based analysis, as I show in detail in Chapter 8.

1.2.2 Empirical contributions

Empirically I contribute to our knowledge of phonology in general and prosody in particular by documenting the phonetics and phonology of an less well-studied stress system as well as its interactions with the segmental system. I report on the first acoustic investigation of word stress in Abkhaz (Chapters 3 and 4). This includes a study of the acoustic properties (F0, intensity, duration) which separate unstressed vowels from vowels with primary stress, as well as an investigation of secondary stress. Impressionistic reports of secondary stress in Northwest Caucasian exist, but no one transcribes it reliably. I find evidence for secondary stress in the positions where it is predicted by previous analyses (Chapter 4).

Using corpora compiled from an Abkhaz dictionary I describe generalizations about stress assignment in 990 noun, adjective, and verb stems, and how stress assignment is affected by a wide range of phonological and morphosyntactic factors (Chapter 6). In many cases I find confirmation of statements from earlier literature on Abkhaz, but I also document several previously unreported generalizations, such as the exact conditions for pre-accentuation. The fact that the data are quantitative allows me to describe the empirical coverage of particular theories in detail. The theory I argue for correctly assigns stress to 98.89% of the inflected noun and adjective forms I study, and to 95.70% of the inflected verb forms.

1.2.3 Methodological contributions

Historically many studies of stress have relied on relatively small amounts of relatively unreliable data, chiefly in the form of transcriptions of stress placement by non-native speakers without additional experimental evidence (see Bogomolets 2020: 38-39 for recent discussion). With such data both the reliability of the transcribed stresses as well as the representativeness of the forms for the language as a whole are called into question. In this dissertation I rely on new corpora of stress alternations to provide quantitative data on how common particular patterns are across the nominal and verbal lexicon. I also provide preliminary data on the acoustics of primary and secondary stress in Abkhaz, to verify that the stresses I and other non-native researchers have transcribed are really present. In discussing the syllabification of Abkhaz I discuss evidence from poetry which converges with the intuitions about syllables from both linguist and non-linguist native speaker (see Chapter 2 for methodological discussion).

In combining multiple methodologies and sources of data I hope to alleviate some of the concerns about reliability and representativeness of data in earlier stress literature. A key component of this work is based on computer-guided approaches to phonology as well as digital sources. The traditional approach in theoretical phonology of presenting small, representative datasets which illustrate minimal contrasts is often insufficient for Abkhaz. The verbs in particular can be subdivided based on so many morphological and phonological properties, due in large part to the morphological complexity of Abkhaz verbal affixation, that neat minimal pairs for every contrast do not exist. I illustrate and apply a method for developing empirically successful theories even with such complex multidimensional data (Chapters 6 and 7).

By implementing a previous theory of Abkhaz stress assignment in the programming language Python (Python Software Foundation 2024), I am able to evaluate its empirical coverage against all 3,115 forms in my verbal corpus. Since the forms are glossed with morphological and phonological information, this allows me to identify the verb classes for which the theory performs poorly. I make revisions to the theory of stress assignment based on its performance, and when this revised theory is implemented in Python the empirical coverage is increased or stays the same for all classes of verbs (Chapters 6 and 7). Even if the original theory is imperfect, this method allows for iterative improvements based on a combination of computer- and human-guided work. I hope this method, which is rare in theoretical phonology, may be of use to readers who face similar analytical challenges in their research languages.

1.3 Language background

In this section I give an overview of some basics of segmental and suprasegmental phonology, as well as inflectional morphology, in Abkhaz. I focus on Abzhywa Abkhaz, the dialect studied in this dissertation, but also describe how it differs from other dialects of Abkhaz, and from other Northwest Caucasian languages. I begin with an overview of the Northwest Caucasian family in Section 1.3.1, followed by phonological information in Section 1.3.2, and morphology in Section 1.3.3.

1.3.1 Abkhaz as a Northwest Caucasian language

Abkhaz (ISO 639-3 [abk]; Eberhard et al. 2021) belongs to the Northwest Caucasian language family, sometimes called West Caucasian or Abkhaz-Adyghe. This small language family consists of five languages, all primarily spoken on or near the east coast of the Black Sea in the Caucasus. The languages are listed below with approximate numbers of native speakers from Dobrushina et al. (2021: 29). I group Ubykh with Abkhaz and Abaza, but some group it instead with the Circassian languages (see Chirikba 2003: 11). Since the 1990s, Ubykh has had no living native speakers (Fenwick 2011: 10-12).

(5) Family tree of Northwest Caucasian languages

- Proto-Northwest Caucasian
  - Proto-Circassian
    - Kabardian or East Circassian [kbd] (505,000)
    - Adyghe or West Circassian [ady] (115,000)
  - Proto-Ubykh-Abkhaz
    - Ubykh [uby] (0)
    - Proto-Abkhaz-Abaza
      - Abkhaz [abk] (124,000)
      - Abaza [abq] (36,600)

There are areal similarities between Northwest Caucasian and both Northeast Caucasian (also East Caucasian or Nakh-Dagestanian) and Kartvelian (also South Caucasian). Few believe that Kartvelian is related to either of the other families, but while it is far from universally accepted, the proposal that Northwest and Northeast Caucasian are related as part of a larger North Caucasian family is more popular (Dobrushina et al. 2021: 28).

The native term for Abkhaz is [ápʰswa bəzʃʷá] or [ápʰsʃʷa] (Hewitt 2005: 93), a language which itself has several dialects. The main groups are Abzhywa (also Abzhuy or Abzhui), Bzyp (also Bzyb), and Sadz (O'Herin 2021). Chirikba (2003: 14), who treats Abaza and Abkhaz as dialects of the same language, gives a more detailed division of the node which I have labeled 'Proto-Abkhaz-Abaza' in (5) above. He includes not only Abzhywa, Bzyp, and Sadz, as well as (Tapanta) Abaza, but also Ahchypsy and Ashkharywa.

In this dissertation I focus on Abzhywa Abkhaz, which is now the standard variety on which the writing system is based (Hewitt 2010: 17). Abzhywa displaced Bzyp, which up until the 1920s had served as the basis for written Abkhaz, and was the dialect described in early linguistic work (Hewitt 2010: 16-17). Since only approximately half of Abkhazia's population speaks Abkhaz natively (Dobrushina et al. 2021: 39), Russian serves as a lingua franca in Abkhazia, where it is is increasingly displacing Abkhaz, especially in urban environments (Chirikba 2003: 8).

1.3.2 Abkhaz phonology

In this section I give a brief introduction to the phonology of Abzhywa Abkhaz, which I will refer to simply as 'Abkhaz' throughout this dissertation, except where other dialects are discussed. Much like other Northwest Caucasian languages, Abkhaz has a large consonant inventory and a small vowel inventory. Below are the 58 consonant phonemes of the Abzhywa dialect. The transcription system in this paper is broad, and does not reflect the exact phonetic realization of the consonants, for which see Hewitt (1979), Chirikba (2003) and Yanagisawa (2013) on Abzhywa. Recognizable in this inventory is the three-way laryngeal contrast for stops and affricates — voiced, voiceless aspirated, and voiceless ejective — and several secondary articulations. These are Sprachbund features shared also with the neighboring Northeast Caucasian and Kartvelian language families (Polinsky 2021, Beguš 2021).

(6) Figure 1.1

	Labial	*Dental*	*Other coronal*	*Velar*	*Uvular*	*Phar.*
Vcd. stop	b <б>	d dʷ <д дә>		g gʲ gʷ <г гь гә>		
Asp. stop	pʰ <ԥ>	tʰ tʷʰ <ҭ ҭә>		kʰ kʲʰ kʷʰ <қ қь қә>		
Ej. stop	p’ <п>	t’ t’ʷ <т тә>		k’ k’ʲ k’ʷ <к кь кә>	q’ q’ʲ q’ʷ <ҟ ҟь ҟә>	
Vcd. fricative	v <в>	z <з>	ʐ ʒ ʒʷ <ж жь жә>		ʁ ʁʲ ʁʷ <ғ ғь ғә>	
Vcl. fricative	f <ф>	s <с>	ʂ ʃ ʃʷ <ш шь шә>		χ χʲ χʷ <х хь хә>	ħ ħʷ <ҳ ҳә>
Vcd. affricate	d͡z <ӡ>		d͡ʐ d͡ʒ d͡ʒʷ <џ џь ӡә>			
Asp. affricate	t͡sʰ <ц>		t͡ʂʰ t͡ʃʰ t͡ʃʷʰ <ҽ ч цә>			
Ej. affricate	t͡s’ <ҵ>		t͡ʂ’ t͡ʃ’ t͡ʃ’ʷ <ҿ ҷ ҵә>			
Nasal	m <м>	n <н>				
Liquid	l <л>	r <р>				
Glide	(w) <у>		j ɥ <и ҩ>	w <у>		

Consonant phonemes (graphemes in <angle brackets>) (Arstaa et al. 2014: 50-51)
Vcd. = voiced, vcl. = voiceless, asp. = aspirated, ej. = ejective, phar. = pharyngeal

Notable here are the 18 dorsal obstruents and the 20 contrastive sibilants, although the conservative Bzyp dialect has an even larger inventory of sibilants (Bgažba 1964: 28, Chirikba 2003: 12), and some Sadz varieties have additional dorsal obstruents (Čirikba

2014: 298). Abkhaz currently uses a Cyrillic writing system which represents all of the phonemic contrasts of Abzhywa in a one-to-one mapping, although digraphs are used to indicate secondary articulations (Hewitt 2010: 19-20). Since this dissertation will include considerable discussion of schwa, note in particular that the Abkhaz grapheme <ә> represents labialization of a preceding consonant, and not a vowel.

The inventory of vowels is considerably smaller. In its native phonology, Abkhaz is typically analyzed with two vowel phonemes, /a, ə/ (Hewitt 1979, Colarusso 1988, Chirikba 2003, Yanagisawa 2013, O'Herin 2021). The phonemic status of schwa has been questioned in Abkhaz and related languages (see Kuipers 1960 on Kabardian, Allen 1965 on Abaza, with discussion of Kabardian and Abkhaz, Anderson 1978 on Abaza and Kabardian, Colarusso 1988 on Northwest Caucasian in general). In Chapter 4 I will argue that schwa is predictably inserted, and does not represent a phoneme in Abkhaz. On the surface, additional vowel qualities beyond [a] and [ə] appear, often conditioned by adjacent glides (Arstaa & Č̣′ḳadua 2002: 23-29, Jakovlev 2006: 306, O'Herin 2021: 453-454). In the numerous loanwords of Abkhaz, /i u e o/ also appear freely. [a] is sometimes transcribed as back [ɑ] and [ə] is sometimes transcribed as high [ɨ] (O'Herin 2021).

(7) Figure 1.2

	Front	Central	Back
High	(i) <и>		(u) <у>
Mid	(e) <е>	ə <ы>	(o) <о>
Low		a <а>	

Vowel phonemes; non-native vowels in (parentheses) and graphemes in <angle brackets>
(Arstaa et al. 2014: 49-50)

Long [aː] is treated in this dissertation as a sequence /aa/, and does not represent a separate phoneme. Below I illustrate the main processes of what I call vowel coloring, where adjacent glides ‘color’ the quality of [a] and [ə]. Notice how the stem [gə́la] ‘stand’ surfaces as [gə́lo] before [w] and as [gə́le] before [j], while the stem [t^{wh}ə́] ‘full’ surfaces as [t^{wh}ú] and [t^{wh}í] in the same environments. The stems are bolded in (8).

(8) Vowel coloring by [j] and [w]

a. Yanagisawa (2010: 74)

i. агылара
[a-**gə́la**-ra]
DEF-**stand**-INF
‘stand up’

ii. сгылоуп
[s-**gə́lo**-wp’]
1SA-**stand**-STAT.PRES
‘I am standing’

iii. сгылеит
[s-**gə́le**-jt’]
1SA-**stand**-DYN.FIN
‘I stood up’

b. Yanagisawa (2010: 420-421)

i. аҭәы
[a-**tʷʰə́**]
DEF-**full**
‘full’

ii. иҭәуп
[ji-**tʷʰú**-wp’]
3NA-**full**-STAT.PRES
‘it is full’

iii. иҭәит
[ji-**tʷʰí**-jt’]
3NA-**full**-DYN.FIN
‘it filled up’

For the outcomes of vowel coloring, which I have transcribed [ow, ej, uw, ij] above, one also often hears monophthongs. Hewitt (2010) transcribes the relevant sequences as [oː, eː, uː, iː] instead. Vowel coloring does not apply to /aa/, nor to /a/ preceded by /ħ/, so that /ħaj/ and /aaj/ surface as [ħaj] and [aaj] rather than *[ħej] and *[aej] or *[eej] (Arstaa et al. 2014: 59-60).

Other common examples of vowel coloring include the high vowels [i] and [u] surfacing instead of [ə] not only before but also after the glides [j] and [w] respectively (Spruit 1986: 86, Hewitt 2010: 21). Finally, note that the sequence /awa/ surfaces as [o] if and only if the /-wa/ represents the suffix for dynamic verbs (see Section 1.3.3 below for this term and for other morphological distinctions), as shown by (9) a.-b.. This change also does not apply to /aawa/ (9) c. or /ħawa/ (9) d. even if this morpheme is involved.

(9) The sequence /awa/

a. дцоит
[dt͡sʰ**ó**jt’]
/d-t͡sʰ**a-wa**-jt’/
3SHA-**go-DYN**-DYN.FIN
‘(s)he goes’
Spruit (1986: 85)

b. аүа
[**áwa**]
/**a-wa**/
DEF-relative
‘relative’
Hewitt (2010: 13)

c. ибааүам
[jib**aawá**m]
/j-b**aa-wa**-m/
3NA-rot-DYN-NEG
‘it does not rot’
Spruit (1986: 85)

d. дкаҳаүам
[dk’á**ħawa**m]
/d-k-’a-**ħa-wa**-m/
3SHA-PREV(down)-**fall-DYN**-NEG
‘(s)he does not fall’
Spruit (1986: 85)

In most Abkhaz work there is no indication of vowel coloring in transcriptions, since the specialist reader is familiar with the rules as well as their exceptions, and can easily work out the correct pronunciation. I do not follow this practice here, and instead transcribe something closer to the actual pronunciation. However, the transcriptions I use are still broad. For example, palatalized and labialized consonants can also have noticeable effects on vowel quality (Čirikba 2014: 293-294), although these tend to be optional and highly variable within and across speakers (Colarusso 1988: 295). They are not transcribed here. It would be perfectly legitimate, for example, to transcribe ‘person’ as [ɑwɔɥʏ́], but I favor the broader [awaɥə́] (Spruit 1986: 86, Arstaa & Č̣ʼḳadua 2002: 23).

As for stress, which will occupy most of the pages of this dissertation, I show some of the data below illustrating that stress is contrastive but subject to alternations within paradigms. Because of the centrality of stress to this dissertation, I give a fuller introduction to the basic phonological and phonetic properties of the stress system in Chapter 3.

(10) Minimal pairs for stress (Gulia 1939: 97)

a.

i. ала
[á-la]
DEF-eye
'eye'

ii. ала
[a-lá]
DEF-dog
'dog'

b.

i. ача
[á-t͡ʃʰa]
DEF-quail
'quail'

ii. ача
[a-t͡ʃʰá]
DEF-bread
'bread'

(11) Stress alternations

a. Dybo (1977: 42)

i. ала
[a-lá]
DEF-dog
'dog'

ii. алақәа
[a-la-kʷʰá]
DEF-dog-N.PL
'dogs'

iii. алақәагьы
[a-la-kʷʰa-ɡʲə́]
DEF-dog-N.PL-also
'and dogs'

b. Hewitt (1979: 272)

i. Ишәфа!
[ji-ʃʷ-fá]
3NA-2PE-eat
'Eat it! (plural addressee)

ii. иафеит
[j-á-fe-jt']
3NA-3SNE-eat-DYN.FIN
'it ate it'

iii. илфеит
[ji-l-fé-jt']
3NA-3SFE-eat-DYN.FIN
'she ate it'

1.3.3 Abkhaz morphology

A description of the inflectional morphology of Abkhaz could easily fill the entire dissertation and still leave many important topics without coverage. In this section I begin with a basic overview of the relatively simpler nominal morphology, followed by a greatly simplified introduction to some of the basics of the considerably more complex verbal morphology.

1.3.3.1 Nominal morphology

Nouns and adjectives in Abkhaz show great morphological similarities, and are treated together here. The citation form of an Abkhaz nominal begins with the ubiquitous definite prefix /a-/ attached to the stem. The indefinite is marked by a suffix /-k'/, and no definite prefix is present on these forms. Note that the English translations I use differ from the semantics implied by 'definite' and 'indefinite'. I discuss this in greater detail in Chapter 2, Section 2.2.1.2.

(12) Definite and indefinite forms of 'eye' (Yanagisawa 2010: 258-259)

a. ала
[á-la]
DEF-eye
'eye'

b. лак
[lá-k']
eye-INDF
'one eye'

Plurals are marked suffixally, with /-t͡ʃʷʰa/ for humans and /-kʷʰa/ for non-humans. These plural forms also have the definite prefix /a-/ just as the singulars do.

(13) Plural suffixes

a. Yanagisawa (2010: 531)

i. аҷкәын
[á-t͡ʃ'k'ʷən]
DEF-boy
'boy'

ii. ачкәынцәа
[á-t͡ʃ’k’ʷən-t͡ʃʷʰa]
DEF-boy-H.PL
‘boys’

b. Yanagisawa (2010: 259)

i. ала
[a-lá]
DEF-dog
‘dog’

ii. алақәа
[a-la-kʷʰá]
DEF-dog-N.PL
‘dogs’

Person prefixes mark possession, and these attach directly to the stem without the definite prefix. This is possible for both singulars and plurals.

(14) Possessive prefixes (Yanagisawa 2010: 259)

a. сла
[s-lá]
1S.POSS-dog
‘my dog’

b. слақәа
[s-la-kʷʰá]
1S.POSS-dog-N.PL
‘my dogs’

There are no nominal case distinctions for roles such as subject or object, which are instead marked by obligatory person prefixes on verbs. I turn to the description of verbs next. Although there are many topics in nominal inflection not covered in the short introduction above, this suffices for the purposes of this dissertation.

1.3.3.2 Verbal morphology

Abkhaz is a highly agglutinative language with complex verbal morphology. There is a wide range of tense-aspect-mood-evidentiality (TAME) distinctions, and verbs may also include person markers and locational information in the form of so-called preverbs. This leads to words such as the following:

(15) Highly agglutinative verbal morphology (Yanagisawa 2010: 413)

Илыцыбҭиуазма?
[ji-lə́-t͡sʰə-b-tʰij-wa-z-ma]
3NA-3SFO-COM-2SFE-sell-DYN-PST-Q
'Were you selling it/them with her?'

Here I give a brief introduction to some of the verbal forms which will be of importance in this dissertation, leaving many topics undescribed.

A fundamental division in Abkhaz verbal morphology is that between stative and dynamic verbs. Stative verbs denote states, while dynamic verbs denote events. Some verbs are compatible with both stative and dynamic morphology, with corresponding differences in meaning. Below the stem /t'ʷa/ 'sit' is shown with stative morphology in (16) a., giving the meaning '(s)he is (in the state of) sitting down'. The same stem with dynamic morphology in (16) b. produces '(s)he is (performing the action of) sitting down'. In (16) b. the underlying form is /d-t'ʷa-wa-jt'/, with vowel coloring from /a-wa/ to [o] as described in Section 1.3.2 above.

(16) Stative and dynamic verbs (Yanagisawa 2010: 396)

a. дтәоуп
[d-t'ʷó-wp']
3SHA-sit-STAT.PRES
'(s)he is sitting'

b. дтәоит
[d-t’ʷó-jt’]
3SHA-sit.DYN-DYN.FIN
‘(s)he sits down’

Stative verbs have a dramatically simplified TAME system, and limited options for person markers, relative to dynamic verbs. In this dissertation I focus on the more complex dynamic verbs, and I describe these in greater detail below.

Abkhaz has three sets of person markers, which appear as prefixes. These are absolutives (direct objects of transitive verbs and single arguments of intransitive verbs), obliques (such as datives and locational arguments), and ergatives (subjects of transitive verbs). All verbs require at least an absolutive prefix. Some verbs idiosyncratically take person markers that would not be expected from the semantics of the verb. (17) illustrates individual bivalent verbs which select for different person prefixes.

(17) Argument structures of bivalent verbs

a. изгоит
[ji-z-gó-jt’]
3NA-1SE-take.DYN-DYN.FIN
‘I (ergative) take it (absolutive)’
Yanagisawa (2010: 37)

b. сасуеит
[s-á-s-we-jt’]
1SA-3SNO-hit-DYN-DYN.FIN
‘I (absolutive) hit it (oblique)’
Yanagisawa (2010: 391)

c. исоуеит
[ji-s-ów-we-jt’]
3NA-1SO-receive-DYN-DYN.FIN
‘I (oblique) receive it (absolutive)’
Yanagisawa (2010: 429)

Oblique person markers often mark the argument introduced by a preverb. In Abkhaz, preverbs are prefixes which typically introduce an additional argument conveying spatial information about an event. However, preverbs do not always add an argument, and their semantic contributions to a given stem are not always transparent. They can be compared to particles in English, which may have transparent spatial meanings (as in *bring out* from *bring* and *out*), or may lack semantic transparency (as in *give up* from *give* and *up*).

(18) Transparent and non-transparent preverbs

a. Semantically transparent 'sit down' + 'on' = 'sit down on'

i. дтәоит
[d-t'ʷó-jt']
3SHA-sit.DYN-DYN.FIN
'I sit down'
Yanagisawa (2010: 396)

ii. сақәтәоит
[s-á-kʷʰ-t'ʷo-jt']
1SA-3SNO-PREV(on)-sit.DYN-DYN.FIN
'I sit down on it'
Yanagisawa (2010: 237)

b. Semantically opaque 'take' + 'in' = 'start'

i. ҳалгоит
[ħa-l-gó-jt']
1PA-3SFE-take.DYN-DYN.FIN
'she takes us'
Yanagisawa (2010: 71)

ii. далагоит
[d-á-la-go-jt']
3SHA-3SNO-PREV(in)-take.DYN-DYN.FIN
'(s)he starts it'
Yanagisawa (2010: 259)

The only other preverbal element this paper discusses is the causative prefix /r-/, which obligatorily occurs with an ergative prefix for the causer. The negative marker /m/ is a suffix in the present tense, but a prefix elsewhere. All tense-aspect-mood-evidentiality marking is suffixal.

All affixes in Abkhaz follow a strict templatic order, as shown in the simplified template below. Not all slots in the template are filled in all verb forms, but when a given morpheme is present, it appears in its templatic slot. An example verb filling most slots is shown.

(19) Simplified verb template (Chirikba 2003: 38-39)

A	O	PREV	E	NEG	CAUS	STEM	DYN	NEG	TAME
иақәдыршәуеит									
[j-	á-	kʷʰ-	də-		r-	ʃʷ	-we		-jt’]
3NA-	3SNO-	PREV(on)	3PE-		CAUS-	be.on	-DYN		-DYN.FIN

‘They throw it/them over it, they cover it with it/them’
Yanagisawa (2010: 236)

One additional verbal category requires comment, since its name does not straightforwardly indicate its semantic function. This is the so-called past absolute, which is the name some scholars use for forms which translate English ‘having VERBed’. Below is an example of how it is used in a sentence. The form [dápʰχʲanə] дапхьаны ‘him/her having read it’ is a past absolute form of ‘to read’.

(20) The past absolute (Yanagisawa 2013: 373)

Ашәҟәы	дапхьаны	сара	сахь	дааит
[a-ʃʷq’ʷə́	d-á-pʰχʲa-nə	sará	s-áχʲ	d-aá-jt’]
DEF-book	3SHA-3SNO-read-PST.ABS	1S	1SO-towards	3SHA-come-DYN.FIN

‘Having read the book, (s)he came to me’

There is much more that could be said about the verbal morphology of Abkhaz. However, the brief overview on the preceding pages is sufficient for the moment. Arguments are marked through a series of prefixes, while tense and related functions are marked through suffixes. There are preverbs and causative forms, which can change the number of arguments a verb takes. All affixes are arranged linearly according to a template. Additional information about particular verbal forms will be introduced in the discussion of the verbal corpus in Chapter 2, Section 2.2.1.3.

1.4 Structure of the dissertation

After this introductory chapter, Chapter 2 presents some of the methodologies used in the dissertation in greater detail. In particular I introduce the methodological details surrounding the acoustic experiments, as well as the dictionary corpora I have compiled. This information is gathered in one place since both the experiments and the corpora will be discussed in several chapters of the dissertation.

Chapter 3 discusses basic properties of the Abkhaz stress system in more detail, since this will be the focus of the dissertation. I focus on comparing Abkhaz to stress systems which are more widely known to readers not already familiar with the Northwest Caucasian language family. I show that Abkhaz stress is obligatory, culminative, and contrastive. Unlike in many languages, stress assignment is not subject to window restrictions, nor is it sensitive to distinctions of vowel length, or the presence or absence of coda consonants. This chapter also presents the first acoustic investigation of primary stress in Abkhaz.

Chapter 4 presents a discussion of the vowel system of Abkhaz, arguing that the distribution of the vowel [ə] is fully predictable so that it need not be entered into underlying representations. I present novel quantitative data on phonotactic restrictions, as well as acoustic data on secondary stress. These data favor an analysis where [ə] is epenthesized under stress when there is no lexical vowel to carry that stress. The absence of /ə/ from the inventory of underlying vowels leaves many vowelless morphemes, a fact which will be significant in the analyses of stress in subsequent chapters.

In Chapter 5 I present a theory of stress assignment in Abkhaz. I argue that there is a binary division accented-unaccented, without additional categories such as pre-accenting and post-accenting. By studying affixed forms, I show how it is possible to determine accent status empirically. By investigating the stress behavior of forms with particular combinations of accents, I derive a theory which places stress on the leftmost accent not immediately followed by an accent. This is known as Dybo's Rule in previous literature (Dybo 1977), and in deriving the theory from the bottom up by comparing empirically motivated categories of stress behavior I hope to provide stronger empirical evidence that this rule is operative in Abkhaz.

In Chapter 6 I investigate the generalizations about stress alternations found in the nominal and verbal corpora which I have compiled. I show that in both nominals and verbs, longer stems have more patterns of stress alternation, suggesting that something smaller than the morpheme must carry underlying accents. I implement the theory of stress assignment from Chapter 5 using computer programming, and show that it reaches high empirical coverage for nouns and adjectives, but performs more poorly on verbs. I therefore propose a revised theory of stress assignment, which captures many patterns of exceptional stress placement in verbs. This revised theory improves on the empirical coverage of the original theory.

In Chapter 7 I implement the analysis from preceding chapters in Idsardi's (1992) grid-based framework. In this analysis individual consonants and vowels can bear underlying accents. I show that a single phonological grammar, combined with several accentual allomorphies, predicts the regular and exceptional patterns of primary and secondary stress assignment very accurately. It also implements the epenthetic analysis of [ə] from Chapter 4, capturing the interactions between segmental and prosodic domains.

In Chapter 8 I discuss analyses where stress is assigned based on prosodic units, syllables or moras, rather than individual segments. I show that syllabic analyses either contradict all available data on Abkhaz syllabification, or else fail to predict stress placement in over 40% of the lexicon. Moraic analyses fare better, and I provide a Harmonic Serialism grammar of Abkhaz stress assignment based on moraic feet. However, the units relevant for Abkhaz stress assignment look dissimilar from moras in several ways, and many proposed universals about moraic structure are violated by this analysis. Previous moraic analyses of Abkhaz fail to resolve these problems, all of which are absent in a segmental analysis of the stress system.

Chapter 9 summarizes the dissertation, and contains closing discussion of some of the broader phonological, typological, and diachronic questions raised by the segmental analysis of Abkhaz stress.

Chapter 2: Methodology

This chapter gives an overview of the methodologies used in this dissertation. I draw on multiple methodologies, including acoustic experiments, dictionary corpus analysis, computational evaluation of phonological theories, analysis of poetry, and traditional theoretical phonological argumentation. Earlier work on prosody, especially in theoretical phonology, has often relied only on small datasets with the placement of stress determined through transcription by a non-native speaker such as a fieldworker. This casts serious doubts on the reliability of both the data and the generalizations that emerge from work in this tradition, something which is often recognized explicitly in more recent work (de Lacy 2014, Bogomolets 2020, among others). By combining acoustic experiments with corpus analysis as well as other methodologies, I hope to mitigate these concerns, and ensure that the data and generalizations in this dissertation are more reliable.

Rather than repeating methodological information in every chapter, I gather here background information which will be of relevance throughout the dissertation. In particular, I describe the methodology of three acoustic experiments on Abkhaz stress (reported in Chapters 3 and 4), and methodological details on the dictionary data underlying several corpus studies of Abkhaz stress (Chapters 4, 5, 6, and 8). I also discuss the rationale behind computational evaluations of phonological theories (Chapters 6 and 8), and the advantages and disadvantages of computer-based work relative to manually analyzed data.

In Section 2.1 I discuss the methodology for the phonetic experiments reported in this dissertation. I am not aware of any previous work on the phonetics of word stress in

Abkhaz. Because of this, it is of interest not only to test theoretical proposals about Abkhaz stress acoustically, but also to phonetically document the word-level prosodic system of this language for the first time. One experiment therefore tries to determine the acoustic cues for word stress in Abkhaz, while another looks for secondary stress. Some authors (Genko 1955, Spruit 1986) have reported hearing secondary stresses in Northwest Caucasian languages, but these are not reliably transcribed in any source on Abkhaz, and there is no phonetic data available. Finally, a third experiment aims to test the involvement of consonants in the stress system. I outline how experiments were designed, and provide information about the participants, recording setup, and data analysis. Much of this information is the same for all three experiments, which is why it is helpful to have it gathered in one place. I leave for later chapters the lists of stimuli used, which differ for each experiment.

In Section 2.2 I discuss methodologies based on the corpora I have created from Yanagisawa's (2010) dictionary of Abkhaz. Much of the Abkhaz data in this dissertation comes from this dictionary. In particular, the corpus studies of Abkhaz nominal and verbal stress in Chapter 6 are based on databases compiled from this work. I discuss the source of the data that make up the dictionary, and the exclusions I have made when compiling the corpora. Much of the work creating database corpora from the dictionary was carried out in Pyhton 3, and the discussion in this section may be useful to other linguists aiming to use dictionary-based methodologies in phonological work.

Also in Section 2.2 I discuss advantages and disadvantages of semi-automated analysis of phonological data in software relative to traditional phonological derivations done by hand. This methodology underlies the analyses of stress in Chapters 6 and 8, where phonological theories are implemented in code and evaluated against large amounts of Abkhaz stress data. I describe how such a theoretical evaluation was performed, and its benefits in allowing linguists to test theories empirically on much larger datasets than is possible with manual analysis. However, computers require data to be presented in a uniform, unchanging format, which creates the risk of artificially eliminating variation from datasets prepared for computer analysis. I also highlight the need for close collaboration between automatic computer processing of data and human linguistic insight.

2.1 Phonetic methodology

2.1.1 Introduction

There is little previous work on the phonetics of stress on Abkhaz. Brief comments on phrasal intonation patterns can be found in Arstaa & Č̣′ḳadua (2002: 37), Jakovlev (2006: 33-35), and Až′iba (2008: 95-96). Aršba (1979: 7, see also Aršba 1992) describes intensity as a main cue for word stress, but notes that experimental research does not currently exist, and would be needed to determine the cues.

Intuitions about stress placement, especially for lower levels of stress, can be unreliable (de Lacy 2014, Bogomolets 2020 among others). Some may hear stresses for which there is no phonetic evidence (sometimes called stress ghosting; Tabain et al. 2014), and some may fail to hear stresses for which there is phonetic evidence (sometimes called stress deafness; Dupoux et al. 2002). Recent cases where phonetic data have led to revisions of impressionstically based analyses of stress include Bowern et al. (2013) on Yidiny, and Shih (2018) and Bowers (2019) on Gujarati. In order to address any such concerns about the data in this dissertation, I have conducted three acoustic production experiments on Abkhaz word stress, the methodology of which is described in this section.

In order to document and the acoustics of Abkhaz word stress and test phonological hypotheses about Abkhaz stress experimentally, I conducted three experiments in the summer of 2022. These three experiments were part of a single study, carried out with the same participants at the same time. All work discussed in this section was funded by an International Dissertation Research Fellowship from the Yale MacMillan Center, whose support I gratefully acknowledge. The study was deemed exempt from review by Yale's Institutional Review Board (Protocol ID 2000032241). The scope of the experiments reported here is smaller than what was originally planned. Both the COVID-19 pandemic and Russia's so-called special military operation in Ukraine made travel to Abkhazia in the summer of 2022 infeasible. The study was instead carried out in the United Kingdom and online.

2.1.2 Description of the three experiments

2.1.2.1 Experiment 1: primary stress

Experiment 1 aimed to document the acoustic cues for primary stress in Abkhaz. Words were selected where the native vowels [a] and [ə] bear primary stress/no stress in initial, medial, and final position. Schwa was not measured in initial position, since absolute word-initial schwas do not occur in Abkhaz (see Chapter 4, Section 4.2.3). Words which may contain secondary stresses (see Experiment 2 below) were not included. The full list of stimuli is given in Chapter 3, where the results of this experiment are presented. I was not able to investigate changes in vowel formants based on stress. The secondary articulations of palatalization and labialization on consonants greatly affect the quality of surrounding vowels. Since the segmental environment of the vowels was not controlled, I instead extracted measures of vowel pitch, intensity, and duration:

(1) Measures for Experiment 1

Cue	Measure
Pitch	Mean F0 (Hz) in the middle 50% of the vowel (25%-75%)
Intensity	Peak intensity (dB) during the vowel
Duration	Duration (ms) of the vowel

Because of the aforementioned lack of control for place of articulation and secondary articulations on surrounding consonants, I excluded the initial and final 25% of each vowel for the F0 measurements. Vowels typically showed a clear rise-fall contour in intensity, due to surrounding lower-intensity consonants, and the peak of this contour was measured.

2.1.2.2 Experiment 2: secondary stress

Experiment 2 sought to test impressionistic claims of secondary stress. Most work on Abkhaz deals exclusively with primary stress. Since primary stress is contrastive in Abkhaz, speakers without linguistic training can often reliably indicate where stress falls even though it is not marked in any way in Abkhaz orthography. The location of primary stress also appears to be reliably identified by linguists who are not native speakers of Abkhaz; there are no disagreements about the location of stress in work from linguists with a variety of native languages (English, Dutch, Russian, Japanese, Swedish), whose transcriptions agree with those given by native-speaker linguists.

However, secondary stress is more elusive. Spruit (1986: 73) reports that some schwas appear to bear secondary stress in particular phonological contexts, and Genko (1955: 31) reports the same intuition for closely related Abaza. Arstaa et al. (2014: 97) report multiple stresses for some words, which may involve one primary and one secondary stress. However, no author transcribes secondary stress consistently, which is why I have conducted an experiment to examine whether it is present in the places where some previous researchers hear it.

The stimuli involve words with the native vowels [a] and [ə] in three conditions, based on the level of stress predicted according to previous work: primary stress vs. secondary stress vs. no stress. Underlying accents can belong to either of the three conditions, the distribution of which is discussed in detail in Chapter 4, Section 4.3, where the full list of stimuli as well as the results of Experiment 2 are presented. The measures used to investigate secondary stress were the same as those reported in (1) above for Experiment 1.

2.1.2.3 Experiment 3: consonantal stress

Experiment 3 was intended to test the participation of consonants in the Abkhaz stress system phonetically. Many morphemes in Abkhaz consist of only a single consonant, but according to previous analyses of Abkhaz such morphemes nevertheless participate in the stress system of the language. However, stress in Abzhywa Abkhaz is always transcribed as falling on a vowel, so previous work implicitly assumes a neutralization of the underlying sequences /Ć-V/ (accented consonant, unaccented vowel) and /C-V́/ (unaccented consonant, accented vowel). For example, both (2) a. and (2) b. are transcribed as beginning with the same sequence [bá], even though (2) a. has an underlyingly accented /b́/ followed by an unaccented /a/, while (2) b. has the inverse accentual configuration.

(2) /ĆV/ vs. /CV́/ contrasts (experimental stimuli)

a. бабџьар
[**bá**bd͡ʒar]
/**b́-a**bd͡ʒar/
2SF.POSS-weapon
'your weapon'

b. бацхьоит
[**bá**pʰχʲojt']
/**b-á**-pʰχʲa-wá-jt'/
2SFA-3SNO-read-DYN-DYN.FIN

However, the phonetic manifestation of these underlying phonological contrasts is not known. If /ĆV/ and /CV́/ sequences are acoustically different, this would be strong evidence for consonants participating in the Abkhaz stress system not only at an abstract level, but also in terms of the phonetic realization. The experiment involved three conditions: underlying stress on the consonant only, underlying stress on the vowel only, and a third category where the /CV/ sequence was monomorphemic, where no underlying /ĆV/-/CV́/ contrast is known to occur. There are three voiced person prefixes which readily allow for the creation of suitable stimuli: /w-/ '2nd person masculine', /b-/ '2nd person feminine', and /j-/ '3rd person singular masculine (oblique), 3rd person non-human (absolutive), 3rd person plural (absolutive)'. Only /b-/ was used in the CV sequences in the experiment, since segmenting a stop-vowel sequence /ba/ is far more tractable than a glide-vowel sequence like /wa/ or /ja/. The stimuli and results of this study are presented and analyzed fully in Chapter 3, Section 3.3.

Only measures of pitch and duration were used for this experiment, since intensity results on a /CV/ sequence are confounded by the high intrinsic differences in intensity between consonants and vowels.

(3) Measures for Experiment 3

Pitch	Mean F0 (Hz) during five normalized time periods in the consonant (0%-20%, ..., 80%-100%), and five during the vowel
Duration	Duration (ms) of consonant and vowel as well as the duration ratio V:CV

The separate time normalization for the consonant and the vowel mean that the time steps during the consonant may be of a different duration than those during the vowel, if the two segments differ in duration. However, creating ten normalized time steps for the whole CV interval is not desirable. Again due to potential differences in consonant and vowel duration, this would mean that a statement like ‘the F0 maximum is at time step 5’ may be referring to an F0 maximum during the vowel or during the consonant depending on the relative segment durations of an individual token. Since it is precisely the alignment of stress with respect to the consonant and the vowel that is being investigated, I have preferred to normalize the time for each segment separately.

2.1.3 Experiment design

Across the three experiments, participants read a total of 400 sentences consisting of a carrier phrase with a target word. The methodological recommendations for best practices for studies of word stress in Roettger & Gordon (2017) guided the design of the experiments, particularly Experiments 1 and 2 (see discussion of Experiment 3 later in this section). The target words were placed in phrase-medial position to avoid potential intonational effects at the starts and ends of phrases. The target words were also placed in a phrasally unfocused position, with contrastive focus on parts of the carrier phrase rather than on the target word. This helps separate the effects of word stress from any intonational effects caused by phrasal pitch accents. This focus manipulation was achieved through the use of a context sentence, which participants read silently before reading the carrier sentence out loud. A representative context-carrier pair for the target word 'train' (bolded) is given below:

(4) Context and carrier sentences (experimental stimuli)

a. Шәара шәоума «адәыҕба» ҳәа зҳәаз?

[ʃʷará	ʃʷ-ó-w-ma	**a-dʷə́-ʁba**	ħʷá	z-ħʷá-z]
2P	2PO-be-STAT-Q	DEF-field-ship	QUOT	E.REL-say-PST

'Was it you who said 'train'?'

b. Мап, иара иоуп «адәыҕба» ҳәа зҳәаз.

[máp'	jará	j-ó-wp'	**a-dʷə́-ʁba**	ħʷá	z-ħʷá-z]
no	3SM	3SMO-be-STAT.PRES	DEF-field-ship	QUOT	E.REL-say-PST

'No, it was he who said 'train'.'

Note that the stop burst of the ejective [p'] before the target word and the frication of the [ħʷ] in the quotative particle after the target word make for easier segmentation of the materials, which for Experiments 1 and 2 begin and end in vowels.

Each target word appeared nine times in the study. They each appeared with eight personal pronouns (I, you masculine, you feminine, he, she, we, you plural, they).[1] For each target word, exactly one pseudorandomly chosen pronoun was used twice for the ninth repetition. A tenth repetition of each target word was recorded with phrasal prominence, in a carrier phrase with no preceding context sentence and the pronoun 'those, they':

1 Since these serve as subjects of the verb 'say', the ninth personal pronoun 'it' was not included.

(5) Carrier sentence (experimental stimuli)

Урт̦ «ад̦әыг̦ба» х̦әа рх̦әоит.

[wúrtʰ	**a-dʷə́-ʁba**	ħʷá	r-ħʷó-jt’]
those	DEF-field-ship	QUOT	3PE-say.DYN-DYN.FIN

‘They say ‘train’.’

Again a consonant immediately before and after the (vowel-initial and vowel-final) target words was included to aid segmentation. Such sentences were not included in the statistical analysis, but allowed me to get an impression of stress on phrasally prominent tokens. For the role of these sentences in exclusions of tokens, see Section 2.1.5 below.

In Experiment 3 ten repetitions of each word were recorded in a similar carrier sentence to that in (5). In other words, all tokens were phrasally prominent, and there was no context sentence. It would be interesting if /ĆV/ and /CV́/ sequences differed even in something like the alignment of phrasal pitch accents. Therefore there was no need to limit the study to phrasally unprominent tokens. The ten repetitions used all eight personal pronouns discussed above, as well as two pseudorandomized pronouns to be repeated, which were guaranteed to be different from each other. An example sentence is shown below:

(6) Carrier sentence (experimental stimuli)

Сара «бабц̦ьар» х̦әа сх̦әоит.

[sará	**b-ábd͡ʒar**	ħʷá	s-ħʷó-jt’]
1S	2SF.POSS-weapon	QUOT	1SE-say.DYN-DYN.FIN

‘I say ‘your weapon’.’

All pronouns used end in the vowel-final pronominal suffix /-ra/, facilitating the identification of the beginning of the consonant in the target word. This is not a huge concern, since Abkhaz voiced stops are typically prevoiced, which was essential in order to be able to collect F0 data during the stop closure.

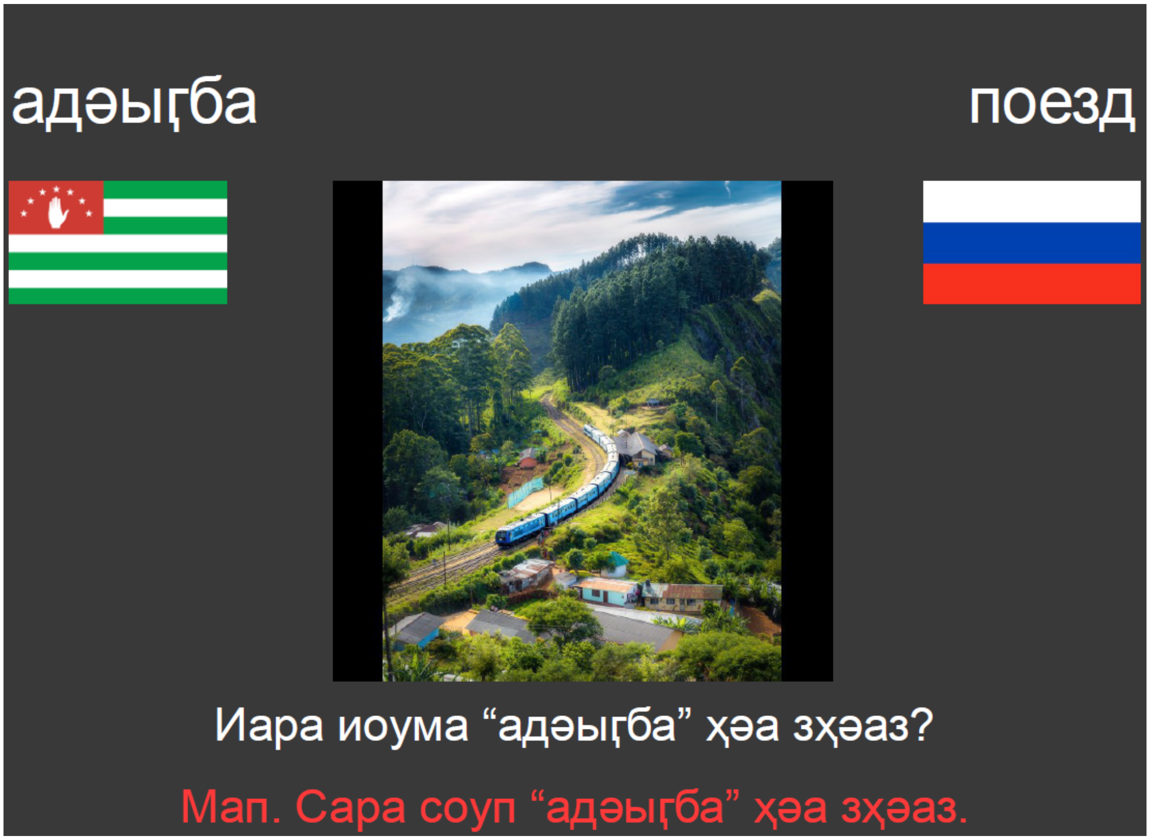
2.1.4 Information about how the study was carried out

I conducted an online pilot study with one male native speaker of Abkhaz living in Turkey, and an in-person study with three female native speakers in the United Kingdom. I will refer to speakers where necessary only with the anonymized labels A, B, C, D. Working online with the many Abkhaz speakers in Russia, not to mention in Abkhazia itself, did not prove to be possible. American sanctions on the Russian banks on which Abkhazians rely would have made it impossible to reimburse participants for their time in a legal and traceable manner. In view of the small number of speakers involved, the results of the study should be treated as preliminary and subject to verification or falsification by more extensive future experiments.

The participants were recruited through contacts with linguists working on Abkhaz and word of mouth. All participants were given a consent form in Abkhaz, informing them that they were taking part in a research study on Abkhaz pronunciation, and that they were free to withdraw from the study at any time for any reason without any impact on their financial compensation. They were also given options for who would have access to the recordings; all four consented to have their materials made available in a linguistic archive, enabling other linguists to use their recordings for other experiments. Participants were paid GBP25 for their participation in the study (although the pilot participant refused payment even after multiple attempts), which took approximately 30-60 minutes.

Before the experiments, participants read through a list of the target words, enabling me to check that they were familiar with the words in the experiments. They were also given a few training slides to practice before the study began. Items were presented to participants as slides in a PDF document. An example slide is shown below for the word ‘train’. The target word appears on the top, both in Abkhaz (cued by an Abkhazian flag), and in Russian (cued by a Russian flag). A picture of the target word was shown in the center of the screen. Abkhaz word stress is not marked in any way in the orthography, so visual cues and a Russian translation were necessary to convey word identity in the case of homographs. The context sentence appears in white below the picture, and the carrier sentence which was read out loud by the participant in red at the bottom of the slide.

(7) Figure 2.1



Example slide presented to participants

The order of slides was pseudorandomized separately for each participant, subject to the following constraint: no two adjacent items can be homographs or repetitions of the same word. Items for all three experiments were randomized together, so that from the participant’s point of view, there were no distinct phases corresponding to Experiments 1, 2, and 3.

The in-person recordings were made with a Zoom H4n recorder placed approximately 1m from the participant, with sample rate 44.1KHz in 32bit stereo .wav format. For the online pilot, recordings with the same specifications were made locally by the participant in Audacity using a directional laptop microphone. Two speakers were recorded in their homes, while two had to be recorded in the much noisier environment of a public library. See Section 2.1.5 for discussion of exclusions due to background noise.

The recordings were then transferred to me after the experiment. Since the pilot recordings were made locally to the participant, there is no concern about possible audio artifacts introduced by compression in video call software (for remote phonetic methodologies during the COVID-19 pandemic, see the methodologies and recommendations in Sanker et al. 2021, Zhang et al. 2021). Throughout both in-person and online versions of the study, I was present to answer any questions, and I advanced the slides after each item had been read.

Recordings were segmented into individual utterances in Audacity. Occasional speech errors and false starts lead to items being reread. In these cases only the last repetition was extracted. Utterances were then aligned with the Montreal Forced Aligner (McAuliffe et al. 2017). Although acoustic models for Abkhaz are available (Ahn & Chodroff 2022), experimentation showed these to have poor performance on Abkhaz speech. This is likely due to the fact that they are trained on only two hours of Abkhaz audio. I instead used acoustic models for German (McAuliffe & Sonderegger 2022) trained on over 3,000 hours of audio. The phoneme inventory of German contains affricates as well as dorsal fricatives just like Abkhaz, which is why this language was chosen. Experimentation also showed that alignment of Abkhaz speech was generally successful. I wrote a custom dictionary transcribing all Abkhaz words which appear in the study using the phone set for the German acoustic model. For this approach to forced alignment of low-resource languages, see recent discussion in Babinski et al. (2019) and Babinski (2022).

The alignments were overall successful, but proved occasionally unreliable, especially for [r] and [rr]. The acoustic model was not trained on varieties of German with coronal rhotics, and a [d] was used as a substitute in the custom dictionary I wrote. Since stops and sonorants have little in common acoustically, this often resulted in incorrect segmentations. The forced alignment of all target words was corrected by hand, although alignment errors in some carrier phrases may remain. No part of the carrier phrase is examined or measured in any of the three experiments.

The aligned recordings were analyzed in Praat (Boersma & Weenink 2017) based on edited versions of scripts originally written by Katherine Crosswhite. Apart from modifying the scripts for the pitch ranges of the individual participants, default settings for pitch and intensity tracking were generally used. However, for Experiment 3 the silence threshold was lowered from default 0.03 to 0.01. This follows a recommendation from the Praat FAQ on pitch analysis (Boersma 2022) to correct errors when analyzing quiet parts of an otherwise loud recording. This is the case in Experiment 3, where pitch during a stop closure is being analyzed, as well as pitch on the much louder following vowel.

The outputs of these scripts were edited lightly in Python to add information about item condition and to exclude certain items (see next section). Homographs were also disambiguated at this stage. In version 4.1.2 of R (R Core Team 2021) I performed statistical analysis and visualization tasks using the packages *lme4* (Bates et al. 2015) and *ggplot2* (Wickham 2016) respectively. The statistical analysis relies on ANOVAs to compare nested linear mixed effect models. The full model specifications are reported along with the results for each experiment in Chapters 3 and 4.

For earlier work with subsets of these data reported in Andersson (2023), I originally attempted within-utterance methods of normalization. In particular, I attempted to use words such as [ħʷá] ‘QUOT’, which followed all target words, as a baseline to compute relative measures for pitch, intensity, and duration. This did not work, for the simple reason that the pronunciation of the quotative particle depended greatly on where stress fell in the preceding target word. If stress was closer to the particle the F0 of the particle was affected by the F0 curve of the stressed syllable, while no or smaller effects were seen if the stress on the target word was further away. In the present version of the study, the data were instead Z-scored by participant in R to normalize for between-participant variations in F0, intensity, and duration.

2.1.5 Exclusions and other modifications of data

As mentioned in Section 2.1.3 each participant read a total of 400 sentences. Speaker C only has 377 sentences recorded, due to me forgetting to hit the record button before starting the experiment. Aside from this accidental exclusion, there were several reasons to intentionally exclude particular datapoints:

(8) Reasons for exclusions of datapoints

- The participant was not familiar with, or did not want to read, the target word
- The target word had too much background noise to be used for analysis
- The stress of the target word did not match the stress expected from the dictionary, and the stress pattern used by the participant could not be conclusively determined
- The pitch, intensity, or duration measured resulted from a measurement error
- The pitch, intensity, or duration of the target word could not be measured by Praat

For speaker A, four target words were excluded due to lack of familiarity. One target word was excluded for speaker B which they preferred not to read. For speaker C, 45 of the 400 utterances were discarded due to background noise, while for Speaker D 41 utterances were excluded for this reason.

In a few cases participants varied in how a particular word was stressed. This often took the form of the participant hesitating when the word appeared, and trying multiple stresses out loud to see which they preferred. In other cases they confidently read the word without hesitation, apparently unaware that other stress patterns for the given word are possible. I wanted to avoid a situation where I had to decide on a token-by-token basis where stress fell, so in cases of any ambiguities on any of the ten repetitions of a target word I excluded the relevant vowels from the study. Only if all ten repetitions unambiguously had the same stress placement did I include the word, adding item-specific code to shift which stress pattern the word was considered to have for this speaker. Recall from Section 2.1.2 that identification of the location of primary stress in Abkhaz words is relatively straightforward, and that linguists with a wide variety of different native languages do not disagree with each other, or with native-speaking linguists, in their transcriptions.

I was aided in these judgements by two factors. First of all, recall from Section 2.1.3 that all words had at least one phrasally prominent repetition where the location of stress was easier to detect. Secondly, participants were often metalinguistically aware of stress, making comments for 'burn', to take one example word, such as "I'm not sure if it's [ábəlra] or [abəlrá]." This alerted me to the fact that this word from this speaker may not be stressed as the dictionary transcribes it. If all tokens then sounded like [abəlrá], rather than the dictionary-specified [ábəlra], I could then be relatively confident that I was not hallucinating the fact that this speaker does indeed show a different stress placement.

For the single word ‘approximately twenty’, stress variation for one word affected other words in the study. For Speaker B who pronounces [ɥaʒʷa-q’á] twenty-approximately ‘approximately twenty’ with word-final primary stress, we should expect any secondary stress in [ɥə́n-ɥaʒʷa-q’à] twice-twenty-approximately ‘approximately forty’ to also be word-final. But for Speaker A who says [ɥaʒʷáq’a] ‘approximately twenty’ with penultimate stress, we should instead expect any secondary stress in [ɥə́n-ɥaʒʷà-q’a] ‘approximately forty’ to be penultimate. See Chapter 4 and especially Chapter 5, Section 5.6 for a fuller explanation of how the possible location of secondary stresses is predicted. Below in (9) are all words which had measurements excluded (E) or the expected location of stress modified (M) based on my listening to the words, in conjunction with the participant’s comments during the experiment. I give the word as pronounced by speaker. I also include a comment on where stress falls on the word in the dictionary. Note that for excluded words, speakers showed variation. I only include variants which do not match the dictionary pronunciation in (9).

(9) Excluded and modified words

Speaker A

[ɥaʒʷáq’a]	‘approximately twenty’	(M, final stress)
[abəlrá]	‘burn’	(M, initial stress)

Speaker B

No modifications or exclusions based on deviations from dictionary stress

Speaker C

[ɥáʒʷaq’a]	‘approximately twenty’	(M, final stress)
[akʷʰk’ʲə́sra]	‘to touch above’	(E, initial stress)
[akʷʰtʰə́χra]	‘to redraw’	(E, initial stress)
[amdə́rra]	‘ignorance’	(E, initial stress)

Speaker D

[ʮaʒʷáq’a]	‘approximately twenty’	(M, final stress)
[abəlrá]	‘burn’	(E, initial stress)
[amdə́rra]	‘ignorance’	(E, initial stress)

Exclusions were also made due to measurement errors. Items which were more than three standard deviations away from the speakers’ mean for pitch or intensity measurements were inspected by hand. Duration was not examined, since I had already corrected the alignment of all utterances by hand. For inspected items which appeared to have no measurement errors, the value given by the Praat scripts was left in. Measurements with errors were replaced with “NA”, so that they would be ignored in the statistical analysis in R. Note that only the affected measurement was removed, and that the token was not thrown out. If Praat failed to track the pitch on a vowel accurately, only the pitch measurement was removed, and intensity and duration were left unmodified.

In Experiment 3, ten pitch measurements were made during a CV sequence, five during the consonant, and five during the vowel (Section 2.1.2.3). A repetition of a word in this experiment was removed entirely if more than two pitch measurements were missing from either the consonant or the vowel. After all of these exclusions have been made, the following numbers of vowels (or consonant-vowel sequences in the case of Experiment 3) remain for each combination of experiment and speaker:

(10) Figure 2.2

	Experiment 1	Experiment 2	Experiment 3
Speaker A	234	234	64
Speaker B	279	234	95
Speaker C	237	195	100
Speaker D	237	205	120
Total	987	868	379

Number of tokens for each participant and experiment

2.2 Database corpora

Almost all of the data on stress alternations reported in this dissertation come from Yanagisawa's (2010) Abkhaz-English dictionary. From this dictionary I have compiled two database corpora of stress alternations, where each form is supplied with morphological and phonological information. One corpus consists of definite and indefinite forms of 545 nominal stems, i.e. nouns and adjectives. The other has seven inflected forms for each of 445 verb stems. By studying stress alternations in this way, it is possible to ascertain quantitatively how reliable a particular phonological generalization is. Theories can be evaluated against a large subset of the Abkhaz lexicon, and there is no need to rely on small datasets of (hopefully) representative examples as has been common in earlier theoretical literature on prosody. There is less danger of building a theory on cherry-picked examples when thousands of forms are studied, and this in turn reduces the need for the reader to trust that the author has been responsible in choosing which datapoints to highlight.

These corpora underlie the empirical generalizations on Abkhaz stress in Chapter 6, and the theoretical evaluation of theoretical approaches to Abkhaz prosody in Chapters

6 and 8. In this section I report the methodological decisions on which this work depends. I begin by describing the dictionary, as well as which inflected forms of stems were chosen for inclusion and the reasons for these choices (Section 2.2.1). I then discuss how I used Python 3 scripts to create the corpora in a semi-supervised manner (Section 2.2.2). Finally I describe how the corpora were used to test phonological theories implemented in Python 3, and methodological questions that arise in the use of computers to (partly) automate phonological analysis.

2.2.1 The dictionary data

The dictionary data on stress alternations in this dissertation come from Yanagisawa (2010). Several other comprehensive dictionaries of Abkhaz exist (Marr 1926, Džanašia 1954, Šakryl & Kondžarija 1986/7, Genko 1998, Kaslandzija 2005, among others), but Yanagisawa (2010) was deemed to be the most appropriate. It regularly provides inflected forms of stems, and marks the stress in all such cases. Explicit indications of where stress falls are vital to study stress alternations in the language, since the modern orthography does not mark stress in any way. The dictionary is mostly based on the speech of Anna Tsvinaria-Abramishvili, who was Yanagisawa's main consultant during fieldwork in Georgia. Tsvinaria-Abramishvili was a speaker of the Abzhywa dialect from the village Kutol (Abkhaz [k'^{w}t'ól] Кәтол) in the Ochamchira region of Abkhazia (Yanagisawa 2010: 4-5).

2.2.1.1 Sources of stress data

It is worth discussing the source of the stress marks in Yanagisawa's (2010) dictionary further. Yanagisawa (2010: 5) states that "all of the word-stresses have been marked, based on criteria provided by my consultant." If 'criteria' refers to the researcher applying, and potentially overapplying, a set of regular stress assignment rules, this is a potential concern for a study of stress patterns in Abkhaz. There is a risk of artificial regularity in datasets where linguists may extend patterns based on criteria provided by native speakers. Below I show that the data contain no indications of artificial regularity, and I give several reasons not to be concerned about the validity of the stress data in the dictionary.

Firstly, the dictionary data are far from regular, and show clear signs of having been elicited. Words are sometimes given with multiple possible stress patterns, or different inflected forms of the same stem appear to follow different rules. Forms are included which are marked with asterisks to explicitly indicate ungrammaticality according to Tsvinaria-Abramishvili. If the data I discuss occasionally seem suspiciously regular, this is in no small part due to the properties of the Abkhaz language itself. In a language where a verb can often have many thousands of inflected forms, it is virtually guaranteed that a native speaker has never heard large parts of the paradigms, even for some common stems. Abkhaz speakers are constantly assigning stress to forms they have not heard before, and to do so they rely on internalized rules for stress assignment. Large paradigms of forms will display regularities because their stresses were assigned by rule, but by native speakers' rules rather than those of linguists.

The dictionary contains stress alternation patterns which Yanagisawa appears not to be consciously aware of, and which in fact contradict the generalizations about stress assignment in Yanagisawa (2013). Such a situation could not arise if stresses on inflected forms were assigned by the linguist based on generalizing stress patterns they are familiar with. For example, when discussing indefinite forms of nominals (covered in greater detail below), Yanagisawa (2013: 42) states that stems with initial stress in the definite have stress immediately before the indefinite suffix. There is no doubt that this is often true in Abkhaz, but the location of indefinite stress is contrastive. It can appear on non-final vowels, as Yanagisawa's (2010) data show (11) (see Chapter 6 for detailed discussion).

(11) Stress alternations

a. Stress alternations which obey Yanagisawa's (2013) rule

	Definite	Indefinite
i.	агəнаҳа [á-gʷnaħa] DEF-sin 'sin' Yanagisawa (2010: 83)	гəнаҳак [gʷnaħá-k'] sin-INDF 'one sin'
ii.	асакаса [á-sak'asa] DEF-stretcher 'stretcher' Yanagisawa (2010: 388)	сакасак [sak'asá-k'] stretcher-INDF 'one stretcher'

b. Stress alternations which disobey Yanagisawa's (2013) rule

	Definite	Indefinite
i.	ашкəакəа [á-ʂk'ʷak'ʷa] DEF-white 'white' Yanagisawa (2010: 556)	шкəакəак [ʂk'ʷák'ʷa-k'], not *[ʂk'ʷak'ʷá-k'] white-INDF 'a white one'

ii. азамана заманак

[á-zamana] [zamána-k’], not *[zamaná- k’]

DEF-excellent excellent-INDF

‘excellent’ ‘an excellent one’

Yanagisawa (2010: 131)

In general, the typology of accent types in Yanagisawa (2013) does not mention stem length, which I argue is crucial in determining how many stress alternations a given stem shape can have (see Chapter 6). If a source contains patterns which its creator is unaware of, this is a good sign that the creator has not regularized the dataset according to what they know about the language.

The exceptional or unusual stress patterns in Yanagisawa (2010) also match what is independently reported in work on Abkhaz by other authors. For example, non-final stresses on inflected forms of ‘white’ and ‘excellent’, as in (11) b. above, are also found in Marr (1926: 79) and Šinkuba (2003: 10) respectively. Another example I encountered while conducting the experiments discussed in Section 2.1. I incorrectly used a form of the non-causative verb [aχáʂtʰra] ‘forget accidentally’ when I should have used the causative [aχárʂtʰra] ‘forget intentionally’ (lit. make oneself forget). The participant I was working with corrected me, producing the correct causative form [ħχáħarʂtʰwejt’] ‘let’s forget about (it)’. The stress rules for causative verbs (see Chapter 6, Section 6.3 for discussion) would put stress on the vowel after /χa/, but the verb ‘forget intentionally’ appears to be an exception: *[ħχaħárʂtʰwejt’]. In Yanagisawa’s (2010: 442) dictionary entry for this verb, the theoretically unexpected forms, violating the usual stress rules by placing stress on /χa/, are the only ones given. This shows that in cases where the data do not conform to the regular rules, Yanagisawa (2010) correctly gives the exceptional forms which speakers produce rather than overgeneralized regulars.

Finally Yanagisawa (2010: 4-5) is explicit that especially the verbal inflected forms, on which he focused in his research, come from the seven years of fieldwork he conducted on Abkhaz. This explains why his data include many exceptions like that for ‘forget intentionally’ mentioned above. Indeed these data could not have been copied from previous dictionaries or grammatical works, because the verbal paradigms given are far more comprehensive than anything found in earlier literature. Dictionaries like Genko (1998) and Kaslandzija (2005) give one inflected form for each verb, while Yanagisawa (2010: 5) states that in his dictionary all verbs have at least six. Some common verbs like ‘to give’ have well over 100 inflected forms.

Another concern about the data is that they may be overly specific, describing primarily a single speaker. As I have argued above, even the details of stress on specific lexical items appear to match well what is reported in other work. In particular, the generalizations about Abkhaz stress based on Yanagisawa (2010) in Chapters 4 and 6 match closely the generalizations from previous work on Abkhaz stress (Lomtatidze 1974, Dybo 1977, Spruit 1986). This includes work which discusses different dialects of Abkhaz (e.g. Bruening 1997, Vaux 2015, Vaux & Samuels 2018, Andersson et al. 2023 on Cwyzhy Abkhaz; see Aršba 1979 for a book-length treatment of Abkhaz stress with data from several dialects).

The patterns of Abkhaz stress assignment also appear to have been stable over a very long time. The earliest grammar of Abkhaz, Uslar (1887), contains many inflected forms of representative stems like /q’a/ ‘be’ with the exact patterns of stress behavior that characterizes this verb today. Similar but non-identical stress systems are also found in other Northwest Caucasian languages, notably Abaza and Ubykh (on Abaza see Genko

1955: 62-68, on Ubykh see Dybo 1977; see Borise 2021b for discussion and additional references). Having dealt with the nature of the stress data in the dictionary, I will now discuss the inflected forms of both nominals and verbs which I chose for inclusion in the studies of stress in this dissertation.

2.2.1.2 Nominal data

I examined definite and indefinite forms of nominals for the corpus study. The definite form of an Abkhaz noun is its citation form, serving as the headword in dictionaries. Dictionaries typically also include the indefinite form of nominals, sometimes accompanied by plurals and possessed forms. The indefinite was chosen since it is present for more nominals in Yanagisawa (2010), allowing for more data to be included. In addition to this, alternations between definite and indefinite nominals frequently figure in theoretical literature on Abkhaz stress (Dybo 1977, Spruit 1986), making them a good basis for an empirical evaluation of theories of Abkhaz stress. Definites are marked with a prefix /a-/, while indefinites are marked suffixally with /-k'/. Examples are shown in (12).

(12) Definite-indefinite pairs (Yanagisawa 2010: 258-259)

a. ала
[á-la]
DEF-eye
'eye'

b. лак
[lá-k']
eye-INDF
'one eye'

I retain the terminology ‘definite’ and ‘indefinite’ in glosses and when discussing these forms in text. However, as reflected by the translations in (12), these categories do not always map onto the English meanings of ‘the’ and ‘a(n)’ respectively. Chirikba (2003: 23-24) notes so-called generic uses of the definite article /a-/, which are translated with English bare nouns, a convention I follow throughout this dissertation. Sometimes the definite /a-/ may even be used when an English translation requires an *indefinite* article (Hewitt 2010: 29):

(13) Non-correspondence between Abkhaz and English definiteness

Ас дуӡӡа ауит.
[a-s-dúw-d͡zd͡za a-wí-jt’]
DEF-snow-big-INTENSIFIER 3SNO-work-DYN.FIN
‘There was a (*the) really huge snowfall.’
Hewitt (2010: 276)[2]

Similarly the way to say ‘one NOUN’ is to attach the indefinite article to the stem, exactly as in (12) b. (Yanagisawa 2013: 87). Since the English ‘a NOUN’ can often be rendered with the definite article in Abkhaz as in (13) above, I have preferred to translate indefinites as ‘one NOUN’, a sense which is never found for /a-/. This should not be taken to imply that such words do not also have meanings which are closer to English ‘a(n)’.

2.2.1.3 Verbal data

For verbs I decided to extract seven inflected forms. Inspecting the dictionary showed that these seven forms were consistently reported for a large number of verbs, and that

2 I treat the noun-adjective combination here as one word, since a noun and its following adjective form a single domain for stress assignment and processes sensitive to stress, such as schwa epenthesis (see Chapter 5 for data, and Chapter 8, Section 8.2.6 for some discussion; on schwa epenthesis, see Chapter 4).

they often exhibited stress alternations. All forms come from so-called dynamic verbs, which denote events, as opposed to stative verbs which denote states. Below are glossed examples of the seven categories of verb forms I will study, labeled with the slots of the verbal template that they fill. I also repeat the verb template from Chapter 1 here (see Chapter 1, Section 1.3.3.2 for discussion). Note that throughout, the person markers are prefixal, while the tense-aspect-mood-evidentiality morphology is suffixal. The infinitive (also called the masdar) behaves rather more like a noun than a verb, and does not follow the verb template; instead it is marked by the ubiquitous definite nominal prefix /a-/ and the suffix /-ra/. I translate such forms as 'VERB' in this dissertation, but 'VERB-ing' would have been no less appropriate. The forms are from the verb 'disappear', with the preverb [k'əla-] 'through' and the stem [d͡z] 'disappear'.

(14) Simplified verb template (Chirikba 2003: 38-39)

A	O	PREV	E	NEG	CAUS	STEM	DYN	NEG	TAME

(15) Glossed examples (Yanagisawa 2010: 213)

a. Infinitive (verbal noun)

акылаӡра
[a-k'ə́la-d͡z-ra]
DEF-PREV(through)-disappear-INF
'disappear'

b. Present (affirmative)

дкылаӡуеит
A-PREV-STEM-DYN-TAME
[d-k'ə́la-d͡z-we-jt']
3SHA-PREV(through)-disappear-DYN-DYN.FIN
'(s)he disappears'

c. Present (negative)

дкылаӡуам
A-PREV-STEM-DYN-NEG
[d-k'ə́la-d͡z-wa-m]
3SHA-PREV(through)-disappear-DYN-NEG
'(s)he does not disappear'

d. Imperative (affirmative)

Бкылаӡ!
A-PREV-STEM
[b-k'ə́la-d͡z]
2SFA-PREV(through)-disappear
'Disappear!'

e. Imperative (negative)

Бкыламӡын!
A-PREV-NEG-STEM-TAME
[b-k'ə́la-m-d͡zə-n]
2SFA-PREV(through)-NEG-disappear-NEG.IMP
'Don't disappear!'

f. Past absolute (affirmative)

дкылаӡны
A-PREV-STEM-TAME
[d-k'ə́la-d͡z-nə]
3SHA-PREV(through)-disappear-PST.ABS
'him/her having disappeared'

g. Past absolute (negative)

дкыламӡкәа
A-PREV-NEG-STEM-TAME
[d-k'ə́la-m-d͡z-k'ʷa]
3SHA-PREV(through)-NEG-disappear-NEG.PST.ABS
'him/her not having disappeared'

An important caveat is in order here about fixed stress. Some stem have stress in the same position for all seven forms, without any alternations. This is exemplified by 'disappear' in (15) above, where stress always falls on the preverb. However, the forms included only comprise a small subset of possible nominal and verbal inflections in Abkhaz. Stress shifts can and do occur in other forms as well. It is easy to get the impression that both (16) a. and (16) b. show the same pattern, both with fixed stress, albeit on different syllables of the stem. However, as (16) c. shows, these words belong to different categories, since they exhibit different behavior in the plural. (16) d. i.-v. illustrates that the stem 'stand' appears to exhibit fixed stress on all forms in its paradigm(s). This is revealed to be an inaccurate generalization in (16) d. vi. I am not aware of any Abkhaz stems which always have surface stress in a fixed location. Stress alternations can always be created with the right combination of affixes.

(16) Absence of forms with fixed stress

a. Yanagisawa (2010: 259)

i. алаба
[a-labá]
DEF-stick
'stick'

ii. лабак
[labá-k']
stick-INDF
'one stick'

b. Yanagisawa (2010: 202)

i. акаба
[a-k'ába]
DEF-shirt
'shirt'

ii. кабак
[k'ába-k']
shirt-INDF
'one shirt'

c.

i. алабақәа
[a-laba-kʷʰá]
DEF-stick-N.PL
'sticks'
Yanagisawa (2010: 259)

ii. акабақәа
[a-k'ába-kʷʰa]
DEF-shirt-N.PL
'shirts'
Yanagisawa (2010: 202)

d.

i. сымгылеит
[sə-m-gə́le-jt']
1SA-NEG-stand-DYN.FIN
'I didn't stand up'
Yanagisawa (2010: 74)

ii. дгыланы
[d-gə́la-nə]
3SHA-stand-PST.ABS
'him/her having stood up'
Yanagisawa (2010: 75)

iii. сгылахьан
[s-gə́la-χʲa-n]
1SA-stand-PRF-PST
'I had already stood up'
Yanagisawa (2010: 74)

iv. Бангыл!
[b-a-n-gə́l]
2SFA-3SNO-PREV(on)-stand
'Stand on it! (feminine addressee)'
Yanagisawa (2010: 313)

v. иахагыло
[j-a-χa-gə́lo]
A.REL-3SNO-PREV(over)-stand.DYN
'who is standing over it (relative clause)'
Yanagisawa (2010: 437)

vi. самхагылеит
[s-ámχa-gəle-jt’]
1SA-NONVOLITIONAL-stand-DYN.FIN
‘I stood up against my will’
Yanagisawa (2010: 75)

We are now ready to see how the corpora made up from the inflected nominal and verbal forms discussed above were created.

2.2.2 Creation of the corpora

I used a semi-automated process involving a series of Python 3 (Python Software Foundation 2024) scripts to create the database corpora for nominal and verbal stress alternations. Below I describe this process, covering any exclusions I made, as well as some details on the data processing steps taken. The purpose is not to describe every line of code in this process, but to give a brief overview of how the corpora were created, including a discussion of the division of labor between manual and automated work. I also include methodological discussion aimed to help other linguists who wish to create similar corpora for other languages.

2.2.2.1 Creating a corpus using Python 3

This study was made possible by Tamio Yanagisawa, who kindly provided me with a PDF version of his dictionary. Although I have access to the print version of Yanagisawa (2010), the avoidance of scanning, Optical Character Recognition (OCR), and correcting the OCR saved me great amounts of time. I copied the text of the dictionary into a plaintext .txt document which served as the input for the Python scripts. The dictionary is typeset in a proprietary font, so that when “шə-а-мы́-пхьа-н!” ‘don’t read (it)!’ is written in the dictionary, copying the text yields “w´-a-my¡-ђх;a-n@”. Fortunately all characters used in the Abkhaz alphabet are rendered uniquely, making it straightforward to map the illegible renderings back to Unicode Abkhaz letters.

Relevant headwords were identified based on the grammatical tags in square brackets supplied after each headword: [n.] ‘noun’, [adj.] ‘adjective’. Verbs were identified based on the headword having the morphological structure [a-...-ra] (see (15) a. above), and the entry containing information about transitivity, a property unique to verbs. For nominals it was straightforward to look for forms immediately after the headword which appeared to be indefinites, i.e. having the structure [...-k’]. However, not all verbs in the dictionary are inflected for the same forms, and some verbs have more inflected forms than others. The verbal scripts instead looked for grammatical tags like [pres.] ‘present tense’ in the verb entry to check that all seven forms in (15) could be found.

A sample dictionary entry for the verb ‘open’ is shown below. It begins with the infinitive headword in bold **а-рт-рá** [a-rt’-rá], followed by verb category information ([tr.] for a transitive verb). The bracketed “C3 open C1” gives a translation as well as an indication of the argument structure: the opener is marked by an ergative (abbreviated C3 in the dictionary), and the thing opened by an absolutive (abbreviated C1). After this are inflected forms of ‘open’, preceded by tags such as [pres.] for present tense. Later the entry contains example sentences using the verb ‘open’, translated into English and sometimes also into Russian.

(17) Figure 2.3

а-рт-ра́ [tr.] [C1-a-C3-S / C1-a-C3-Neg-S [C3 open C1] (**Fin.** [pres.] **и-а-сы-рт-уе́-ит / и-а-сы-рт-уа́-м (-рт-ӡо́-м)**, [aor.] **и-а-сы-рт-и́т / и-а-с-мы-рт-и́т (-рт-ӡе́-ит)**, [imper.] **и-а-рты́! / и-а-б-мы-рты́-н!, и-а-шәы-рты́! / и-а-шә-мы-рты́-н!**; **Non-fin.** [pres.] (C1) **и-а-лы-рт-уа́ / и-а-л-мы-рт-уа́**, (C3) **и-а-зы-рт-уа́ / и-а-з-мы-рт-уа́**, [aor.] (C1) **и-а-лы-рты́ / и-а-л-мы-рты́**, (C3) **и-а-зы-рты́ / и-а-з-мы-рты́**, [impf.] (C1) **и-а-лы-рт-уа́-з / и-а-л-мы-рт-уа́-з**, (C3) **и-а-зы-рт-уа́-з / и-а-з-мы-рт-уа́-з**, [past indef.] (C1) **и-а-лы-рты́-з / и-а-л-мы-рты́-з**, (C3) **и-а-зы-рты́-з / и-а-з-мы-рты́-з**; **Abs.** **и-а-рт-ны́ / и-а-мы-рты́-кәа**) **1.** to open: **А-ıђе́нцьыр а-ды-рт-уе́-ит.** *They are opening the window.* **А-ıђе́нцьыр а-рт-ра́ ҟало́-у?** *Is it possible to open the window? Можно открыть окно?* **А-ıђе́нцьыр а-сы-рты́-р ҟало́-ма?** *May I open the window? Мне можно открыть окно?* **Аıђсуаа р-еихабы́ ды́-ҟа-м-кәан а́изара с-з-а́а-рт-уа-м, и-а́арласны у-ца-ны́ д-аа-у-га́-р-о-уп!** (AF) *I cannot open the assembly without the leader of the Abkhazians being present.* [cf. **а-т-ра́** "to open"]

Sample entry from Yanagisawa (2010)

For both corpora, it was necessary to clean up punctuation marks which had incorrectly been parsed as part of an Abkhaz word. I mapped the orthographic forms with stress marks to simplified phonological forms, with <C> for any consonant, <Aa> for [a] and <Yy> for [ə]. Capital <A, Y> denote stressed vowels, while lowercase <a, y> denote unstressed vowels. Replacing all consonants by a single symbol reflects an assumption that the sonority of the consonants does not affect stress placement. Although no previous work has identified any sonority restrictions on Abkhaz stress, I provide evidence which supports this assumption in Chapter 6, Section 6.1.6.

I excluded four types of words: 1) words with stress on long [aa], 2) words with non-native vowels, 3) words with no stress marked, and 4) words with multiple stresses marked. Many speakers of Abkhaz have a stress contrast between [áa] and [a.á] (Cvinaria 1987: 70), and dictionaries typically reflect this (Genko 1998, Kaslandzija 2005). However, some speakers have lost this contrast, so that in Hewitt (2010) the two are transcribed identically. Yanagisawa (2010: 14) writes that Tsvinaria-Abramishvili "could not tell which of them is stressed", but such words are transcribed either with [áa] or [aá] based on etymological information and other dictionaries. I have preferred to exclude such words, since their stresses do not come from the speaker who provided the forms.

Even recent loanwords appear to largely follow the same principles of stress assignment as native words. They still exhibit stress alternations in the same contexts as the native vocabulary:

(18) Stress patterns in native and borrowed words

a. Native /la/ 'dog' (Dybo 1977: 42)

i. ала
[a-lá]
DEF-dog
'dog'

ii. алакҩа
[a-la-k^{wh}á]
DEF-dog-N.PL
'dogs'

b. Borrowed /st'at'ja/ 'article' < Russian /stat^{j}ja/ 'article' (Yanagisawa 2010: 393)

i. астатиа
[a-st'at'já]
DEF-article
'article'

ii. астатиакҩа
[a-st'at'ja-k^{wh}á]
DEF-article-N.PL
'articles'

Nevertheless I have excluded stems which contain the non-native vowel graphemes <и у е о> (transliterated <i u e o>). Common verbal affixes which include <и у> have been left intact. I have replaced these symbols with G for 'glide' in the simplified phonological transcriptions, since it is not always straightforward to determine whether these represent consonants or vowels in Abkhaz orthography (see discussion immediately below).

Removing these four graphemes in stems is a very coarse-grained way of removing loanwords, which is both too restrictive and not restrictive enough. It is too restrictive because <и у> are also used to write the native glide phonemes /j w/, and the native sequences [ij, uw] arising from vowel coloring (see Chapter 1, Section 1.3.2). However, orthographic conventions render some words with these phonemes difficult to use in a study of stress. For example, if one is told that the orthographic word <аҵәуара> 'to cry' with the four vowel graphemes <а...уа...а>[3] (which we may transliterate as <a...ua...a>) has peninitial stress, it is not possible to know whether the pronunciation is [at͡ʃʼ^{w}úwara] (correct, stress on <у> grapheme) or *[at͡ʃʼ^{w}wára] (incorrect, stress on <а> grapheme) (Hewitt 2010: 22). Yanagisawa (2010) generally conveys the pronunciation in such cases, and even has IPA transcriptions for some words to disambiguate <у> = [wu] vs. <у> = [uw], both of which are seen in <а**у**с**у**рҭа> [a**wú**s**uw**rt^{h}a] 'place of work' (Yanagisawa 2010: 432). However, these distinctions are not marked consistently, and I have therefore excluded such words.

On the other hand, there are also many loanwords which are included in the corpora because they contain only the native vowels [a], [ə]. To exclude these it would be necessary to check each word in resources on Abkhaz loanwords (see Chirikba 1996 for an etymological dictionary of Northwest Caucasian). Even then it is difficult to know which words to include, since Abkhaz has a long history of language contact with many languages (see Chapter 4, Section 4.4.2 for discussion of the synchronic status of older

3 Recall from Chapter 1, Section 1.3.2 that the Abkhaz grapheme <ә> denotes labialization on the preceding consonant, and does not mark the vowel [ə], which is written <ы>.

loanwords with non-native vowels in Abkhaz). In a study of native English words, it is clear that words like *fish* should be included, but which to include out of *egg* (< Old Norse), *army* (< Old French), *passion* (< Old French), *tea* (via Dutch, and ultimately < Proto-Sino-Tibetan), *cot* (< Hindi), *robot* (< Czech)? Like in English there are many older loanwords in Abkhaz which only linguists know are non-native, but it is not clear where to draw the line between native-like loanwords and loanwords which are still recognized as such.

Occasionally forms are left without stresses in the dictionary, and these clearly cannot be included. Yanagisawa (2010: 14) uses multiple stress marks if a word has several possibilities for stress.[4] I have excluded such words because when multiple forms are considered, it is not clear which variants belong together. For example, some forms of 'to conclude' show optionality in stress placement while others do not. Does (19) a. belong in a set of stress alternations with the present tense form in (19) b. i. or with the present tense form in (19) b. ii.? Based on my knowledge of Abkhaz stress, I would assume that the answer is (19) c., but I do not want to impose on the data my theoretical ideas of which forms 'ought to' belong together.

(19) Ambiguous stress patterns (Yanagisawa 2010: 59)

a. ирыбжьаҵаны
[ji-rə-bʒa-t͡s'a-nə́]
3NA-3PO-PREV(between)-put-PST.ABS
'them having concluded it'

4 In cases of optionality concerning factors other than stress, e.g. vowels which can be present or absent optionally, I arbitrarily included the first variant given.

b.

i. ирыбжьартцоит
[ji-rə́-bʒa-r-t͡s’o-jt’]
3NA-3PO-PREV(between)-3PE-put.DYN-DYN.FIN
‘they conclude it’

ii. ирыбжьартцоит
[ji-rə-bʒá-r-t͡s’o-jt’]
3NA-3PO-PREV(between)-3PE-put.DYN-DYN.FIN
‘they conclude it’

After these exclusions the nominal corpus is finished. It contains 545 stems, each with a definite and an indefinite form, for a total of 1,090 words. The verbal data are considerably more complex, and some additional processing is required.

In order to use a corpus of Abkhaz verbs to study stress, it is necessary to know the gloss of each form. Different morphemes have different stress properties, and it is important to know whether a particular instance of the prefix /r-/ represents the accented ‘3PO’ or the unaccented ‘3PE’. Yanagisawa’s dictionary provides this information indirectly in headword translations, aided by the fact that all inflected forms have morpheme boundaries marked. Note in (17), for example, that the stem is not translated as ‘close’, but ‘C3 close C1’. In the dictionary’s terminology, this means that the verb takes an absolutive (C1) and an ergative (C3).[5] Since Abkhaz verbs follow a strict templatic order, this is sufficient to gloss each inflected form based on which templatic slots are filled. For a transitive verb like ‘close’, with an ergative and an absolutive, the present tense affirmative form will always be: A-E-STEM-DYN-DYN.FIN. This predictability makes it possible to automatically gloss all forms in the verbal corpus, with a few exceptions discussed immediately below.

5 C stands for ‘column’, and the number denotes the linear order of the person prefixes in the verbal template. The order is absolutive-oblique-ergative, giving C1-C2-C3 respectively.

Errors in the automatic glossing procedure can arise in several ways. Some forms contain missing morpheme boundaries in the dictionary, others are problematic since the hyphens separating forms spread across multiple lines are identical to the hyphens that separate morphemes within a form, and still others contain segmentally null morphemes which still affect stress. This latter problem is common with certain preverbs, where a singular third-person oblique argument is not expressed segmentally, but where stress falls as if it were still there. These forms all have incorrect or misleading glosses, since there is a discrepancy between the expected number of morphemes and the number of morphemes actually found in the surface form.

(20) Null oblique arguments (Spruit 1986: 62)

a. Дыруама?
[də́-Ø-r-wa-ma], *[də-Ø-r-wá-ma]
3SHA-3SNO-cross-DYN-Q
'Does (s)he cross it?'

b. Дрыруама?
[d-rə́-r-wa-ma]
3SHA-3PO-cross-DYN-Q
'Does (s)he cross them?'

Some attempts were made to fix morpheme boundary typos automatically, but many verbs would require a hand-supplied gloss for all seven forms to ensure that there are no mistakes. In the future it may be worth taking the time to gloss such cases by hand, but for the present version of the corpus, they were instead excluded. This has the advantage of removing segmentally null morphemes from the corpus, making the scripts for the evaluation of theories of Abkhaz stress considerably simpler (see Section 2.2.3).

Manual inspection of the data was necessary, however, to identify cases where morphemes appeared in an unexpected position. According to the verbal template, the negative prefix is expected to appear between a preverb and its verb stem: PREV-NEG-STEM. In some forms, however, we see NEG-PREV-STEM instead. Such forms may have been lexicalized as not having a preverb at all (PREV-STEM > STEM), which would explain why the 'preverb' is never separated from its stem. These forms were excluded since it is not clear that the morphological analysis given in the dictionary corresponds to the structure speakers assign it synchronically.

Two additional datapoints for each verb were entered by hand. First of all, a translation into English was included. Secondly, the dictionary does not include a morpheme boundary between the causative prefix and the following stem, with the rationale that they are always immediately adjacent to each other. This meant that automatic identification of causative verb forms was impossible, and this information was instead entered manually. Causative and non-causative verb forms have previously been described as having different stress patterns (Dybo 1977, Spruit 1986), so this information cannot be ignored in a study about stress. This is an example of a situation where the benefits of hand annotating forms outweighs the time cost, and where excluding data would not be suitable.

The automatic glosses arrived at may still seem to be deficient. Is it really enough to gloss a form like [b-t͡sʰá] 'go!' as A-STEM rather than 2SFA-go? Of course each verb stem is listed on a separate row in the corpus, so using 'STEM' rather than 'go' does not cause different stems to be mixed up. The exact identity of the prefix may seem important, but in fact, all absolutive prefixes have the same stress properties, and the same holds for obliques and ergatives, with one exception discussed below. The parallelism in stress assignment across affixes is clearly seen in paradigms like those below. See Section 2.2.3 for further discussion of the accent status of functional morphemes in Abkhaz and Chapter 7, Section 7.4 for a theoretical analysis of why affixes with the same case show the same accentual behavior.

(21) Identical behavior of person markers with same case (Yanagisawa 2013: 145-146)

a. [X-Y-mo-wp’]
X.A-Y.O-have-STAT.PRES
‘Y has X’

b.	[s-bə́-mo-wp’]	‘you (feminine) have me’
c.	[s-lə́-mo-wp’]	‘she has me’
d.	[s-á-mo-wp’]	‘it has me’
e.	[s-ʃʷə́-mo-wp’]	‘you (plural) have me’
f.	[s-rə́-mo-wp’]	‘they have me’
g.	[wu-sə́-mo-wp’]	‘I have you (masculine)’
h.	[b-sə́-mo-wp’]	‘I have you (feminine)’
i.	[d-sə́-mo-wp’]	‘I have him/her’
j.	[ji-sə́-mo-wp’]	‘I have it/them’
k.	[ʃʷ-sə́-mo-wp’]	‘I have you (plural)’

The only exception is that for ergatives, the morpheme /a-/ ‘3SNE’ is accented, while other ergatives are unaccented (Spruit 1986: 57). Since this morpheme does not occur in the corpus, nothing needs to be changed to account for it. In Chapter 7, Section 7.4 I propose that the metrical parallelism is because person prefixes should be decomposed into a segmentally overt prefix with person/number/gender/animacy features, and a segmentally null prefix with case features which can be either accented or unaccented. If all obliques contain the same accented oblique case morpheme, it explains why they are all accented, as seen in (21). But independently of why this pattern arises, nothing is lost in terms of stress by glossing all absolutive prefixes simply as absolutive.

Once glosses have been provided, and relevant information added by hand, the verbal corpus is complete. It contains seven inflected forms each of 445 verb stems, for a total of 3,115 words. A partial entry for the verb ‘to feel’ is shown below. The first three columns are the infinitive form [ak’rá] ‘to feel’, written акра (column 1; with morpheme boundaries and a capital A for stress on the final vowel), with the phonological transcription a-C-CA (column 2), and the simplified gloss DEF-STEM-INF (column 3), i.e. the first morpheme is the definite prefix, the second the stem, the third the infinitive suffix. The full entry includes six other such triplets of forms for the remaining six verb forms analyzed (not shown). At the end of the entry is grammatical information about the verb: it has absolutive and oblique person markers (column 4; there is no preverb), it means ‘to feel’ (column 5), and it lacks a causative (column 6).

(22) Figure 2.4

а-к-рА	a-C-CA	DEF-STEM-INF	...	Absolutive, oblique	‘to feel’	No causative

Partial verb entry from the corpus

The verbs included have all attested common combinations of person prefixes in Abkhaz. All verbs have at least an absolutive marker. Some verbs also have either an oblique marker, or an ergative marker, or both. These verb types can appear with and without preverbs, and verbs with an ergative marker may also have a causative prefix. In (23) I summarize how many verbs belong to each of these categories in the final version of the corpus. An N means the relevant property is absent, while a Y means that it is present.

(23) Figure 2.5

Person markers	Causative	Preverb	Example	Translation	Number of verbs
Absolutive	N/A	N	[a͡tsʰará]	‘to go’	72
		Y	[ak’áħara]	‘to fall’	24
Absolutive-oblique	N/A	N	[áχara]	‘to pull’	12
		Y	[apʰə́lara]	‘to meet’	72
Absolutive-ergative	N	N	[aʐrá]	‘to dig’	59
	Y		[argə́lara]	‘to build’	64
	N	Y	[agʷátʰara]	‘to notice’	54
	Y		[atʰart͡ʃʷʰrá]	‘to make empty’	14
Absolutive-oblique-ergative	N	N	N/A	N/A	0
	Y		[arbará]	‘to show’	7
	N	Y	[ákʷʰtʷʰara]	‘to pour on’	57
	Y		[aχart’ʷará]	‘to seat at’	10
Total					445

Morphological verb categories found in the corpus

2.2.2.2 Methodological recommendations

I close this section with some methodological recommendations for others who wish to work with similar data from other languages. Whichever methodology is used, it is crucial to document the workflow. This section has documented my methodology in writing, but I also have the scripts I ran to produce the corpora in the first place.

One of the most important choices is finding an appropriate source. At the start of this section, I mentioned the reasons for choosing Yanagisawa’s (2010) dictionary over the many other dictionaries available. The specific requirements for each project are different, but for computer analysis, it will always be easier to work directly with digital materials (rather than pages scanned from a printed book, for example) with consistent formatting. Linguistic materials prepared using database software will often have a high degree of internal consistency in formatting, but compiling a dictionary is an enormous undertaking, and some inconsistencies are sure to appear.

As for the code itself, I have attempted to follow the usual best practice recommendations for programming languages. This includes ensuring proper version control as scripts are edited and refined, and including comments in the code to make it clear which script does what. In creating the corpora described above I have used multiple scripts to accomplish subparts of the necessary processing, and I have given these scripts a number according to the order in which they should be run. Even with descriptive filenames, it may not be clear whether to run “Extract wordforms.py” before or after “Sort headwords.py”, and such information is easy to forget over the course of months or years of working on a project.

I have avoided editing the files created by Python scripts manually to correct any errors. For each corpus I have had to rerun the scripts many times, even when I was certain that everything was in its final version. In such cases, it is not feasible to remember details such as having to insert a hyphen in the item on line 343 after the third script. It is preferable to include a line of code whose sole purpose it is to fix the hyphen on line 343. This goes counter to usual programming recommendations against item-specific code, but I have found this solution preferable to the two alternatives of discarding such forms or correcting them by hand each time.

2.2.3 Using corpora to evaluate theories empirically

There are several problems which face linguists who wish to understand stress assignment in Abkhaz, especially in the highly complex verbs. It is difficult to pick out a small set of representative forms to get an overview of the system. Each verb has hundreds or thousands of possible inflected forms, and verbs can be divided into a wide array of categories based on the presence or absence of certain person prefixes, of a preverb, or of a causative marker. These problems are compounded by phonological factors such as stem length, and the fact that different stems may belong to different accentual categories.

In this dissertation, I instead begin with a hypothesis about Abkhaz stress assignment, and evaluate it empirically against the data in the corpus using Python scripts. The evaluation procedure is explained in greater depth below, but it involves starting with underlying representations of the words in the corpora and using the hypothesized stress assignment algorithm to derive surface forms. The predicted locations of stress can then be checked against the actual locations of stress recorded for each word in the corpus.

This initial hypothesis may be incorrect; in fact, it is expected to be incomplete at the very least. However, by evaluating even an imperfect hypothesis, we can identify where its empirical problems lie, looking for patterns in where the theory makes incorrect predictions. Equipped with this knowledge, we can then modify the initial hypothesis to attempt to remedy its flaws. This work requires human linguistic insight, and cannot be automated. By evaluating the new theory against the corpus again, we receive quantitative feedback on how much we have improved. In this way we not only use corpora to evaluate hypotheses from previous work, but there is also a mechanism for how to iteratively improve on those hypotheses and come up with new theories with increased empirical coverage.

The initial hypothesis for Abkhaz stress assignment is Dybo's Rule, originally formulated as in (24) a. and rephrased slightly with no empirical consequences in (24) b. Dybo (1977) uses the terms 'dominant' and 'recessive' for 'accented' and 'unaccented' respectively. These terms have become influential in subsequent work (Spruit 1986, Yanagisawa 2013, Vaux & Samuels 2018), but I use the 'accented' terminology throughout the dissertation. Dybo (1977) also refers to dominant morphemes as having a higher 'valence' than recessive morphemes.

(24) Dybo's Rule (Dybo 1977: 43)

a. "[S]tress always falls at the end of the first sequence of morphemes of the highest valence"[6]

b. Stress falls on the leftmost accent not immediately followed by an accent

I discuss Dybo's Rule more in Chapter 5, where I derive it from the bottom up using small datasets of Abkhaz stress alternations, arguing that it is a necessary component of a theory of Abkhaz stress.

In order to use this rule of stress assignment to assign stress to the forms in the nominal and verbal corpora by means of a Python script, the computer needs to have access to the underlying accentual status of all morphemes in the corpus. I begin by discussing functional morphemes, covering stems and preverbs further on in the text. Here I rely on Spruit (1986), who gives an analysis of the accents of many functional morphemes in Abkhaz based on the stress behavior of these morphemes in his fieldwork data. I stress that these assumptions are not necessarily correct. It is necessary to start with a theory, which may be more or less promising. Once it is evaluated empirically

6 Original Russian: "[у]дарение всегда ставится в конце первой последовательности морфем высшей валентности", my translation.

against the corpus data, it will be possible to make improvements based on where the original assumptions proved inadequate. In Chapter 6, Section 6.3 I will propose several amendments to these assumptions.

(25) Accent status of functional morphemes (Spruit 1986: ch. 2)

Accented	*Unaccented*
All oblique person markers: /s-/ 1SO, /w-/ 2SMO, /b-/ 2SFO, /j-/ 3SMO, /l-/ 3SFO, /a-/ 3SNO, /ħ-/ 1PO, /ʃʷ-/ 2PO, /j-/ 3PO	All absolutive person markers: /s-/ 1SA, /w-/ 2SMA, /b-/ 2SFA, /d-/ 3SHA, /j-/ 3NA, /ħ-/ 1PA, /ʃʷ-/ 2PA, /r-/ 3PA
One ergative person marker: /(n)a-/ 3SNE[7]	Most ergative person markers: /s-/ 1SE, /w-/ 2SME, /b-/ 2SFE, /j-/ 3SME, /l-/ 3SFE, /ħ-/ 1PE, /ʃʷ-/ 2PE, /r-/ 3PE
The dynamic suffix: /-wa/	The negative prefix/suffix: /m/
The past absolute suffix: /-n/	The dynamic finite suffix: /-jt'/
The definite prefix: /a-/	The negative imperative suffix: /-n/[8]
The infinitive suffix: /-ra/	The negative past absolute suffix: /-k'ʷa/
	The indefinite suffix: /-k'/

Spruit's (1986) analysis also involves a number of affixes which have segmentally identical but accentually different allomorphs in certain environments. Implementing the exact proposal in Spruit (1986) was not possible for a number of reasons. In some cases, the proposals are too narrow, discussing the effects that individual verb stems have on other morphemes (Spruit 1986: 72). In other cases, Spruit (1986) notices and exemplifies

7 Recall from Section 2.2.2.1 that this morpheme does not occur in the corpora.
8 As far as I know, Spruit (1986) does not discuss the accent status of this morpheme, but since it never bears stress in any surface form, I have treated it as unaccented here.

an exception to Dybo’s Rule, but does not identify the context precisely enough to allow a computer to interpret it unambiguously. In Chapter 6, Section 6.3 I return to the question of which of the above assumptions need to be modified to better account for Abkhaz verb stress, including some of the patterns of allomorphy proposed by Spruit (1986).

There is, understandably, no source which attempts to list the accent status of all stems and preverbs in Abkhaz. But in order for a computer to evaluate Dybo’s Rule against the corpus, it needs to have precisely this information. Here the script evaluates all possible options by trial and error, and uses whichever set of accent specifications works best empirically on the inflected forms of each stem. In other words, the script answers the question: Is there any possible underlying accent specification for this stem, such that Dybo’s Rule yields the pattern of stress alternation observed in the corpus? In the verb [a-t^h-q’^{j}a-rá] аҭҟьара ‘to jump out’ (Yanagisawa 2010: 414), there is a preverb /t^h/ which can be accented or unaccented, and a stem /q’^{j}a/ which can be accented or unaccented. This gives 2 x 2 = 4 total options for the accent specifications of this verb. The script evaluates all four possibilities against the seven forms of this verb in the corpus, and uses the accent specifications that lead to the highest number of forms being correctly predicted. Note that the causative prefix /r-/, absent in (25), is segmented as part of the stem in the dictionary (see Section 2.2.2), and the current implementation of the Python program treats it as such, potentially allowing its accent specification to vary across different stems. In Chapter 6, Section 6.3 I return to the stress behavior of the causative prefix, and modify this assumption.

The automated evaluation of Dybo’s Rule evaluates each row in the corpora separately. This means that the stem /sas/ ‘guest’ could have different accent specifications as a nominal stem ‘guest’ and as a verbal stem ‘be a guest, go as a guest’. Similarly, preverbs and stems which appear in multiple verbs are re-evaluated separately for each new preverb-stem combination. Empirically this is not of great significance. Both nominal and verbal stems for ‘guest’ behave the same, which is unsurprising since they involve the same unaccented stem /sas/. Technically it is a waste of time for the computer to discover this fact twice, but the scripts still run in a matter of seconds.

In order to avoid this behavior, it would be necessary to gloss each noun and verb in the corpora by the preverb and stem morphemes they contain. This includes disambiguating many homographs and homophones, such as /d͡z/ ‘flea’, /d͡z/ ‘water’, and /d͡z/ ‘disappear’. In many cases where a preverb combines with a stem, it is also difficult to know which morphemes are involved. The verb [á-k^{wh}-k’-ra] ‘to aim at’ is a non-compositional combination of the preverb /k^{wh}/ ‘on’ and a verb stem /k’/, but it is unclear which of the six homophonous verb stems /k’/ is being used. Is it ‘catch’, ‘hold’, ‘fit into’, ‘feel’, ‘shut’, or ‘pester’ (Yanagisawa 2010: 208-209)? I have not attempted such identifications, meaning that the verb stem in ‘to aim at’ may have a different accent status than all six of the independently occurring verb stems /k’/.

In Chapters 6 and 8, where I use these scripts several times to evaluate different theories of Abkhaz stress assignment, I make particular assumptions about the size of the stress-bearing unit in Abkhaz. The description above is written as if each morpheme does or does not carry an accent, following Dybo (1977). However, the scripts can be used to divide longer morphemes into syllables or even smaller units, allowing each of these to carry a separate accent. I return to this question in Chapter 6, and in Chapters 7 and 8 I discuss several possibilities for the size of stress-bearing units in Abkhaz in depth, arguing for a segmental analysis in Chapter 7.

Running the scripts produces numbers indicating what proportion of the forms in the corpora successfully had their stress placement predicted. Interpreting such numbers is not straightforward. Intuitively higher numbers are better. However, we would like our linguistic theories to neither overgenerate nor undergenerate, and the scripts only report undergeneration. There is no attempt to automatically test whether all predicted accent combinations in some theory do in fact correspond to some nominal or verbal stem in Abkhaz. This means that a theory which predicts that any two morphologically related forms can have any imaginable stress pattern with no restrictions will account for 100% of the forms in the corpora. The automatic evaluation of a theory against the corpora must therefore be accompanied by theoretically informed discussion, particularly where overgeneration is concerned. I return to these topics in Chapters 6 and 8 where the scripts are used.

The analysis described above uses Python programming to implement Dybo's Rule computationally, allowing a computer to evaluate the empirical merits of this stress assignment algorithm against all 3,115 forms in the verb corpus and all 1,090 forms in the nominal corpus. However, the examination of patterns and generalizations in the data, and the proposed amendments to analyses of Abkhaz, are left to linguists. In this way, the methodology I employ takes advantage both of what computers can do best – extremely quick implementation of algorithms – and of what human linguists can do best – identifying patterns in phonological data, and suggesting new theories to account for these. This approach has the additional advantage of forcing us to commit to an explicit version of a theory – precise enough to be implemented by a computer – which is something that is often hard to achieve with natural language descriptions in linguistic papers alone.

I offer some discussion about the advantages and disadvantages of the this methodology. A recurring theme in this type of digital phonological work is the division of labor between computer software on the one hand, and human linguists on the other. There are several advantages to computer-assisted phonological analysis. Testing whether Dybo's Rule accounts for 4,205 Abkhaz wordforms would take a human weeks or months, but because the individual steps of the algorithm are so simple, it takes a modern computer less than a second to accomplish the same task. Unlike humans, computers also do not make errors due to fatigue or distractions, ensuring that the analysis is fully reproducible. By implementing a theory on a computer, the linguist is also forced to state it precisely and unambiguously, something that may be difficult to accomplish in natural language.

Of course there are also many disadvantages. In order to be parsed by a computer, all data must conform strictly to some very precise format. Any forms that do not meet the specifications must either be tediously hand-corrected, a process which may take longer than analyzing the forms by hand, or else discarded, risking biases in the form of artificially regular datasets. In the interests of transparency, I have described the exclusions in detail in Section 2.2.2.1 above.

Computers also make errors, but of a different kind than those human linguists tend to make. A linguist who analyzes Abkhaz forms by hand can notice morphemes appearing in unexpected positions, words which appear to be loanwords, or typos. By contrast, unless it is told in advance about every possible exception and edge case, a computer will not care if it is fed Abkhaz verb forms or song lyrics or randomly generated strings. A computer program will only notice what it is told to notice, meaning that all work to ensure the quality of the input data is still the responsibility of a human linguist.

Despite the disadvantages, I hope the discussion above has also highlighted the positive aspects of conducting phonological analyses digitally. By using implementations of phonological theories none of the theoretical rigor of smaller-scale manual analyses needs to be lost, and the burden of the intellectually challenging work involved in phonological analysis still falls on the shoulders of the linguist. The computer analysis speeds up the repetitive steps of applying the same phonological grammar again and again to thousands of forms, and the analysis is fully reproducible. This allows linguists to study much larger datasets, thereby placing theories on a firmer empirical footing.

2.3 Conclusions

In this chapter I have surveyed some of the important methodological details which form the basis of the empirical and theoretical work in subsequent chapters. I have given a detailed overview of the methods involved in three acoustic experiments with four speakers each, and will give the full lists of stimuli for each experiment in Chapters 3 and 4 where the results and analyses from the experiments are presented.

I have discussed the data present in two database corpora I have created from a dictionary of Abkhaz, one for nominal stress alternations in 545 stems, and one for verbal stress alternations in 445 stems. The patterns of stress assignment found in the corpora will be discussed empirically in Chapter 6, and analyzed theoretically in Chapters 7 and 8. In both Chapters 6 and 8 I will evaluate several theories of Abkhaz stress assignment against the corpus data in a semi-automated fashion, using the Python-based methodology I have described in this chapter.

I have attempted to highlight methodological choices which may be of use to linguists who wish to use similar collections of digital data to study the phonologies of other languages. This includes a discussion at the end of the chapter of the advantages and disadvantages of automating parts of phonological analysis. I hope to have shown that semi-automated computer-assisted research is viable even in theoretical phonology, and that it allows theories to be put to the test empirically on a scale not possible without digital methodologies.

The choice of using several different quantitative and theoretical methodologies in this dissertation is motivated by the desideratum that theories should be built on a solid empirical foundation. Especially in the domain of stress and prosody, it has been common in previous theoretical work to rely on small datasets of forms transcribed by non-native speakers. This makes it difficult to know whether the placement of stress is reported accurately, and whether any patterns reported generalize to the rest of the lexicon. If both the data and their representativeness are in question, it will be difficult to make any theoretical progress in understanding stress.

Although speakers of different native languages agree where primary stress in Abkhaz falls, the acoustic experiments discussed in this chapter document the phonetic dimensions which differentiate stressed and unstressed vowels, and are also designed to provide experimental data on the more elusive secondary stresses. The dictionary corpus data ensure that the generalizations reported in this dissertation are representative of the nominal and verbal lexicon of Abkhaz. Hypotheses can easily be tested against thousands of forms, without reliance on a handful of carefully selected example words. This is especially useful for a language with the morphological and phonological complexity of Abkhaz, where especially the verbs can be subdivided into a large number of categories which cannot easily be studied without large digital corpora.

With the methodological background of this chapter, we are ready to turn to an in-depth discussion of the properties of stress in Abkhaz in Chapter 3. Parts of this chapter will introduce new phonological data, while other parts build directly on this chapter, and will discuss the results and analysis of some of the acoustic experiments on Abkhaz stress that I have conducted.

Chapter 3: Properties of Stress in Abkhaz

In this chapter I provide an overview of some basic properties of Abkhaz primary stress in relation to typologically common properties of stress systems. It serves as a data-driven overview of the basics of stress in Abkhaz for Caucasianists and, especially, for readers without prior familiarity with the language or language family. I begin with a survey of crosslinguistically common properties of stress, and illustrate with data which of these do and do not apply to Abkhaz. This is followed by an illustration of other properties of the Abkhaz stress system which are important to know about even though they are not crosslinguistically common. The conclusions can be summarized as follows: Abkhaz stress is obligatory, culminative, and contrastive. Unlike in many languages, stress assignment is not subject to window restrictions, nor is it sensitive to vowel length or the presence or absence of coda consonants. In Chapter 9, I will return to the question of how the theoretical analysis of Abkhaz stress in Chapter 7 fits into existing typologies of stress.

Aside from these phonological characteristics of Abkhaz stress, I also provide the first acoustic description of the word-level prosody in Abkhaz, based on a small study with four participants. I find that F0, intensity, and duration all play a role in differentiating stressed and unstressed vowels in Abkhaz, although speakers differ in which dimensions they use, and how large the differences between stressed and unstressed vowels are. Duration shows the least variation, followed closely by intensity. For all participants in the experiment, stressed vowels are longer and louder than their unstressed counterparts. However, there is much more variation in the use of F0. It appears that some do not use F0, while others mark stressed vowels with low F0, and still others mark stressed vowels with high F0.

I also report on an experiment investigating the role of consonants in the Abkhaz stress system. In terms of the phonology, morphemes consisting only of consonants are known to participate in stress alternations in Abkhaz. The phonological participation of consonants in the stress system will become important in Chapters 7 and 8. Previous work implicitly assumes a neutralization of /b́a/ (accented consonant, unaccented vowel) and /bá/ (unaccented consonant, accented vowel) to [bá]. I do not find any evidence to reject this assumption, and the analysis in Chapter 7 neutralizes these sequences in the phonology. However, the statistical analysis is likely to be underpowered, so these results should be interpreted with caution.

3.1 Phonological properties of Abkhaz stress

The table below summarizes some important properties of Abkhaz stress in the form of yes-no questions. The properties chosen are common in many other languages around the world, and are frequently addressed in literature on stress (see for example Kager 2007). The remainder of this section will then illustrate the presence or absence of each property with Abkhaz data.

(1) Figure 3.1

Is Abkhaz primary stress ...	Yes	No
... obligatory on content words?	X	
... culminative, appearing at most once per word?	X	
... contrastive, forming perfect minimal pairs?	X	
... subject to window restrictions, never occurring further than a fixed distance away from one of the word edges?		X
... fixed in morphologically related forms of the same word?		X
... limited to falling on a long vowel if there is one?		X
... limited to falling on a syllable with a coda consonant if there is one?		X
... limited to falling on a unit of a minimum size?		X

Abkhaz stress in a typological perspective

In Chapter 7 I propose a theoretical analysis of Abkhaz stress where individual segments carry lexical accents, and suggest that whether syllables, moras, or segments serve as accent-bearing units is a parametric choice with different languages having different settings. Questions of stress typology will therefore continue to be relevant throughout the dissertation, and I discuss some of the typological aspects in more detail in Chapter 9.

3.1.1 Obligatoriness

When uttered on their own, as in citation forms for example, Abkhaz words obligatorily have primary stress on one vowel. This is illustrated for nouns, adjectives, verbs, and adverbs in (2).

(2) Obligatory stress on content words

a. Noun
ала
[a-lá]
DEF-dog
'dog'
Yanagisawa (2010: 259)

b. Adjective
ацәгьа
[á-t͡ʃʷʰɡʲa]
DEF-bad
'bad'
Yanagisawa (2010: 505)

c. Stative verb (denoting state)
исымоуп
[ji-sə́-mo-wp']
3NA-1SO-have-STAT.PRES
'I have it/them'
Yanagisawa (2010: 238)

d. Dynamic verb (denoting event)
сапхьоит
[s-á-pʰχʲo-jt']
1SA-3SNO-read.DYN-DYN.FIN
'I read it'
Yanagisawa (2010: 342)

e. Adverb
ирласны
[jí-r-las-nə]
3NA-CAUS-quick-PST.ABS
'quickly'
Yanagisawa (2010: 190)

The same is true of function words, again when uttered in isolation, as shown for conjunctions, demonstrative pronouns, interrogative pronouns, and postpositions in (3). In the context of a sentence, function words are of course more likely than content words to lack phrasal prominence.

(3) Obligatory stress on function words

a. Conjunction
аха
[aχá]
but
‘but’
Yanagisawa (2010: 436)

b. Demonstrative pronoun
урҭ
[wúrt^{h}]
those
‘those’
Yanagisawa (2010: 430)

c. Interrogative pronoun
Ишԥа?
[ji-ʂ-p^{h}á]
A.REL-how-Q
‘How?’
Yanagisawa (2010: 200)

d. Postposition
ашьҭахь
[á-ʃt^{h}aχ^{j}]
3SNO-behind
‘behind it, after it’
Yanagisawa (2010: 566)

Individual content morphemes may lack stress in particular morphosyntactic contexts. This can include noun phrases with a modifying adjective, compounds, noun phrases with a postposition, and verbs with an incorporated noun, as shown in (4).

(4) Content words without stress

a. Adjective-noun phrase
аҩнҿыц
[a-ɥn-t͡ʂ’ə́t͡s^{h}]
DEF-house-new
‘new house’
Yanagisawa (2010: 582)

b. Compound
аҩ(ы)н усқәа
[a-ɥ(ə)n-wús-kʷʰa]
DEF-house-work-N.PL
'household chores'
Yanagisawa (2010: 582)

c. Postpositional phrase
аҩнаҿы
[a-ɥn-a-t͡ʂ'ə́]
DEF-house-3SNO-in
'in the house'
Yanagisawa (2010: 582)

d. Non-finite[9] verb with incorporated noun
аԥсызкра
[a-pʰsə́d͡z-k'-ra]
DEF-fish-catch-INF
'to fish'
Yanagisawa (2013: 308)

e. Finite verb with incorporated noun
дыԥсызкит
[də-pʰsə́d͡z-k'-ijt']
3SHA-fish-catch-DYN.FIN
'(s)he fished'
Yanagisawa (2013: 309)

3.1.2 Culminativity

Primary stress is also culminative in Abkhaz, meaning that it appears at most once per word. This is easiest to illustrate with incorporation and compounding. Such constructions always have only one primary stress, and do not retain the multiple stresses of their multiple constituent morphemes. Examples are shown in (5) a.-b. below. Arstaa et al. (2014: 102) report that reduplicated forms may have multiple stresses, although others typically transcribe such forms with only one primary stress. (5) c. i. comes from Arstaa et al. (2014), while (5) c. ii. and iii. with only one primary stress come from Kaslandzija

9 Here and immediately below I use 'non-finite' in its crosslinguistically familiar meaning, avoiding the usual terminology in work on Abkhaz where this word refers to relative clauses (Chirikba 2003: 41).

(2005: 754) and Yanagisawa (2010: 461). Unique to Arstaa et al. (2014) are also non-reduplicated forms with multiple stresses. These appear to be irregularly distributed across morphological paradigms, and are not reported by other linguists working on Abkhaz. Some examples are shown in (5) d.-e., with data from Arstaa et al. (2014: 97). However, some of these words are predicted to have secondary stresses (see Chapter 4, Section 4.3 for data and discussion concerning the distribution of secondary stress). Even if (5) d.-e. are rendering secondary stress, I have no explanation for the irregular distribution of these stresses across morphological paradigms.

(5) Culminativity of stress

a.

i.	[a-wús] DEF-work Yanagisawa (2010: 431)	аус	‘work (noun)’
ii.	[a-w-rá] DEF-make-INF Yanagisawa (2010: 429)	аура	‘make, do’
iii.	[a-wúsu-w-ra] *[a-wúsu-w-rá] DEF-work-make-INF Yanagisawa (2010: 431)	аусура	‘to work’

b.

i.	[a-t’ʷə́la] DEF-country Yanagisawa (2010: 397)	атəыла	‘country’
ii.	[a-waɥə́] DEF-person Yanagisawa (2010: 426)	ауаҩы	‘person’

iii. [a-t’ʷə́la-waʮ] атәылауаҩ ‘citizen’
DEF-country-person
Kaslandzija (2005: 647)

c.

i. [á-χər-χə́r-ħʷa] ахырхырҳәа ‘sound of snoring’
DEF-snore-snore-QUOT
Arstaa et al. (2014: 102)

ii. [á-χər-χər-ra] ахырхырра ‘snore (noun)’
DEF-snore-snore-NMLZ
Kaslandzija (2005: 754)

iii. [á-χər-χər-bʒə] ахырхырбжьы ‘sound of snoring’
DEF-snore-snore-voice
Yanagisawa (2010: 461)

d. Arstaa et al. (2014: 97)

i. [á-t͡ʃ’k’ʷən] аҷкәын ‘boy’
DEF-boy

ii. [ħá-t͡ʃ’k’ʷə́n] ҳаҷкәын ‘our boy’
1P.POSS-boy

iii. [á-t͡ʃ’k’ʷən-t͡ʃʷʰa] аҷкәынцәа ‘boys’
DEF-boy-H.PL

e. Arstaa et al. (2014: 97)

i. [á-tʰawad] аҭауад ‘prince’
DEF-prince

ii. [ħá-tʰawad] ҳаҭауад ‘our prince’
1P.POSS-prince

iii. [á-tʰawád-t͡ʃʷʰa] аҭауадцәа ‘princes’
DEF-prince-H.PL

3.1.3 Contrastiveness

Abkhaz has contrastive stress, meaning that there are segmentally identical words which are distinguished only by contrasts in where primary stress falls. Stress can serve to distinguish nouns (6) a. and verbs (6) b. from each other. It can also distinguish different functional morphemes attached to the same stem (6) c.-e. There are also perfect minimal pairs for stress where the words have different stems and also belong to different parts of speech (6) e.-f. Within a stem with a sequence /aa/, stress can fall on either /a/ (6) g., although some speakers apparently lack such contrasts (Yanagisawa 2010: 14; see Chapter 2, Section 2.2.2.1 for discussion).

(6) Contrastive stress

a.			
i.	[á-la] DEF-eye Yanagisawa (2010: 258-259)	ала	‘eye’
ii.	[a-lá] DEF-dog Yanagisawa (2010: 259)	ала	‘dog’
b.	Yanagisawa (2010: 583)		
i.	[á-ɥ-ra] DEF-run-INF	аҩра	‘to run’
ii.	[a-ɥ-rá] DEF-write-INF	аҩра	‘to write’
c.	Yanagisawa (2010: 53-54)		
i.	[jí-z-bo] A.REL-1SE-see.DYN	избо	‘what I see’
ii.	[ji-z-bó] 3NA-E.REL-see.DYN	избо	‘who sees it (relative clause)’
d.	Gulia (1939: 99)		
i.	[jí-z-bəl-wa-da] A.REL-1SE-burn-DYN-who	Избылуада?	‘Who do I burn?’

ii.	[ji-z-bəl-wá-da] 3NA-E.REL-burn-DYN-who	Избылуада?	‘Who burns it?’
e.	Yanagisawa (2010: 454)		
i.	[a-χ-ʂá-ra] DEF-PREV(on)-create-NMLZ	ахшара	‘child, generation’
ii.	[a-χ-ʂa-rá] DEF-PREV(on)-create-INF	ахшара	‘to give birth’
e.	Gulia (1939: 102)		
i.	[ħá-ɥ-nə] 1PA-run-PST.ABS	ҳаҩны	‘us having run’
ii.	[ħa-ɥnə́] 1P.POSS-house	ҳаҩны	‘our house’
f.	Yanagisawa (2010: 331)		
i.	[á-p^{h}a-ra] DEF-jump-INF	аԥара	‘to jump’
ii.	[a-p^{h}ára] DEF-money	аԥара	‘money’
g.	Kaslandzija (2005: 144)		
i.	[a-báa] DEF-fortress	абаа	‘fortress’
ii.	[a-baá] DEF-rotten	абаа	‘rotten’

3.1.4 Window restrictions

In some languages stress is subject to so-called window restrictions (Kager 2012). For example, stress may be constrained so that it always falls on one of the three final syllables in the word. This is the case in Spanish, where monomorphemic words can have stress on the final, penultimate, or antepenultimate syllable, but never on the preantepenultimate syllable or earlier.

(7) Window restrictions in Spanish (Roca 2007: 240-242)

a.	[menú]	menú	'menu'
b.	[kaníβal]	caníbal	'cannibal'
c.	[ínteɾin]	ínterin	'interim'
d.	*[ánalisis]		

Abkhaz has no such fixed window within which stress must appear. Monosyllabic words have stress on the only vowel (8) a. Disyllabic words may have stress on either of the two vowels (8) b., trisyllabic words on either of the three vowels (8) c., tetrasyllabic words on either of the four vowels (8) d., and so on. In (8) e. we see a seven-syllable word with stress on the fourth syllable, i.e. more than three syllables away from both word edges at the same time.

(8) Absence of window restrictions

a.

i.	[án] DEF.mother Yanagisawa (2010: 302)	ан	'mother'

b. Yanagisawa (2010: 258-259)

i.	[á-la] DEF-eye	ала	'eye'
ii.	[a-lá] DEF-dog	ала	'dog'

c. Yanagisawa (2010: 331)

i. [á-p^{h}a-ra] аԥара ‘to jump’
DEF-jump-INF

ii. [a-p^{h}ára] аԥара ‘money’
DEF-money

iii. [a-p^{h}a-rá] аԥара ‘to knit’
DEF-knit-INF

d.

i. [á-zamana] азамана ‘excellent’
DEF-excellent
Yanagisawa (2010: 131)

ii. [a-t͡ʃ^{wh}á-mat^{wh}a] ацәамаҭәа ‘underwear’
DEF-skin-clothes
Yanagisawa (2010: 503)

iii. [a-t͡s^{h}aláq’^{j}a] ацалаҟьа ‘floorboard’
DEF-floorboard
Yanagisawa (2010: 494)

iv. [a-t^{h}amadá] аҭамада ‘toastmaster’
DEF-toastmaster
Kaslandzija (2005: 655)

e.

i. [a-χəlɥap^{h}sə́lɥa-χa-ra] ахылҩаԥсылҩахара ‘to evaporate’
DEF-steam-become-INF
Yanagisawa (2010: 459)

3.1.5 Mobility of stress within morphological paradigms

Even though Abkhaz stress is contrastive, so that word stress can differentiate between different stems, this does not mean that stress is fixed. In (9) a. we see that the word ‘dog’ can show stress on the stem, or on suffixes. In (9) b. I show that the stem ‘eat’ can have stress on prefixes, on the stem, or on suffixes, depending on which form one looks at. In fact, rather than having fixed stress, Abkhaz is characterized by an unusual mobility in stress placement across affixed forms of the same stem. In some languages with similar stress alternations to Abkhaz, there is nevertheless a large portion of the lexicon where stress is fixed. For example, Russian also has words with alternating stress, but Halle (1997: 281) reports, citing Zaliznjak (1967), that 91.6% of Russian nouns (30,100 of 32,865) show fixed stress on a stem syllable. In Russian alternations are limited to a relatively small set of frequent words, but in Abkhaz stress alternations are ubiquitous. Some work on the language does include a category of words with fixed stress (Dybo 1977, Arstaa et al. 2014: 95-102), but even these show alternations when placed in the appropriate morphological environment. In fact, I am not aware of any morpheme in the language with truly fixed stress. An example of apparent fixed stress is in (9) c., where forms of 'stand' almost always shows primary stress on the stem. However, (9) c. vi. reveals that there are forms where primary stress falls elsewhere.

(9) Absence of truly fixed stress

a. Dybo (1977: 42)

i. ала
[a-lá]
DEF-dog
'dog'

ii. алақәа
[a-la-kʷʰá]
DEF-dog-N.PL
'dogs'

iii. алақәагьы
[a-la-kʷʰa-gʲə́]
DEF-dog-N.PL-also
'dogs also'

b. Yanagisawa (2010: 433)

i. афара
[á-fa-ra]
DEF-eat-INF
'eat'

ii. Ифа!
[jí-fa]
3NA-eat
'Eat it! (singular addressee)'

iii. Ишəфа!
[ji-ʃʷ-fá]
3NA-2PE-eat
'Eat it! (plural addressee)'

iv. бысфахьеит
[bə-s-fa-χʲé-jt']
2SFA-1SE-eat-PRF-DYN.FIN
'I have already eaten you (feminine singular)'

v. бафахьеит
[b-á-fa-χʲe-jt']
2SFA-3SNE-eat-PRF-DYN.FIN
'it has already eaten you (feminine singular)'

c.

i. сымгылеит
[sə-m-gə́le-jt']
1SA-NEG-stand-DYN.FIN
'I didn't stand up'
Yanagisawa (2010: 74)

ii. дгыланы
[d-gə́la-nə]
3SHA-stand-PST.ABS
'him/her having stood up'
Yanagisawa (2010: 75)

iii. сгылахьан
[s-gə́la-χʲa-n]
1SA-stand-PRF-PST
'I had already stood up'
Yanagisawa (2010: 74)

iv. Бангыл!
[b-a-n-gə́l]
2SFA-3SNO-PREV(on)-stand
'Stand on it! (feminine addressee)'
Yanagisawa (2010: 313)

v. иахагыло
[j-a-χa-gə́lo]
A.REL-3SNO-PREV(over)-stand.DYN
'who is standing over it (relative clause)'
Yanagisawa (2010: 437)

vi. самхагылеит
[s-ámχa-gəle-jt']
1SA-NONVOLITIONAL-stand-DYN.FIN
'I stood up against my will'
Yanagisawa (2010: 75)

3.1.6 Weight sensitivity

A common restriction on the stress systems of the world is some form of weight sensitivity, where syllables pattern differently based on the presence of long vowels and/or coda consonants (Gordon 2006). Weight sensitivity is possible even in languages like Abkhaz with contrastive stress. For example, stress in Spanish is contrastive, but there is weight sensitivity in that heavy penultimates preclude antepenultimate stress (Fuchs 2018). In actual Abkhaz, however, we find no such weight restrictions. Long vowels can be stressed or unstressed in both initial (10) a. and final (10) b. position. The same is true of syllables closed by consonants (10) c.-d. Syllables which contain both a long vowel and a coda consonant can similarly be either stressed or unstressed in initial and final position (10) e.-f. Syllabifications follow the criteria in Hewitt (1979: 262-263).

(10) Absence of weight sensitivity

a.	Yanagisawa (2010: 44)		
i.	[áa-ra] DEF.guilt-NMLZ	аара	‘guilt’
ii.	[aa-rá] DEF.come-INF	аара	‘to come’
b.			
i.	[á-maa] DEF-handle Yanagisawa (2010: 282)	амаа	‘handle’
ii.	[a-t͡s’áa] DEF-ice Yanagisawa (2010: 515)	атцаа	‘ice’
c.			
i.	[á-rma] DEF-left Yanagisawa (2010: 369)	арма	‘left (opposite of right)’
ii.	[a-nt͡ʃʷʰá] DEF-God Yanagisawa (2010: 318)	анцәа	‘God’
d.			
i.	[á-sas] DEF-guest Yanagisawa (2010: 389)	асас	‘guest’
ii.	[a-k’ʲát’] DEF-rod Yanagisawa (2010: 217)	акьат	‘rod’
e.			
i.	[a-jáaj-ra] DEF-defeat-INF Yanagisawa (2010: 161)	аиааира	‘to defeat’

ii. [aajgʷá] ааигәа ‘near, nearby’
near
Yanagisawa (2010: 38)

f.

i. [á-t͡ʃʷʰaak’] ацәаак ‘humid’
DEF-humid
Yanagisawa (2010: 501)

ii. [a-sáan] асаан ‘plate’
DEF-plate
Yanagisawa (2010: 387)

3.1.7 Minimality

Another common restriction on stress systems is some form of requirement on the minimum size of the word which carries the stress (see Gordon & Applebaum 2010 on Kabardian, another Northwest Caucasian language). Again Abkhaz appears to lack such restrictions. Content words, though typically polymorphemic due to prefixes and suffixes, can be as small as light syllables (11) a.-c. The form of the minimal utterance can also be monosyllabic, and may again be as small as a light syllable (11) d. It is somewhat difficult to say whether content words are ever truly monomorphemic. In some morphological contexts, unaffixed content words do appear. However, these could also be interpreted as some form of compound, given the existence of compounds with only one primary stress (see the discussion of culminativity above) and of noun incorporation. Some forms are shown in (11) e. with alternative analyses: one with a free-standing monomorphemic content word, and one with a compound-like structure. These forms come from Meurer (2018), an orthographic corpus of Abkhaz without stress marked. The stresses in (11) e. have been supplied by me based on Yanagisawa (2010).

(11) Absence of minimality restrictions

a. Yanagisawa (2010: 331)

i.	[a-pʰá] DEF-son	аҧа	‘son’
ii.	[s-pʰá] 1S.POSS-son	сҧа	‘my son’

b. Yanagisawa (2010: 549)

i.	[a-t͡ʂ’ə́] DEF-mouth	аҿы	‘mouth’
ii.	[s-t͡ʂ’ə́] 1S.POSS-mouth	сҿы	‘my mouth’

c.

i.	[bə́-pʰ] 2SFA-jump Yanagisawa (2010: 331)	Быҧ!	‘Jump!’
ii.	[b-ɥə́] 2SFA-write Yanagisawa (2010: 584)	Бҩы!	‘Write!’

d.

i.	[áaj] yes Yanagisawa (2010: 38)	ааи	‘yes’
ii.	[máp’] no Yanagisawa (2010: 286)	мап	‘no’
iii.	[wá] there Yanagisawa (2010: 422)	уа	‘there’

e. Meurer (2018), searched on 2021-10-05

i.	[á-mza t^wh^ə́] [á-mza-t^wh^ə] DEF-moon-full	амза ҭәы амзаҭәы	‘full moon’
ii.	[a-t͡s’ə́χʷa k’ə́] [a-t͡s’ə́χʷa-k’ə] DEF-tail-catch	Аҵыхәа кы!	‘Grab the tail!’

3.1.8 Conclusions

In summary, Abkhaz stress is obligatory, culminative, and contrastive. It is not subject to window restrictions, and does not obligatorily fall on heavy syllables if they are present in the word. It is not obvious that there are minimality restrictions, and even light syllables can serve as complete utterances in the right context. However, some of the data on nominals and verbs could be analyzed in multiple ways, such that it is not clear that there are free-standing monomorphemic content words in the language. Finally, and importantly for the rest of this dissertation, stress is not fixed on morphologically related forms of the same stem. Stress alternations are pervasive, and I am not aware of any stem in Abkhaz with truly fixed stress. In the remainder of this chapter I move from the phonological characterization of primary stress in Abkhaz to the phonetics, discussing the acoustics of primary stress in Section 3.2, and potential stress-bearing consonants in Section 3.3. The data presented in subsequent chapters, especially Chapters 4 and 6, lead to an analysis of Abkhaz stress where individual segments (rather than moras or syllables) are the relevant units for understanding stress assignment in this language. The theme of stress typology will therefore continue to be relevant beyond the brief discussion in this chapter, especially in Chapter 7 which presents the segmental analysis of Abkhaz stress, and in Chapter 9 where I discuss explicitly the typology of the size of accent-bearing units in the languages of the world.

3.2 Acoustics of primary stress

In this section I discuss the acoustics of primary stress in Abkhaz, based on the methodology reported in Chapter 2, Section 2.1. I refer to that chapter for details, but by way of a brief summary, four Abkhaz speakers read words with different vowels and stress patterns nine times in a carrier phrase. Based on hand-corrected textgrids produced by forced alignment, I used Praat scripts to extract measures of pitch, intensity, and duration. I analyzed the data using nested linear mixed effects models in R. Below I will first discuss the stimuli, followed by visualization of the data and discussion of statistical results.

3.2.1 Stimuli

Since I adapted the stimuli based on speaker feedback about particular words, especially after the pilot, the participants read slightly different words. Below are all the words used in the experiment, classified by the position and identity of the stressed vowel. Where the stimuli appear especially lopsided, this was because a word was replaced by another one with a similar stress pattern. For example, no participant read four words with final stressed [a]. Instead, different participants read 1-2 words in this category, but the word(s) depended on the participant. Immediately below I give a table showing which participants read which of the words in (12). Recall from Chapter 2, Section 2.1.2.1 that no words begin with [ə], explaining why the initial stressed [ə] cell is empty.

(12) Figure 3.2

	Initial		Medial		Final	
Stressed [a]	[ála]	‘eye’	[asáχʲa]	‘reflection’	[ap’á]	‘thin’
	[ábəlra]	‘to burn’			[alá]	‘dog’
					[at͡ʂ’ətʰrá]	‘to scream’
					[ɥaʒʷaq’á]	‘approx. 20’
					[at͡sʰəgʷkʷʰá]	‘cats’
					[(j)esd͡zənrá][10]	‘every summer’
Stressed [ə]	N/A	N/A	[agʷə́ʁra]	‘hope (n.)’	[at’ə́]	‘owl’
			[adə́rra]	‘knowledge’	[at’ʷə́]	‘possession’
			[adʷə́ʁba]	‘train’		

Stimuli for Experiment 1

In the table below I show which words were read by which participants. A check ✔ in a speaker column indicates that the word was read by this participant and included in the analysis (see Chapter 2, Section 2.1.5 for exclusions). As (13) shows there is much overlap, although a few items were replaced between different runs of the experiment.

10 Genko (1995: 88) treats the prefix [(j)es-] ‘every, each’ as coming from /jas-/, with a glide causing vowel coloring (see Chapter 1, Section 1.3.2), but the participants who read this word tended to pronounce it as [es-] without the glide. I nevertheless coded this vowel as a phonemic /a/.

(13) Figure 3.3

Word	Translation	Speaker A	Speaker B	Speaker C	Speaker D
[ála]	‘eye’	✔	✔	✔	✔
[ábəlra]	‘to burn’	✔	✔	✔	
[asáχʲa]	‘reflection’	✔	✔	✔	✔
[ap’á]	‘thin’		✔	✔	✔
[alá]	‘dog’	✔	✔	✔	✔
[at͡ʂ’ətʰrá]	‘to scream’	✔			
[ɥaʒʷaq’á]	‘approx. 20’	✔	✔	✔	✔
[at͡sʰəgʷkʷʰá]	‘cats’		✔		
[(j)esd͡zənrá]	‘every summer’			✔	✔
[agʷə́ʁra]	‘hope (n.)’	✔	✔	✔	✔
[adə́rra]	‘knowledge’	✔			
[adʷə́ʁba]	‘train’		✔	✔	✔
[at’ə́]	‘owl’	✔	✔	✔	✔
[at’ʷə́]	‘possession’	✔	✔	✔	✔

Breakdown of which participants read which words (Experiment 1)

(14) shows the number of vowel tokens analyzed for each speaker. These numbers are affected by the small differences in stimuli lists shown in (13) above, and by exclusions of individual tokens (see Chapter 2, Section 2.1.5).

(14) Figure 3.4

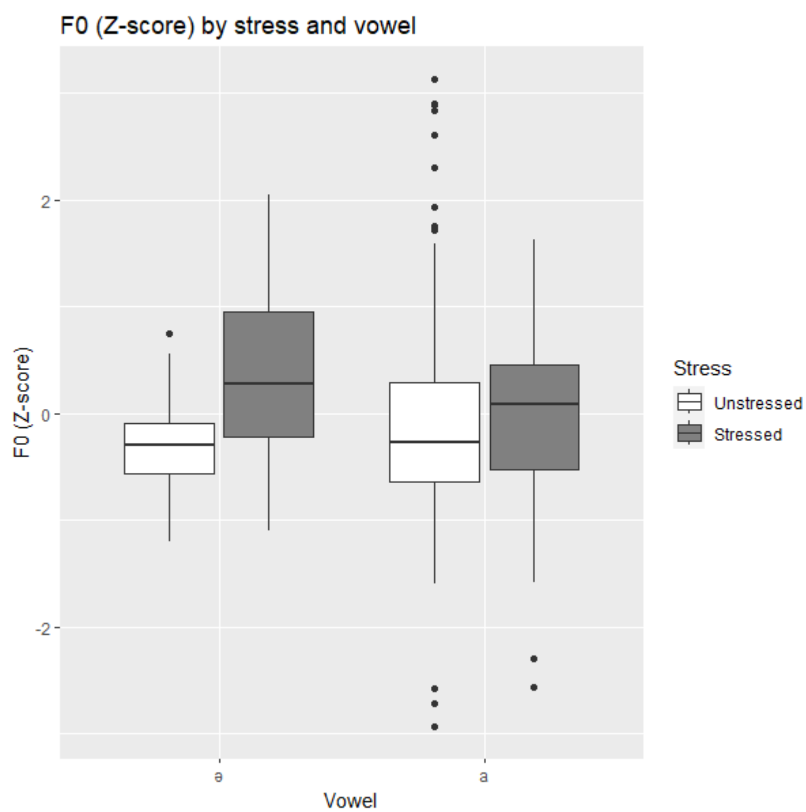
Speaker A	Speaker B	Speaker C	Speaker D	Total
234	252	213	213	912

Number of tokens per participant (Experiment 1)

3.2.2 Visualization of data

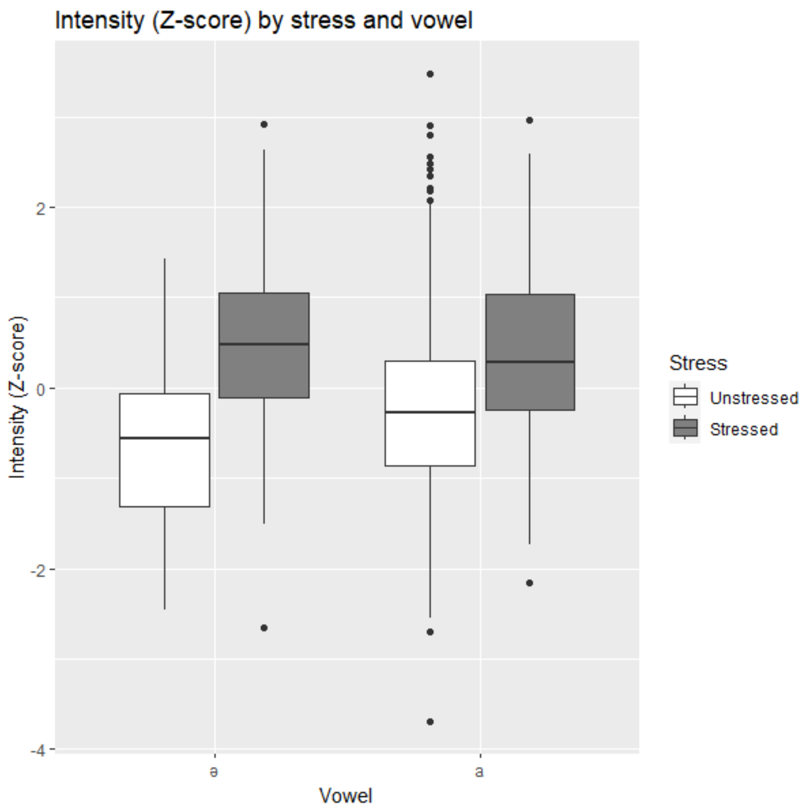
The graphs below visualize the effects of stress (stressed/unstressed) and vowel ([a] or [ə]) on measures of pitch, intensity, and duration. Overall, unstressed vowels appear to have a lower F0, lower intensity, and shorter duration than stressed vowels. For F0 and intensity, the difference between stressed and unstressed vowels appears to be slightly smaller for [a] than for [ə]. For duration the difference appears to be similar for the two vowels, although [a] is generally longer than [ə].

(15) Figure 3.5



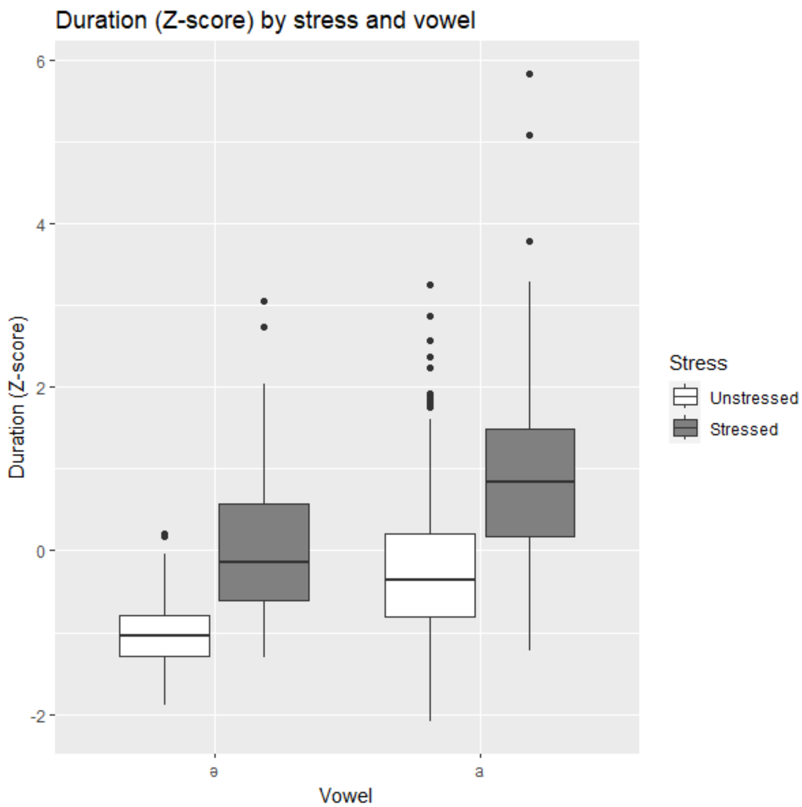
F0 (Z-score) by stress and vowel (Experiment 1)

(16) Figure 3.6



Intensity (Z-score) by stress and vowel (Experiment 1)

(17) Figure 3.7

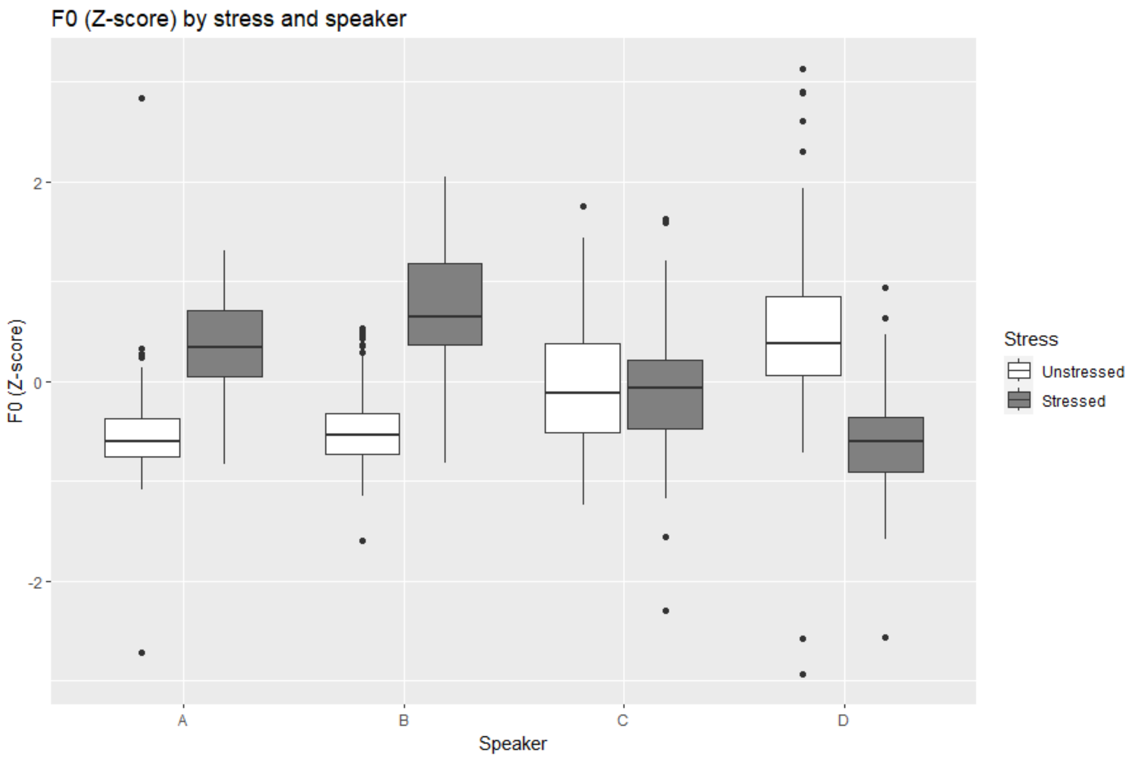


Duration (Z-score) by stress and vowel (Experiment 1)

It is also interesting to consider the effects of stress on F0, intensity, and duration, broken down by participant.[11] This reveals considerable variation. Speakers A and B have higher F0 on stressed vowels than on unstressed vowels. Speaker C shows no obvious effect of F0, while speaker D has lower F0 on stressed vowels.

11 For graphs which include effects of both vowel and participant, see Appendix A.

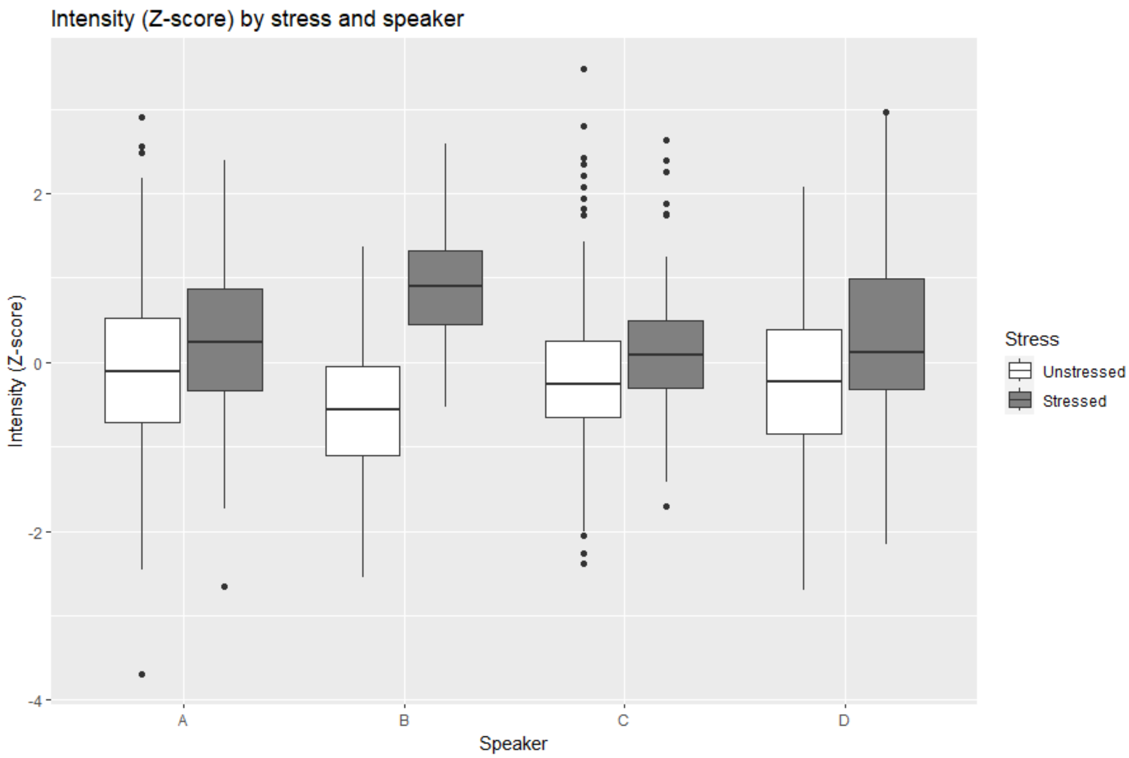
(18) Figure 3.8



F0 (Z-score) by stress and participant (Experiment 1)

For intensity, speaker B shows a clear difference where stressed vowels have higher intensity. Speakers A, C, and D show much smaller effects in the same direction.

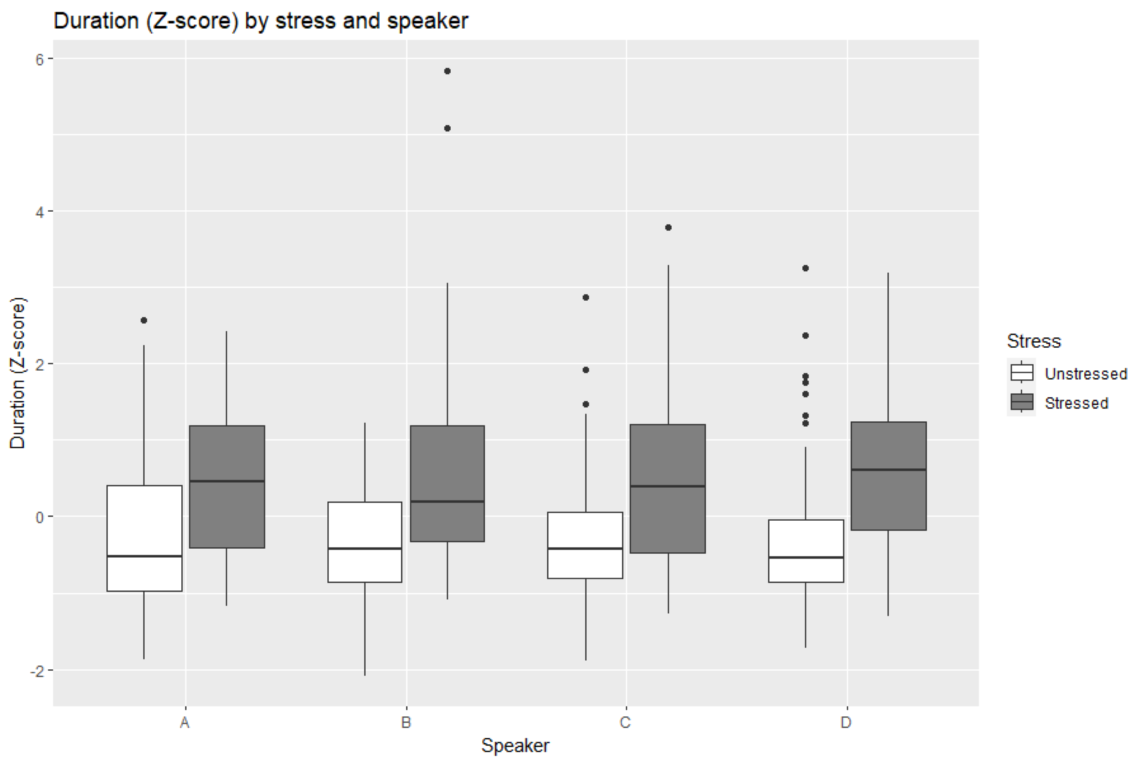
(19) Figure 3.9



Intensity (Z-score) by stress and participant (Experiment 1)

The duration graph is the most uniform, with all speakers showing a clear pattern of stressed vowels being longer than unstressed vowels.

(20) Figure 3.10



Duration (Z-score) by stress and participant (Experiment 1)

3.2.3 Statistical analysis

In order to evaluate the reliability of the trends, I analyzed the data using nested linear mixed effects models in R, which are compared to each other with ANOVAs. Each measure (F0, intensity, and duration) was analyzed with a separate model. All models were fit to the values for one of the three measures for all vowels in the dataset. For each measure, I considered four models: 1) a baseline with no stress information whatsoever, 2) an intermediate model with a random slope for the effect of stress by participant, 3) a model which in addition to a random slope also considers a fixed effect of stress, and 4) a model like 3) but with an interaction term for stress and vowel. The model specifications are shown below using R syntax. I use F0 as an example, but the models for intensity and duration were identical. Vowel has the possible values {[ə], [a]}, while Position may be {Initial, Medial, Final} and Stress {Unstressed, Stressed}.

(21) Figure 3.11

Model	Addition to previous model	Model specification
a.	N/A (baseline)	F0 ~ Vowel + Position + (1|Word) + (1|Speaker)
b.	Random slope	F0 ~ Vowel + Position + (1|Word) + (1+Stress|Speaker)
c.	Fixed effect	F0 ~ Stress + Vowel + Position + (1|Word) + (1+Stress|Speaker)
d.	Interaction	F0 ~ Stress * Vowel + Position + (1|Word) + (1+Stress|Speaker)

Model specifications (Experiment 1)

Here the comparison between (21) a. and (21) b. is the most relevant. If the experiment had many more participants, it may have been possible to make "statistically robust inferences over a speaker population" (Roettger & Gordon 2017: 7). The models in (21) c. and (21) d. ask whether stress has an effect on F0 above and beyond the effect stress has on F0 for individual speakers. This answer may be affirmative if all or nearly all speakers realize stress in similar ways (e.g. with higher F0 on stressed vowels), albeit with different effect sizes for each speaker. Conclusions about such a dataset could be phrased as applying to a speech community (or speaker population in Roettger & Gordon's wording).

With only four speakers in the present experiment, there may be too much individual variation in the realization of stress to allow for any significant differences between models like (21) b. and (21) c. Even if such differences are observed, it would not be wise to interpret results based on only four speakers as representative of the (Abzhywa) Abkhaz speech community. The results I report are therefore not studies of Abkhaz stress, but studies of four individual Abkhaz speakers' realizations of stress. This makes the addition in (21) b. of a random slope for the effect of stress by speaker more relevant than the addition in (21) c. of a fixed effect for stress.

Fitting the more complex models in (21) sometimes results in singular fits, a problem which may suggest that the models are overly complex and have low statistical power. There is no consensus on how to resolve these. Barr et al. (2013) make the general recommendation of using the maximal random effects structure possible. They discuss several alternatives when this is not possible, including "progressively simplifying the random effects structure" (Barr et al. 2013: 266). Experimenting with several types of models revealed that the random slope introduces singular fits whenever it is introduced, no matter how simple the rest of the model is. As discussed in the immediately preceding paragraphs, the random slope (1+Stress|Speaker) is of more theoretical interest than the Stress fixed effect, so it cannot be dropped to simplify the model structure.

Barr et al. (2013: 276) also discuss the possibility of fitting separate linear mixed effects models for individual speakers or items to circumvent the problems caused by complex random effects structures. Models like F0 ~ Stress * Vowel + Position + (1|EnglishWord) fit separately for each participant converge without singular fits. I report the model summaries and ANOVA comparisons for models fit for each participant in Appendix A. In the text below, I use the linear mixed effects models from (21), but I note below which models had problems with singular fits, marking these with a dagger †.

(22) Figure 3.12

	Baseline	Random slope	Fixed effect	Interaction
F0				
Intensity	†	†	†	
Duration	†	†	†	†

Models with singular fits (Experiment 1)

In (23) are model summaries for the interaction models from (21) d. Each row reports a separate model, for F0, intensity, and duration. The columns show the estimates for the fixed effects, plus or minus the standard error. The reference levels for the factors are Unstressed, Initial, and [ə]. Models with singular fits are marked with a dagger † in the Measure column.

(23) Figure 3.13

Measure	Intercept	Stressed	[a]	Stressed * [a]	Medial	Final
F0	0.09±0.22	0.51±0.45	-0.13±0.11	-0.32±0.12	-0.29±0.08	-0.28±0.05
Intensity	-0.13±0.23	0.83±0.31	0.03±0.18	-0.09±0.21	-0.32±0.13	-0.35±0.07
Duration†	-0.48±0.19	0.90±0.17	0.15±0.18	0.28±0.20	-0.47±0.12	0.08±0.07

Models summaries (Experiment 1)

In (24) I report the AIC values for all models, which will be useful in the model comparisons immediately below.

(24) Figure 3.14

	Baseline	Random slope	Fixed effect	Interaction
F0	2,048.9	1,546.6	1,548.3	1,544.6
Intensity	2,682.0	2,479.3	2,476.4	2,477.9
Duration	2,651.3	2,404.0	2,388.5	2,385.6

AIC values (Experiment 1)

The ANOVA model comparisons between the four models from (21) are reported in (25). For each of the three acoustic measures, the pairs of models with adjacent numbers in (21) are compared to each other, i.e. baseline to random slope, random slope to fixed effect, and fixed effect to interaction. I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p) from each ANOVA.

(25) Figure 3.15

Measure	Baseline-random slope			Random slope-fixed effect			Fixed effect-interaction		
	χ^2	df	p	χ^2	df	p	χ^2	df	p
F0	459.18	2	$< 2.2 * 10^{-16}$	0.36	1	0.55	5.95	1	0.01
Intensity	190.01	2	$< 2.2 * 10^{-16}$	4.57	1	0.03	0.17	1	0.68
Duration	246.29	2	$< 2.2 * 10^{-16}$	16.43	1	$5.05 * 10^{-5}$	1.89	1	0.17

ANOVA model comparisons (Experiment 1)

How should the results presented in (25) be interpreted? The models in (21) b. with a random slope for the effect of stress by speaker always significantly outperform the models in (21) a. without such a random effect, and result in a lower AIC. In other words, all of F0, intensity, and duration are more successfully predicted by a model with stress information than one without it. In light of the problems with singular fits discussed above, the conclusions for intensity and duration should be treated with caution. I discuss the variable patterning of F0 for the four participants in the coming paragraphs.

For (21) b. versus (21) c., the more complex model with a fixed effect for stress is significantly better for intensity and duration and results in a lower AIC, but not for F0. Recall from earlier discussion in this section that this distinction, although statistically significant, is not especially meaningful for a study with only four speakers. It is likely that the non-significant p-value only for F0 is due to the variation in how F0 is used to signal stress for the participants, some of whom mark stress with higher F0, and some with lower F0. These opposing effects are canceled out in the fixed effect estimate, which represents an average across the four participants.

For (21) c. versus (21) d., the opposite pattern is found: only the F0 model comparison is significant, again resulting in a lower AIC. It appears that the additional model complexity afforded by the interaction term captures enough additional variation to reach significance. The fixed effect estimate for stress in the interaction model for F0 (from (23) above) is 0.51 ± 0.45. Although this range does not include 0 (i.e. no effect of stress on F0), it comes close. This is again due to participant variation in whether stressed vowels have a higher or lower F0 than unstressed vowels.

A fuller picture of the individual participants' realization of stress can be found by examining the by-speaker random slopes from the models in (21) b. These show separate estimates of the effect stress has on F0, intensity, and duration for each speaker.

(26) Figure 3.16

	Speaker A	Speaker B	Speaker C	Speaker D
F0	0.89	1.24	-0.06	-1.00
Intensity	0.47	1.62	0.29	0.63
Duration	0.89	1.08	1.14	1.29

Random slopes for effect of participant (Experiment 1)

These estimates agree with the generalizations from the graphs in (18)-(20). Stressed vowels are about one standard deviation longer than the intercept for all participants, although some variation is found. The variation is larger for intensity; even though all participants have higher intensity on stressed vowels, the effect is much greater for Speaker B. Finally, F0 shows that Speakers A and B mark stressed vowels with higher F0, while Speaker C does not appear to differentiate stressed and unstressed vowels by F0, and Speaker D marks stressed vowels with lower F0.

3.2.4 Conclusions

In this section I have discussed the acoustics of primary stress in Abkhaz, focusing on the role of F0, intensity, and duration. It appears that all three measures have a role to play in differentiating stressed and unstressed vowels, although there is variation across the four participants of the experiment. Duration appears to be the most reliable, being used by all four participants. Intensity is also useful in telling stressed vowels from unstressed. However, the intensity difference between stressed and unstressed vowels varies much more across the four participants than duration does.

The patterns for F0 depend greatly on the participant examined. One participant does not appear to use F0 differentiate between stressed and unstressed vowels, while the remaining participants differ in whether stress is marked by lower or higher F0 relative to unstressed vowels. As I have emphasized throughout this section, the generalizability of these conclusions to other Abkhaz speakers is not known. Since there has not any previous work on the acoustics of stress in Abkhaz, I hope that even the small-scale experiment reported here provides some useful information on the phonetic realization of word-level prosody in Abkhaz.

3.3 Consonantal stress

In the final section of this chapter, I discuss the role consonants may play in the phonetics of Abkhaz stress. Morphemes consisting only of consonants are relevant for determining the location of primary stress (see Chapters 4-7), but transcriptions of Abkhaz surface representations always place stress on a vowel. In this section I report data on whether accented consonants show acoustic evidence of bearing stress on the surface, ultimately answering this question in the negative.

The methodology for the experiment in this section was covered in Chapter 2, but the experiment involved four speakers reading words beginning in either the polymorphemic sequence /b́-a/ (accented consonant, unaccented vowel) or /b-á/ (unaccented consonant, accented vowel) ten times each in a carrier phrase. A third condition consisted of accented /ba/ sequences within morphemes, where there is no underlying contrast between /b́a/ and /bá/ (Spruit 1986).

If Abkhaz shows a difference between these conditions, it would be a typologically surprising result. Languages with stressed syllabic consonants, such as Czech (Short 2009) or Traditional New Mexico Spanish (Piñeros 2005), show that there is nothing implausible about realizing stress on consonants per se. However, stressing an immediately prevocalic consonant would be surprising, especially in light of the observation that /CV/ sequences are universally syllabified as onset-nucleus (see Breen & Pensalfini 1999 for Arrernte as a counterexample, and Topintzi & Nevins 2017 for counterarguments).

I conclude that there is no evidence for stress-bearing prevocalic consonants in the acoustic data I have collected, but it is likely that the statistical analyses I report are underpowered. Two of the four participants show earlier F0 extrema in some of their productions of /b́a/ than /bá/. A larger-scale study of stress-bearing consonants in Abkhaz would be able to shed light on the reliability of such patterns (or lack thereof). In the remainder of this dissertation, however, I assume that Abkhaz stress never surfaces on a prevocalic consonant.

3.3.1 Stimuli

The stimuli for the experiment are shown in (27). All words in (27) a) begin with the accented prefix /b-/ '2SF.POSS' followed by an unaccented stem vowel /a/. All words in (27) b) begin with the unaccented prefix /b-/ '2SFA' followed by the accented prefix /a-/ '3SNO'. All words in (27) c) have a tautomorphemic /ba/ sequence with no evidence for any underlying contrast in the location of that accent. Note that (27) a) and (27) b) differ in their morphology as well as their phonology. Morphologically identical structures would have been preferable, but there is no unaccented prefix /a/ in Abkhaz, so morphologically minimal pairs cannot be constructed. In the discussion of this experiment, I call (27) a)-c) the Consonant, Vowel, and Indeterminate conditions respectively, based on which segment carries the underlying accent.

(27) Experiment 3 (experimental stimuli)

a) /b́-a/

/b́-a.../
2SF.POSS-STEM
'your STEM'

i.	[b-áb]	баб	'your father'
ii.	[b-ábd͡ʒar]	бабџьар	'your weapon'
iii.	[b-áʒʷa]	бажәа	'your word'
iv.	[b-án]	бан	'your mother'
v.	[b-áʃʷa]	башәа	'your song'

b) /b-á/

/b-á-...-.../
2SFA-3SNO-STEM-TAME
'you STEM it'

i.	[b-á-gʷo-jt']	багәоит	'you push it'
ii.	[b-á-pʰχʲo-jt']	баҧхьоит	'you read it'
iii.	[b-á-s-we-jt']	басуеит	'you hit it'
iv.	[b-á-χo-jt']	бахоит	'you pull it'
v.	[b-á-ʃtʰo-wp']	башьҭоуп	'you look for it'

c) Accented sequence /ba/

/ba...-k'/
STEM-INDF
'one STEM'

i.	[bába-k']	бабак	'a soft/fluffy one (e.g. of bread)'
ii.	[bána-k']	банак	'one bath'
iii.	[bárt͡s'a-k']	барҵак	'one balcony'
iv.	[báχtʰa-k']	бахҭак	'one prison'
v.	[báħt͡ʃʰa-k']	баҳчак	'one garden'

All four participants were shown the same stimuli, but some were unfamiliar with a few of the words, or stressed them in ways not predicted by the dictionary. In these cases the word was excluded from analysis for that participant (see Chapter 2, Section 2.1.5). All words marked with a check ✔ in a speaker column below appear in the analysis for that participant.

(28) Figure 3.17

		Speaker A	Speaker B	Speaker C	Speaker D
[báb]	‘your father’	✔	✔	✔	✔
[bábd͡ʒar]	‘your weapon’	✔	✔	✔	✔
[báʒʷa]	‘your word’	✔	✔	✔	✔
[bán]	‘your mother’	✔	✔	✔	✔
[báʃʷa]	‘your song’	✔	✔	✔	✔
[bágʷojt’]	‘you push it’		✔		✔
[bápʰχʲojt’]	‘you read it’	✔	✔	✔	✔
[báswejt’]	‘you hit it’	✔	✔	✔	✔
[báχojt’]	‘you pull it’	✔	✔	✔	✔
[báʃtʰowp’]	‘you look for it’	✔	✔	✔	✔
[bábak’]	‘a soft one’				✔
[bának’]	‘one bath’		✔	✔	✔
[bárt͡s’ak’]	‘one balcony’	✔	✔	✔	✔
[báχtʰak’]	‘one prison’	✔	✔	✔	✔
[báħt͡ʃʰak’]	‘one garden’	✔	✔	✔	✔

Breakdown of which participants read which words (Experiment 3)

Below I show the total number of tokens analyzed for each participant in the experiment. The number is especially low for Speaker A, whose online participation meant a different recording setup was used (see Chapter 2, Section 2.1). Some tokens were excluded due to undefined pitch measurements, which may have resulted from this participant's microphone not always picking up pre-voicing during the closure of the /b/. Alternatively, the participant may not have produced as much pre-voicing as the others.

(29) Figure 3.18

Speaker A	Speaker B	Speaker C	Speaker D	Total
64	95	100	120	379

Number of tokens per participant (Experiment 3)

3.3.2 Visualization of data

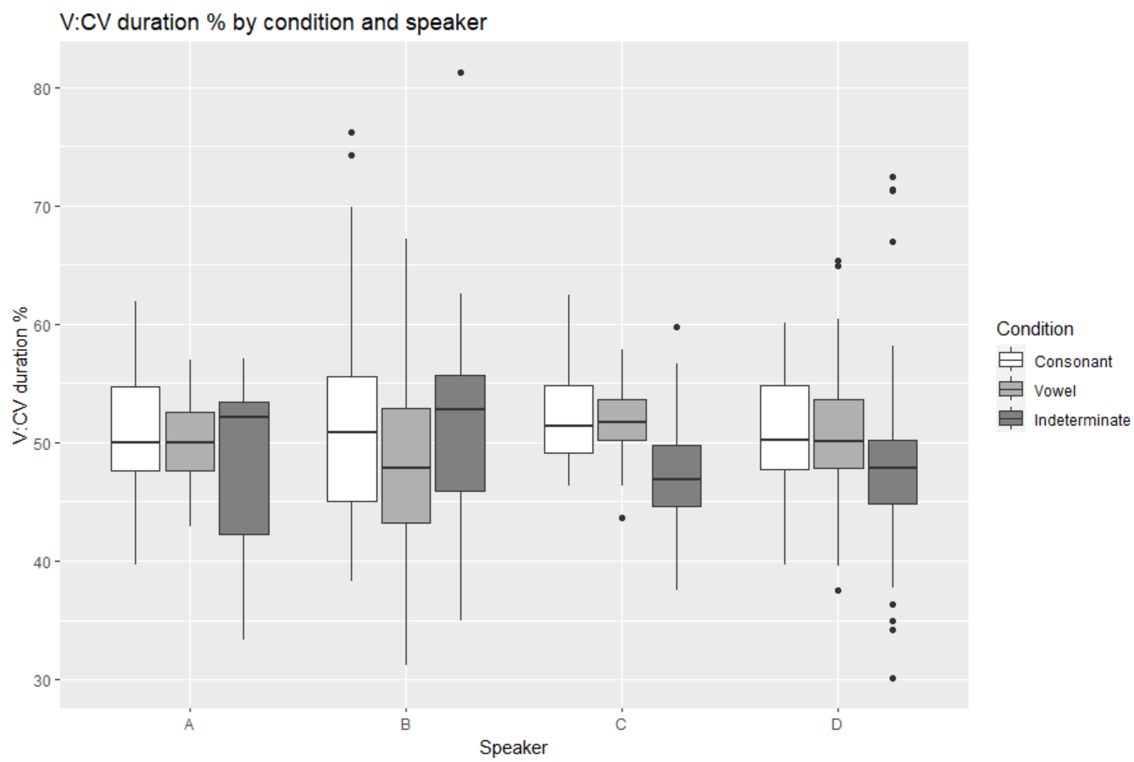
I focus on two dependent variables in the discussion of this experiment. One is the duration of the vowel /a/ relative to the duration of the /ba/ sequence. The other measures which of ten normalized time steps during the /ba/ sequence (steps 1-5 during the consonant, and steps 6-10 during the vowel) contains the F0 extremum. Recall from Section 3.2 that Speaker D was unique in realizing primary stress with a lower F0, while Speakers A-C either used higher F0 or did not show an F0 difference between stressed and unstressed vowels. The F0 extremum therefore refers to the F0 minimum for Speaker D, but to the F0 maximum for Speakers A-C.

Below I show graphs visualizing both of these measures, grouped by condition and participant. It is difficult to discern any clear patterns in the V:CV duration data. All participants hover around 50%, although speakers C-D have slightly shorter vowels in the indeterminate condition, while speakers A-B have slightly longer vowels in the same condition. In the dataset of F0 extrema, there are only ten possible values (1-10), and I have used the *jitter()* function in R to make the graph below easier to read by adding small amounts of random noise to each datapoint.[12] Speakers A and C almost always have the F0 extremum at the end of the vowel, at time step 10, in all conditions. An extremum late into the vowel (time steps 8-10) is also the norm for speakers B and D, but interestingly there is more variation in the consonant condition (and at least for speaker

12 This affects only the visualizations, and not the data used in the statistical analysis in Section 3.3.3.

B, also in the indeterminate condition). For these participants there are more F0 extrema falling earlier, including during the consonant, when it is the consonant which bears an underlying accent.[13]

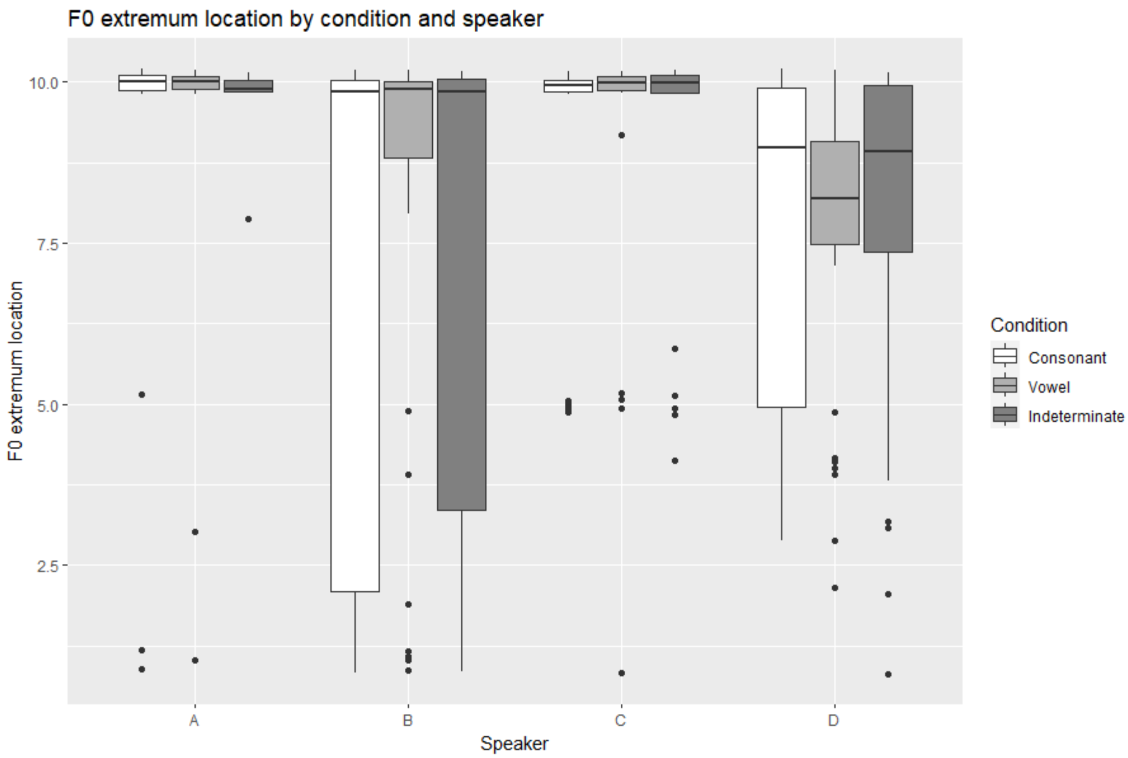
(30) Figure 3.19



V:CV duration (percentage) by condition and participant (Experiment 3)

13 Although the range of possible extremum locations is greater in the consonant condition, note that for speaker D the mean is actually lowest in the vowel condition.

(31) Figure 3.20



F0 extremum location by condition and participant (Experiment 3)

3.3.3 Statistical analysis

I fitted nested linear mixed effects models compared to each other with ANOVAs to assess whether any of the differences between conditions were significant. Below are the model structures used. TrialNo refers to the trial number of the item in the study (1-400). I show the model structures for the location of the F0 extremum (Extremum), but identical models were fitted to predict the V:CV duration ratio.

(32) Figure 3.21

Model	Addition to previous model	Model specification
a.	N/A (baseline)	Extremum ~ TrialNo + (1|Word) + (1|Speaker)
b.	Random slope	Extremum ~ TrialNo + (1|Word) + (1+Condition|Speaker)
c.	Fixed effect	Extremum ~ Condition + TrialNo + (1|Word) + (1+Condition|Speaker)

Model specifications (Experiment 3)

As in the discussion of the acoustics of primary stress (Section 3.2), it is primarily the comparison between (32) a. and (32) b. which is of interest. The participants may show their own patterns of behavior, but with so few participants it may not be possible to say much about the (participant-independent) fixed effect of condition. Again like in the previous experiment, there were problems due to singular fits with some of the models. These problems were more severe for this experiment, a natural consequence of the relatively fewer tokens being analyzed. I have not found a way, with the data available, to fit alternative models which do not lead to singular fits. Neither excluding words read only by one participant, fitting F0 extremum models only for speakers B and D (who show some variability across conditions), nor fitting separate models for each participant without random slopes resolve the problem. I report on the models with singular fits, noting that more caution than usual should be taken when interpreting the results. I note below which models had problems with singular fits, marking these with a dagger †.

(33) Figure 3.22

	Baseline	Random slope	Fixed effect
V:CV duration	†	†	†
F0 extremum		†	†

Models with singular fits (Experiment 3)

Below are model summaries for the fixed effects in the full models from (32) c. I report the fixed effect estimates plus or minus standard errors. The reference level of the Condition factor is Consonant, so this is the condition that the intercept represents.

(34) Figure 3.23

Dependent variable	Intercept	Vowel	Indeterminate	TrialNo
V:CV duration	50.93±1.19	-1.23±1.43	-2.56±1.61	0.003±0.003
F0 extremum	8.10±0.56	0.18±0.40	0.02±0.37	0.001±0.001

Model summaries (Experiment 3)

I report the AIC values for all models in (35), and these will be useful in the model comparisons immediately below.

(35) Figure 3.24

	Baseline	Random slope	Fixed effect
V:CV duration	2,511.2	2,517.8	2,519.4
F0 extremum	1,849.8	1,857.8	1,861.6

AIC values (Experiment 3)

The ANOVA model comparisons between the baseline, intermediate, and full models from (32) are reported in (36). For each of the two dependent variables, the pairs of models with adjacent numbers in (32) are compared to each other, i.e. a. to b., and b. to c.

I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p) from each ANOVA.

(36) Figure 3.25

Dependent variable	Baseline-random slope			Random slope-fixed effect		
	χ^2	df	p	χ^2	df	p
V:CV duration	3.34	5	0.65	2.46	2	0.29
F0 extremum	2.05	5	0.84	0.19	2	0.91

ANOVA model comparisons (Experiment 3)

None of these model comparisons are especially close to reaching significance, and none result in a lower AIC for the more complex model. This means that there is not enough evidence to reject the null hypothesis that the consonant, vowel, and indeterminate conditions behave identically. This is not especially surprising, since the dataset considered here is likely too small to detect any significant effects.

However, it is very interesting that two of the four participants appear to show earlier F0 extrema in words where stress is underlyingly on the consonant. It would be useful to conduct a larger follow-up study of stress alignment on /CV/ sequences in Abkhaz. Such a study should preferably include more words in each condition, and if possible, include more than one morphological structure for those words. Including more speakers is also a necessity, since not all speakers appear to use F0 to differentiate stressed and unstressed vowels (see speaker C in Section 3.2), and not all speakers who do use F0 show a noticeable difference between conditions in this experiment (speaker A in this section). Below I give means and standard deviations for the F0 extremum locations across conditions for all four participants, in the hopes that these estimated effect sizes will be useful in designing future studies with the requisite statistical power. The notation X±Y refers to a mean of X, and a standard deviation of Y.

(37) Figure 3.26

	Consonant	Vowel	Indeterminate
Speaker A	9.21±2.46	9.33±2.28	9.82±0.60
Speaker B	6.94±3.99	8.12±3.27	6.88±3.88
Speaker C	9.25±1.81	9.00±2.29	9.17±1.91
Speaker D	7.87±2.62	7.69±2.34	7.77±2.70

Summary statistics (Experiment 3)

3.3.4 Conclusions

In this section I have shown that there is no acoustic evidence for a surface difference corresponding to the underlying difference between /b́-a/ and /b-á/. The norm for all participants is to have F0 extrema aligned at or near the right edge of the vowel in all conditions. This is consistent with the implicit idea in previous literature that both /b́-a/ and /b-á/ surface with stress on the vowel as [bá]. In the theoretical analysis of Abkhaz stress assignment in Chapter 7, I therefore assume that a stress shift takes place in the phonology, neutralizing the difference between /b́-a/ and /b-á/.

However, the statistical analysis in this section was based on very little data, and the absence of significant results should not be taken as conclusive evidence that no acoustic difference between /b́-a/ and /b-á/ exists. Two of the four speakers showed earlier F0 extrema in some of their productions of /b́-a/. Such tokens may be due to noise, or they may indicate that some acoustic trace of consonantal stress remains. In order to determine this, additional data are needed, and I hope that the preliminary investigation in this section will be of use to anyone who wants to continue the work I have reported here.

3.4 General conclusions

In this chapter I have given an introductory overview of some basic properties of Abkhaz primary stress. I have argued that Abkhaz stress is obligatory, culminative, and contrastive. Unlike in some well-known languages in the literature on prosody, stress assignment is not affected by window restrictions, vowel length, or the presence or absence of coda consonants. Abkhaz stress is also characterized by its mobility, and different forms within morphological paradigms often show stress alternations. These alternations will be the focus of the studies of Abkhaz stress in Chapters 6. The typology of stress systems will return as a discussion topic in Chapters 7-9, where I compare segmental and prosodic analyses of Abkhaz stress with each other, arguing that unlike most languages in the world, Abkhaz stress assignment only makes reference to segment-sized units.

I have given a first, preliminary look at the acoustics of primary stress in Abkhaz. F0, intensity, and duration all play a role in differentiating stressed and unstressed vowels in Abkhaz, although speakers differ in which dimensions they use, and how large the differences between stressed and unstressed vowels are. Duration shows the least variation, followed closely by intensity. For all participants in the experiment, stressed vowels are longer and louder than their unstressed counterparts. However, there is much more variation in the use of F0. It appears that some do not use F0, while others mark stressed vowels with low F0, and still others mark stressed vowels with high F0.

Despite the phonological involvement of consonants in the stress system of Abkhaz, I have not found any evidence that consonants bear stress on the surface. I follow previous literature in assuming that /b́a/ (accented consonant, unaccented vowel) and /bá/ (unaccented consonant, accented vowel) neutralize to [bá]. However, the statistical analysis I have conducted is likely to be underpowered, and I encourage future work to explore the phonetic role consonants play in Abkhaz stress further.

With the background information presented in this chapter, we are ready to investigate the phonological and phonetic behavior of Abkhaz stress in more depth in coming chapters. In particular, Chapters 5-8 provide a detailed phonological description and analysis of stress in Abkhaz. However, I begin in Chapter 4 with a discussion of the vowel system. I will show that an understanding of the vowels is essential to understand the stress system, and I continue the phonetic characterization of Abkhaz prosody in Chapter 4 with an acoustic experiment on secondary stress.

Chapter 4: The Abkhaz Vowel System Without Phonemic Schwa

This chapter discusses the vowel system of Abkhaz, focusing on the distribution of the two native vowel qualities [a] and [ə], which is a longstanding issue in the phonology of Northwest Caucasian languages. I will argue that schwa is not a phoneme in Abkhaz. It does not need to be entered into lexical representations of Abkhaz morphemes and can instead be epenthesized in predictable locations. I discuss three types of schwa in this chapter: 1) unstressed schwas, 2) stressed schwas, and 3) schwas with possible secondary stress. Below I summarize the arguments for each type of schwa.

Previous literature agrees that unstressed schwas are predictably epenthesized in consonant clusters and not underlying. I will summarize the arguments for this position, and illustrate how the location of epenthesis depends on the properties of the relevant consonant cluster. For stressed schwa, there is agreement that there is an empirical correlation between the location of schwa and the position of primary stress. However, there is a debate about whether this should be analyzed as epenthesis in stressed positions (when there is no vowel to carry the stress), or deletion in unstressed positions. I report new quantitative data on phonotactic restrictions which hold across the Abkhaz lexicon, and use these to argue in favor of epenthesis in stressed position. There are phonotactic restrictions on schwa which follow automatically from an analysis where schwa is epenthetic, but which have to be stipulated if schwa is underlying.

Finally, schwas with possible secondary stress have proven problematic for analyses without underlying schwa. Many linguists have transcribed these schwas as unstressed, which makes their distribution difficult to predict, since they appear to form minimal pairs with the absence of schwa. I will argue, strengthening arguments from previous work with additional data, that there is an empirical correlation between the accentual behavior of a morpheme and whether or not it takes a schwa in apparently unstressed position. In other words, the schwas can be predicted based on independently needed information about stress. Such a correlation is entirely unexpected if schwas are lexical rather than epenthesized based on stress.

I report on a small-scale phonetic study showing that for some speakers, both the relevant schwas and low vowels with the same accentual properties show acoustic evidence for secondary stress. For other speakers there is no clear acoustic evidence for secondary stress, since the acoustic differences found in their productions are likely too small to be perceptible. Several authors have noted impressionistically that these schwas have a secondary stress, and I refer to them as secondarily stressed throughout this dissertation. For some speakers this term can be interpreted phonetically as referring to a measurable degree of prominence. For others it refers to a phonological prominence which is independently needed to account for the accentual properties of certain morphemes, but which, at least in the small-scale study reported in this chapter, does not have clear acoustic correlates.

The conclusion from the arguments I have outlined above is that all schwas in Abkhaz are predictably distributed. Some are motivated by consonant clusters, others by primary stress, and still others by accentual properties which may or may not be phonetically apparent. Because of the complexities of the data, and the many connections to the analysis of the stress system, it is understandable that much previous work has not been able to fully predict where schwas appear.

I argue that this evidence all points towards the same conclusion: the distribution of schwa in Abkhaz is predictable, and schwa is not a phoneme of the language. In the coming sections I argue that each of the three categories of schwa is predictable, beginning with unstressed schwa in Section 4.1, schwa with primary stress in Section 4.2, and schwa with secondary stress in Section 343. After this, in Section 4.4, I discuss the theoretical and typological consequences of the analysis, namely a process of stress-induced vowel epenthesis and a native vowel system with only one phoneme. However, I argue that the native-borrowed distinction may not be a synchronic reality for modern speakers, so that the language as a whole has five vowel phonemes /a, e, i, o, u/ rather than only one. Section 4.5 concludes the chapter, emphasizing that the arguments I make about stress in the rest of this dissertation will assume that schwa is predictably epenthesized.

4.1 Unstressed schwa

In this section I describe the data and generalizations surrounding unstressed schwas in consonant clusters in Abkhaz. These are agreed to be predictable in previous literature, and the general rules for their distribution are clear. However, there are also exceptions to these rules, and some environments allow for optionality in schwa placement. Because of this, even though there is agreement that the schwas in this section are not phonemic, it is difficult to formulate rules which predict the realization of every token. I give data in Sections 4.1.1-4.1.3, and summarize the conclusions in Section 4.1.4 where I cite previous work on unstressed schwa in Abkhaz.

4.1.1 Two consonants

Beginning with the simple cases, let us examine word-final C(ə)C sequences, i.e. words which end in two consonants, either separated by a schwa or not. Some data are given below, with the relevant sequences in bold. The general rule is that a schwa does not appear if the sonority of the cluster falls (1) a., but does appear if it rises (1) c. If the sonority is more or less equal (1) b., some words show a schwa while others do not. Oftentimes there is optionality in this category, where the same word can be pronounced with or without a schwa. Some clusters of rising sonority are also found without schwa, as in (1) c. i. These tend to involve obstruents rather than sonorants.

(1) Schwa in final CC clusters

a. Falling sonority

i. [a-q’ʷá**rdʷ**] аҟəардə ‘chair’
DEF-chair
Yanagisawa (2010: 254)

ii. [á-**ʃʷtʰ**] ашəҭ ‘flower’
DEF-flower
Yanagisawa (2010: 574)

iii. [á-**mʃʷ**] амшə ‘bear’
DEF-bear
Yanagisawa (2010: 299)

b. Equal sonority

i. [á-**dəd**] адыд ‘thunder’
DEF-thunder
Yanagisawa (2010: 106)

ii. [á-**χʲd͡z**] ахьӡ ‘name’
[á-**χʲəd͡z**] ахьыӡ
DEF-name
Yanagisawa (2010: 468)

iii. [á-**ləm**] алым ‘lion’
DEF-lion
Yanagisawa (2010: 280)

c. Rising sonority

i. [á-**bz**] абз ‘tongue’
[á-**bəz**] абыз
DEF-tongue
Yanagisawa (2010: 60)

ii. [á-**d͡zən**] аӡын ‘winter’
DEF-winter
Yanagisawa (2010: 156)

iii. [áa**pʰən**] аацын ‘spring’
DEF.spring
Yanagisawa (2010: 43)

By contrast, word-initial and word-medial C(ə)C sequences tend not to have a schwa, as shown for clusters of varying sonority profiles in (2) and (3) a.-c. Initial CəC does sometimes appear, especially in obstruent-obstruent clusters (2) d. Note that even in cases like (2) c. the initial nasal is not syllabic (Arkadiev & Lander 2021: 379; see Chapter 8, Section 8.1.3 for additional discussion of syllabification in Abkhaz). I discuss examples of optional word-medial CəC alternating with CC in Section 4.1.4.

(2) Schwa in initial CC clusters

a. [**t͡s’l**á-k’] ҵлак ‘one tree’
tree-INDF
Yanagisawa (2010: 521)

b. [**f-b**á] фба ‘six (non-human)’
six-N.NUMERAL
Yanagisawa (2010: 434)

c. [**nb**án-k’] нбанк ‘one letter’
letter-INDF
Yanagisawa (2010: 313)

d. [**d-t͡sʰ**é-jt’] дцеит ‘(s)he went’
[**də-t͡sʰ**é-jt’] дыцеит
3SHA-go-DYN.FIN
Spruit (1986: 84)

(3) Schwa in medial CC clusters

a. [á-**ʒʷl**a] ажəла ‘last name’
DEF-last.name
Yanagisawa (2010: 122)

b. [á-**t͡ʃ’ʷt͡sʰ**a] ацəца ‘glass’
DEF-glass
Yanagisawa (2010: 526)

c. [á-**rʁʲ**a] аргьа ‘right (opposite of left)’
DEF-right
Yanagisawa (2010: 363)

4.1.2 Three consonants

The basic rule for three-consonant clusters is that a schwa appears between C1 and C2, as shown in (4) a.-c. for word-initial, word-medial, and word-final position respectively. Word-finally, a schwa sometimes appears between C2 and C3 instead when these two consonants having a rising sonority profile, as in [á-**pʰχən**] DEF-summer ‘summer’ (Yanagisawa 2010: 341).

(4) Schwa in CCC clusters

a.

i. [**sə-pʰħ**á] сыпҳа ‘my daughter’
1S.POSS-daughter
Yanagisawa (2010: 344)

ii. [**də-r-b**ó-jt’] дырбоит ‘they see him/her’
3SHA-3PE-see.DYN-DYN.FIN
Yanagisawa (2010: 53)

iii. [**lə-pʰs**ə́] лыцсы 'her soul'
3SF.POSS-soul
Yanagisawa (2010: 338)

b.

i. [á-**ħʷəzb**a] аҳәызба 'knife'
DEF-knife
Yanagisawa (2010: 492)

ii. [a-**tʰəpʰħ**á] аҭыԥҳа 'girl'
DEF-girl
Yanagisawa (2010: 417)

iii. [s-a-bá-**lə-m-b**o] Сабалымбо? 'Where does she not see me?'
1SA-where-Q-3SFE-NEG-see.DYN
Yanagisawa (2010: 54)

c.

i. [á-**ʂəkʷʰs**] ашықәс 'year'
DEF-year
Yanagisawa (2010: 558)

ii. [a-t͡s'á**bərg**] аҵабырг 'truth'
DEF-truth
Yanagisawa (2010: 516)

iii. [d-tʰá-**mə-zt'**] дҭамызт '(s)he was not in it'
3SHA-be.in-NEG-NEG.STAT.IMPF
Yanagisawa (2010: 401)

4.1.3 Longer sequences and exceptions

The sequence CCCC is rare, and usually CCəCC is found, with a schwa between C2 and C3.

(5) Schwa in CCCC clusters

a. [á-**mt͡ʃʰəbʒ**] амчыбжь 'week'
DEF-week
Yanagisawa (2010: 297)

b. [**d-sə-r-ʃʷ**é-jt’] дсыршәеит ‘I frightened him/her’
3SHA-1SE-CAUS-fear-DYN.FIN
Arstaa et al. (2014: 46)

c. [á-**kʷʰ-bəl-r**a] ақәбылра ‘to burn (on the surface)’
DEF-PREV(on)-burn-INF
Yanagisawa (2010: 228)

Instead of CCCCC, one typically finds CəCCəC, as in [dəsmərʃʷéjt’] ‘I didn’t frighten him/her’ (Arstaa et al. 2014: 46), although such sequences are understandably rather rare.

A general exception to many of the rules above comes in the form of labial stops followed by sibilant fricatives. There is rarely a schwa between such consonants even when the general rules above predict one. This exceptionality seems to be especially common with voiceless (aspirated) clusters, which are abundant in the language. It is difficult to leaf through a dictionary of Abkhaz without noticing the wealth of morphemes containing sequences like /pʰs, pʰʂ, pʰʃ/. Trigo (1992: 202) discusses a possible analysis where some clusters are actually complex segments, but this will not be pursued here.

(6) Absence of schwa in CCC clusters

a. [a-**pʰs-r**á] ацсра ‘to die’
DEF-die-INF
Yanagisawa (2010: 336)

b. [**pʰʃ-b**á] пшьба ‘four (non-human)’
four-N.NUMERAL
Yanagisawa (2010: 348)

c. [a-**pʰʂt’ʷ**ə́] ацштәы ‘color’
DEF-color[14]
Yanagisawa (2010: 348)

14 Historically this form appears to be from /pʰʂ/ ‘see’ and the adjectival suffix /-t’ʷ/.

d. [**bʒ-b**á] бжьба ‘seven (non-human)’
[**bəʒ-b**á] быжьба
seven-N.NUMERAL
Yanagisawa (2010: 59)

4.1.4 Predictability of unstressed schwa

Despite the optionality in many of the categories above, and the sometimes exceptional behavior of particular clusters, there is general agreement that unstressed schwas are predictably inserted in consonant clusters in Abkhaz. This conclusion is reached in work like Lomtatidze (1976), Spruit (1986), Colarusso (1988), Yanagisawa (2005), Arstaa et al. (2014), among others.

An exception is Vaux & Samuels (2018: 173 endnote 8), who argue for phonemic schwa in Abkhaz. They point to a possible minimal pair [ak’ə́lχχa] ‘full of holes’ vs. [ak’ə́ləχχa] ‘lattice’ from Kaslandzija (2005: 369), but these are variant pronunciations of the same lexical item with and without schwa epenthesis. This is seen clearly by the fact that Kaslandzija (2005: 369) gives [ji-k’ə́ləχχo-w] ‘which is full of holes’ with an unstressed schwa as an inflected form of the supposedly schwaless [ak’ə́lχχa] ‘full of holes’. Similar considerations explain the unstressed schwa in Vaux & Samuels’ (2018: 173 endnote 8) form [at͡sʰəgʷə́] ‘cat’ in the Cwyzhy dialect of Abkhaz. Although there is typically no unstressed schwa epenthesis in medial CC clusters (see Section 4.1.1), it is not unattested. For example, Lomtatidze (1976: 299 fn. 2) mentions that for the usual [atʰd͡zə́] ‘wall’, the variant pronunciation [atʰəd͡zə́] also exists.

The general consensus that unstressed schwas are predictable is exemplified by the following citation from Lomtatidze (1976). She mentions the law of two consonants, named after the fact that a schwa appears before the final CC in what would otherwise be

CCC or CCCC sequences as shown in Sections 4.1.2-4.1.3 above. Making reference to many of the generalizations from earlier in this section, and including also the similar patterns in closely related Abaza, she writes:

> Despite a range of exceptions (for example, the appearance of **ə** even between two consonants, and the absence of **ə** between three, four, or more consonants..) the law of "two consonants" is evidently valid for the appearance of the vowel **ə** in these languages. (Lomtatidze 1976: 299, bolding in original)[15]

Arstaa et al. (2014: 45-46) describe the generalizations for the predictable appearance of CCC, CCCC, and CCCCC clusters with example words, some of which I have cited in previous sections, and they argue that unstressed schwa is not a phoneme (Arstaa et al. 2014: 47). Yanagisawa (2005: 34) writes that "the contrast /Cə/ versus /C/ in the unstressed condition does not exist, because the presence or absence of an unstressed schwa is predictable." I will return to Yanagisawa's (2005) study of schwa in Abkhaz in Section 4.3. For now I conclude, with most but not all previous authors, that unstressed schwa is predictable in Abkhaz.

4.2 Schwa with primary stress

Whereas there is general agreement that unstressed schwas are predictable in Abkhaz, the anaysis of stressed schwas is much more controversial. As I show in this section, the presence of schwa and the location of primary stress covary. It is evident that the phonology of Abkhaz makes some connection between schwa and stress. However, two main analyses present themselves as natural hypotheses. In one, underlying schwas are

15 Original Russian: "Немотря на целый ряд исключени й [sic] (напр., появление **ə** и между двумя согласными, остутствие **ə** даже между тремя, четырьмя и более согласными..) в отношении появления гласного **ə** в названных языках явно действует закон 'двух согласных'.", my translation.

deleted in unstressed position. In the other, there are no underlying schwas, and they are instead epenthesized after consonants to carry stress when there is no lexical vowel to do so.

Both of these analyses are plausible, and initially seem to account for the data equally well. However, I will show that there are phonotactic restrictions which apply to schwa, but not to the other main lexical vowel quality in native Abkhaz words, namely /a/. I argue that these phonotactic restrictions, for which I provide quantitative evidence, support the epenthesis analysis. The observable restrictions on schwa follow automatically from an analysis where schwa is epenthesized under stress, but must be stipulated if schwa is a phoneme which deletes in unstressed position. In this section I begin by presenting the data on the connection between schwa and stress. I then outline the two possible analyses, and illustrate the disagreement between these in previous literature. After this I discuss the phonotactic data which I argue support the epenthetic account.

4.2.1 Correlations between schwa and primary stress

In synchronic Abkhaz phonology, there are pervasive alternations between schwa and the absence of a vowel. This can be contrasted with the behavior of the vowel /a/, which shows no such alternations in the same environments. For example, when the stem 'horse' is stressed it surfaces as [t͡ʂʰə́] (7) a. i. When other morphemes in the word bear the stress, 'horse' instead surfaces as [t͡ʂʰ] (7) a. ii.-iii. There is therefore an alternation [Cə́]~[C]. /Ca/ stems show no such alternations. Compare the behavior of 'horse' in (7) a. with the behavior of 'dog' in (7) b., which is [lá]~[la] and not *[lá]~[l]. The affixes in (7)

a. and b. are identical, with only the stems differing. Additional cases of [Cə́]~[C] alternations in other grammatical contexts are shown in (7) c., e., g., with corresponding non-alternations for [Ca] in (7) d., f., h. The morphemes of interest are bolded.

(7) Covariation between stress and [ə]

a. Yanagisawa (2010: 539)

i.	[a-**t͡ʂʰə́**] DEF-horse	аҿы	'horse'
ii.	[a-**t͡ʂʰ**-kʷʰá] DEF-horse-N.PL	аҿеқәа	'horses'
iii.	[a-**t͡ʂʰ**-gʲə́] DEF-horse-also	аҿегьы	'the horse also'

b. Dybo (1977: 42)

i.	[a-**lá**] DEF-dog	ала	'dog'
ii.	[a-**la**-kʷʰá] *[a-**l**-kʷʰá] DEF-dog-N.PL	алақәа	'dogs'
iii.	[a-**la**-gʲə́] *[a-**l**-gʲə́] DEF-dog-also	алагьы	'the dog also'

c.

i.	[**sə́**-pʰʃʷma] 1S.POSS-host Aršba (1979: 90)	сыпшәма	'my host'
ii.	[**s**-nap'ə́] 1S.POSS-hand Aršba (1979: 22)	снапы	'my hand'

d.

i. [**á**-p^{h}ʃ^{w}ma] ацшәма ‘host’
DEF-host
Aršba (1979: 90)

ii. [**a**-nap’ə́] анапы ‘hand’
*[nap’ə́]
DEF-hand
Aršba (1979: 22)

e.

i. [a-**nə́**-la-ra] анылара ‘to go onto’
DEF-PREV(on)-go-INF
Yanagisawa (2010: 324)

ii. [a-**n**-p^{h}a-rá] анцара ‘to bounce off’
DEF-PREV(on)-jump-INF
Yanagisawa (2010: 316)

f.

i. [a-**t^{h}á**-la-ra] аҭалара ‘to go into’
DEF-PREV(in)-go-INF
Yanagisawa (2010: 403)

ii. [a-**t^{h}a**-gə́la-ra] аҭагылара ‘to stand in’
*[a-**t^{h}**-gə́la-ra]
DEF-PREV(in)-stand-INF
Yanagisawa (2010: 400)

g.

i. [də-z-**k’ə́**] дызкы ‘who caught him/her (relative clause)’
3SHA-E.REL-catch
Yanagisawa (2010: 208)

ii. [də-s-**k’**-χ^{j}é-jt’] дыскхьеит ‘I have already caught him/her’
3SHA-1SE-hold-PRF-DYN.FIN
Yanagisawa (2010: 208)

h.

i. [də-z-**bá**] дызба ‘who saw him/her (relative clause)’
3SHA-E.REL-see
Yanagisawa (2010: 54)

ii. [bə-z-**ba**-χʲé-jt’] бызбахьеит ‘I have already seen you’
*[b-zə-**b**-χʲé-jt’]
2SFA-1SE-see-PRF-DYN.FIN
Yanagisawa (2010: 53)

For the sake of completeness, it must be noted that [a]~[Ø] alternations were historically frequent in Abkhaz. For example, the word [án] ‘mother’ comes from an earlier form [ána] through deletion of the unstressed /a/, as is still visible in the plural [ána$\widehat{t\int}^{wh}$a] (Arstaa et al. 2014: 58). This is especially evident when comparing Northwest Caucasian languages and dialects. For example, in Cwyzhy Abkhaz the word for ‘sun’ is [ámara] (Andersson et al. 2023) while in Abzhywa Abkhaz it is [ámra] (Yanagisawa 2010: 292). Aršba (1979, 1992) discusses this question and related issues, with a wealth of data from across the Northwest Caucasian family.

In synchronic Abzhywa Abkhaz, systematic alternations are limited to two contexts that I am aware of. /a/-final stems often show an allomorph without this [a] if they are unstressed in affirmative imperative forms (see Arstaa et al. 2014: 57-58, Yanagisawa 2013: 271-272). Additionally, [a]~[Ø] allomorphy is found in /a/-final preverbs to mark the distinction between introvert (movement inwards or towards the subject) and extrovert (movement outwards or away from the subject) verbal actions (Lomtatidze 1976: 300, Yanagisawa 2013: 105-111). Once again relevant morphemes are bolded.

(8) Morphological alternations between [a] and zero

a. Yanagisawa (2010: 433)

i. [á-**fa**-ra] афара 'to eat'
DEF-eat-INF

ii. [jí-**f**] Иф! 'Eat it/them!'
[jí-**fa**] Ифа!
3NA-eat

b.

i. [á-**ʃa**-t͡s'a-ra] ашьацара 'to put on (the upper body)
DEF-PREV(upper.body)-put-INF
Yanagisawa (2010: 562)

ii. [á-**ʃ**-χ-ra] ашьхра 'to take off (the upper body)'
DEF-PREV(upper.body)-be.on-INF
Yanagisawa (2010: 569)

Despite these scattered morphological traces of earlier /a/-deletion in unstressed position, it is clear from the data above that schwa alternates with zero frequently and in a phonologically defined environment (stressed vs. unstressed position), while /a/ shows no such alternations in the same environments.

4.2.2 Epenthesis and deletion analyses

Whenever there are productive alternations between a segment and zero, at least two analyses are possible: either there is an underlying segment, which is sometimes deleted, or there is no underlying segment, and one is sometimes epenthesized. In the case at hand, we may be dealing with deletion of an underlying unstressed schwa. This would involve underlying forms of the shape /t͡ʂʰə/ 'horse', /sə-/ 'first-person singular possessive', and so on. A surface form like [s-nap'ə́] 'my hand' would come from underlying /sə-nap'ə/ through deletion of schwa. Alternatively, the connection between schwa and stress may be due to epenthesis. On this analysis, a morpheme like /s-/ is not able to bear stress on its own in Abkhaz. When stress is assigned to it, and when there is no immediately adjacent lexical vowel to carry that stress, it surfaces instead with schwa epenthesis as [sə́-]. For example, [sə́-pʰʃʷma] 'my host' is underlyingly /s-pʰʃʷma/, with schwa epenthesis enabling stress to fall on a vowel in the prefix. Lomtatidze (1976: 296-297) succinctly describes the latter position while arguing for the former.

Deciding between these two analyses is a longstanding issue in the phonology of Northwest Caucasian languages. Colarusso (1988: 347-372) provides an overview of some previous work, and argues for the unpredictability of schwa across the family. His conclusion nicely summarizes the analytical conflict both linguists and speakers have found themselves in, as well as his view on how different Northwest Caucasian languages have resolved it.

> All the NWC [Northwest Caucasian - SA] languages have underlying /ə/'s as well as epenthetic ones. /.../ The parent language had underlying /ə/'s, with, perhaps, an early tendency toward deletion in certain unstressed positions. As deletion spread it became a matter of choice in some areas of the grammar whether to treat /ə/'s as underlyingly present and to consider their absence a matter of rule, or to do the opposite, consider their presence as predictable and retain only a few relict /ə/'s. The Circassians and the Ubykhs chose the former alternative, the Abkhazians and Abazins the latter. (Colarusso 1988: 372)

Works arguing for schwa being fully predictable include Kuipers (1960) on Kabardian, and Allen (1965) on Abaza with discussion of Kabardian and Abkhaz, Anderson (1978) on Abaza and Kabardian, and Trigo (1992) on Abkhaz. The modern consensus, however, is that Abkhaz has, and Northwest Caucasian languages have in general, two underlying vowel phonemes in native words, /a/ and /ə/. This is the only analysis presented in grammars of Abkhaz (Aristava et al. 1968, Hewitt 1979, Arstaa & Č̣ʼḳadua 2002, Chirikba 2003, Jakovlev 2006, Yanagisawa 2013, Arstaa et al. 2014), and it has been argued for by Colarusso (1988), Yanagisawa (2005), and Vaux & Samuels (2018) among others.

Many of the proponents of two-vowel analyses recognize that the unstressed schwas in Section 4.1 are predictably epenthesized, but maintain that phonemic schwas remain. One such compromise position is found in Arstaa et al. (2014: 47), who conclude that "the stressed vowel ы́ [schwa - SA] is a phoneme; the unstressed vowel is not a phoneme".[16] Below I will argue that stressed schwas are in fact predictably epenthesized based on stress, and do not require phonemic status.

4.2.3 Arguments for epenthesis

Part of the difficulty in deciding between epenthesis and deletion comes from the fact that both analyses initially seem to explain the data equally well. They both accurately capture the core connection between schwa and stress discussed in Section 4.2.1. However, there are predictive differences between the two accounts, which can be used to argue in favor of epenthesis rather than deletion. In particular, some of the differences between the phonotactic distribution of [a] and [ə] follow automatically from the epenthesis account, but must be stipulated separately if schwa is a phoneme which deletes in unstressed position. Some of the restrictions I discuss are not typically mentioned in previous work on Abkhaz, and none have not been brought to bear on the question of the predictability of schwa to my knowledge.

16 Original Abkhaz: "[а]қәыӷәӷәара змоу абжьыҟа ы́ фонемоуп, измам — фонемаӡам", my translation.

I report quantitative data on phonotactics extracted from Yanagisawa's (2010) dictionary. Using this dictionary as a corpus, it is possible to investigate the distribution of [a] and [ə] in detail. I extracted a list of 5,764 headwords based on the part of speech tags in the dictionary.[17] This list of words includes monomorphemic as well as polymorphic forms, and no separation is made between native and borrowed words. Any restrictions which hold across such a corpus must be explained.

I wrote a Python 3 script to count the number of occurrences of the vowels [a] and [ə] in morpheme-initial, morpheme-medial, and morpheme-final positions in the list of headwords. Note that this is not the same as counting how many morphemes contain each vowel in each position. Many functional morphemes are found in multiple headwords, and each occurrence is counted separately here. The only way to avoid this is to gloss each of the 5,764 words manually, which I have not done. In particular, the numbers for morphemes consisting only of [a] and morphemes which end in [a] will be inflated in the statistics I present. This is because of the ubiquitous /a-/ definite prefix and the infinitive suffix /-ra/. There are several prefixes with the phonological shape /a-/ and several suffixes with the phonological shape /-ra/, so automatic glossing of all headwords to exclude repetitions of these prefixes is not possible.

A separate count is kept for vowels which would otherwise be counted twice: a morpheme consisting just of [a] has both morpheme-initial and morpheme-final [a]. Based on this script the following positional vowel restriction becomes apparent: while many morphemes begin with [a], none begin with [ə]. A restriction against word-initial

17 The tags searched for were: [n.], [adj.], [adv.], [tr., [intr., [labile], [num], [pron.], [prefix, [suffix], [preverb], [verbal, [place name], [interj.], [clitic], [post.], [verbal suffix], [ordinal num.], [Abs.], [personal , [interrog. . Note that some have unclosed square brackets, to allow for cases where additional grammatical information is given before the bracket is closed.

schwa is well-known from previous literature on Abkhaz (Lomtatidze 1976: 301, Hewitt 1979: 261-262, Chirikba 2003: 21, Yanagisawa 2013: 20, Arkadiev & Lander 2021: 379), which follows from the absence of morpheme-initial schwa which I document here.

(9) Figure 4.1

	[a]	[ə]
Morphemes which consist only of...	4,093	0[18]
Morphemes which begin...	778	0[19]
Morphemes which have in the middle...	7,880	1,575
Morphemes which end...	6,121	783

Phonotactic comparison of [a] and [ə]

However, there also exist restrictions on schwa which to my knowledge have not been reported in previous literature. Consider the table below on which vowels occur in hiatus configurations, with data taken from the same source as above. This assumes that [aa] is a sequence of two adjacent vowels, and not a long vowel. This seems justifiable at least for the speakers who contrast [áa] and [aá]. Some speakers lack this contrast (Yanagisawa 2010: 14; see also discussion in Chapter 2, Section 2.2.2.1), and for them a long-vowel analysis may be preferable (but see Chirikba 2003: 20 for arguments that the sound change *ʕa/*aʕ > aa may have a synchronically active analogue ʕa/aʕ → aa in Abkhaz). Note that while vowel hiatus is fairly frequent in this corpus, it never involves the vowel

18 The script returns a 1 rather than a 0 here, as Yanagisawa (2010) includes an entry for [ə-], an allomorph of the agreement prefix /j-/ which surfaces if certain syntactic and phonological conditions are met (Arstaa & Č̦ʼḳadua 2002: 24, Chirikba 2003: 21).

19 The script returns 1 rather than 0 here. The omitted item is a form of [atʰaχə́zaara] ‘want’ with a misplaced morpheme boundary.

schwa either in first or second position.

(10) Figure 4.2

V1↓	V2→	[a]	[ə]
[a]		618	0[20]
[ə]		0[21]	0

Hiatus configurations

As explained by the footnotes in (10), some items are misparsed. I have not verified all 618 instances of [aa] hiatus by hand, so this number likely includes a handful of misparsed forms. Regarding the sole possible example of [aə] hiatus, this appears to be a simple typo. The form in question is [at͡s’aúwla] ацаула ‘depth’, where [uw] is the result of vowel coloring applied to [əw]. Before vowel coloring, Yanagisawa’s (2010) form is therefore [at͡s’aə́wla] with [aə] hiatus. The preferred modern Abkhaz orthographic norms spell this word and others like it ambiguously with <y>, which could represent either [əw] or [wə] (which change to [uw] and [wu] respectively by vowel coloring; see Chapter 1, Section 1.3.2). However, other dictionaries which indicate the pronunciation unambiguously show [at͡s’awúla] without hiatus (Genko 1998: 315). Meurer’s (2018) corpus (searched on 2022-08-30) gives 121 results for ...цауыл... [...t͡s’awúl...] and 0 for ...цаыул... [...t͡s’aúwl...] (and 1,247 hits for the preferred form ...цаул...). The audio materials accompanying Aršpha & Sakaniapha (2015) also provide several examples of

20 The script returns 2 rather than 0 here. One omitted item is [apʰʂáχʲarsra] or [apʰʂáχʲərsra] ‘take a walk’, with one vowel surfacing optionally as [a] or [ə]. This is written in the dictionary as ...а/ы... (...a/ə...), which my script incorrectly parses as a single form *[apʰʂáχʲaərsra] with hiatus. The other item is discussed in the main text.

21 The script returns 6 rather than 0 here. Four are misparses of words which consist of multiple phonological words, such as [agʷə́ at͡ʂ’əʁʲra] ‘be bored’ misparsed as a single word with *[ə́a]. One treats the two orthographic variants of [aʃʷq’ʷə́] ‘book’, ашәҟәы and ашәҟу (the older, now dispreferred variant), as a single word with *[ə́a]. One treats an IPA transcription guide as part of the word: the dictionary has “адауы /a-dawə́/” for ‘ogre’, and this is misparsed as a single word адауыadawə́.

this word and morphologically related forms pronounced without hiatus as [...t͡s’awúl...]. The discussion below will assume that this is a typographical error, and that schwa is categorically absent in vowel hiatus configurations in Abkhaz.

This shows that there are strong restrictions on the distribution of schwa in Abkhaz. The borrowed Abkhaz lexicon features several entirely new vowel phonemes, and the dictionary corpus includes both morphologically simple and complex forms. Despite this, the restrictions on schwa are absolute across all of these words. The following three generalizations are exceptionless:

(11) Generalizations about schwa

a. Schwa never appears as V1 in vowel hiatus

b. Schwa never appears as V2 in vowel hiatus

c. Schwa never appears in morpheme-initial position

Below I will argue that (11) b.-c. can help adjudicate between epenthesis and deletion analyses of schwa in Abkhaz. Before this, I will show that (11) a. is not useful for distinguishing these analyses. The following data show the prefix [sə́-]~[s-] attaching to vowel-initial stems, where outputs with *[əa] are ungrammatical.

(12) Absence of *[əa]

a. Aršba (1979: 90)

i. [árt͡sʰna] арцна ‘hen’
DEF.hen

ii. [s-árt͡sʰna] сарцна ‘my hen’
*[sə́-art͡sʰna]
*[sə-árt͡sʰna]
1S.POSS-hen

b. Yanagisawa (2010: 302)

i. [án] ан 'mother'
DEF.mother

ii. [s-án] сан 'my mother'
*[sə́-an]
*[sə-án]
1S.POSS-mother

If schwa is a phoneme, then underlying /sə-an/ becomes [s-án] 'my mother' by a process of schwa deletion in hiatus. If schwa is epenthetic, underlying /s-an/ stays unchanged as [s-án], since there is an immediately adjacent lexical vowel which can carry the stress, and there is no need to epenthesize a schwa. Both of these analyses are possible, and I am not aware of any predictive differences between them. However, the same is not true of the other distributional restrictions on schwa. (11) b. and c. follow automatically from an epenthesis analysis. For (11) b., schwa cannot appear as V2 in hiatus, because in vowel hiatus there is by definition no preceding consonant to motivate epenthesis. For (11) c., schwa cannot appear in morpheme-initial position because again there is by definition no preceding consonant to motivate epenthesis.

By contrast, in the deletion analysis, there is no reason to expect that schwa should be banned in vowel hiatus or in morpheme-initial position. Given words like [abá] аба 'dry', [ad^{w}ə́] адəы 'field', and [abaá] абаа 'rotten' (Yanagisawa 2010: 51-52, 110), it is not obvious why words like *[abaə́] should not also be possible. Similarly, given vowel-initial words like [án] 'mother' (Yanagisawa 2010: 302) and [árt͡s^{h}na] 'hen', (Aršba 1979: 90) it is not obvious why words like *[ə́n] do not also exist. Full vowels like /a/ and central vowels like /ə/ may of course have different phonotactic distributions in any given language, but such differences have to be stipulated in Abkhaz, and not follow from having unstressed schwas delete. Since they do follow from having schwas be epenthesized under stress, I propose that this is a better analysis of the data in (7) in Section 4.2.1 showing that the location of stress and the presence of schwa covary.

Schwas are predictably epenthesized immediately after a consonant when there is no available lexical vowel to carry stress. The underlying form of the first-person singular possessive prefix is /s-/, and the surface allomorph [sə́-] only appears when the prefix is stressed and there are no immediately adjacent lexical vowels. In /s-an/ 'my mother', a lexical vowel is available, and so the form is [sán] rather than *[sə́-an]. In /s-pʰʃʷma/ 'my host' there is no lexical vowel available, and so the form must be [sə́-pʰʃʷma] with schwa epenthesis.

This epenthesis analysis could be implemented in several ways. In the framework of Harmonic Serialism, Elfner (2009) proposes analyses where some languages allow headless syllables at early stages of the phonological derivation, which are then repaired by a constraint SyllHead: "assign one violation mark for every syllable that does not dominate at least one mora" (Elfner 2009: 16). An alternative analysis would stipulate directly that (stressed) syllables in Abkhaz must contain vowels, without using the mora as an intermediary.

These hypotheses would be empirically distinguishable if Abkhaz had non-moraic epenthetic vowels (for this possibility, see discussion in Piggott 1995, Hall 2011, among others). However, I am not aware of any reason to postulate non-moraic stressed vowels in Abkhaz. In the poetic scansion data in Chapter 8, Section 8.1.3, Abkhaz schwas under primary stress do appear to contribute to syllable weight, as they are counted for the purposes of scansion. Without such evidence, I am not aware of any empirical data that would allow us to adjudicate between the two implementations of the epenthesis analysis.

In the segmental analysis of Abkhaz stress in Chapter 7 I formalize schwa epenthesis as a two-step process where a schwa is first inserted after an accented consonant, followed by a process of stress shift to ensure that stress surfaces on the epenthetic schwa. I also discuss a Harmonic Serialism implementation of schwa epenthesis where a constraint against foot heads which do not contain vowels drives the epenthesis process.

4.2.4 Summary

In this section I have presented data relevant to the predictability of stressed schwa. Whether this vowel is phonemic or not has been a topic of debate in the field of Northwest Caucasian linguistics for many decades. Two analyses appear possible to account for the fact that the presence of schwa covaries with the location of stress in a systematic manner. One analysis posits underlying schwas which delete in unstressed position. Another avoids underlying schwas, and instead epenthesizes them when required to carry stress.

I have argued that phonotactic restrictions provide independent support for the epenthesis analysis. Only this account predicts the absence of schwa in morpheme-initial position, and the absence of schwa in vowel hiatus. These phonotactic restrictions, which I have shown to be exceptionless in Abkhaz, have not previously figured in the debate about the predictability of schwa in Abkhaz. I hope to have shown that by bringing in additional data from other parts of the language, it is possible to make progress on thorny issues in Abkhaz linguistics.

The conclusions in this section do not, however, guarantee the success of an analysis where the phoneme inventory of Abkhaz completely lacks schwas. In order for that argument to go through, one would need to account for all types of schwa in the language, and there is one type I have not yet discussed. In the next section I turn to schwas with secondary stress. These have proven to be some of the most challenging datapoints for analyses without underlying schwa, and it is important to investigate them in some detail.

4.3 Schwas with secondary stress

In the previous section I noted that the consensus view of Abkhaz schwa is that it is a phoneme, at least some of the time. Many of the linguists who have come to this conclusion have done so because of the existence of apparently unstressed schwas which cannot be explained by other mechanisms: they do not always appear in consonant clusters, and they do not obviously bear any relation to the stress system. They are also capable of forming perfect minimal pairs with the absence of a schwa, which is a strong argument for awarding schwa phonemic status in Abkhaz.

In this section I will argue that even these schwas can be predicted, and do not have a random distribution which would require them to be lexical. Instead, these schwas are deeply connected to the stress system of the language, and only appear in morphemes which in other contexts carry primary stress. Since stress is a lexical property in Abkhaz, and since this stress can predict where schwas will appear outside of primary stress contexts, there is no need to additionally posit underlying schwas. These phonological arguments are not new, and essentially replicate the reasoning in Spruit (1986). However, I present additional data supporting the empirical correlation between morphemes which can carry primary stress, and morphemes which show a schwa when they do not carry primary stress. I hope that by making such data more readily available to linguists working on Abkhaz, I can show that the distribution of Abkhaz schwa is not as unpredictable as it may initially seem.

I also report on a small-scale acoustic study showing that for at least some speakers there is a measurable secondary stress on the relevant schwas (and on the vowel /a/ in accentually similar environments), a phonetic correlate of their accentual status. Not all speakers show clear evidence for such secondary stresses, but although they are typically absent in linguists' transcriptions of Abkhaz, several authors have reported impressionistically that the relevant schwas have secondary stress. I will continue throughout this dissertation to refer to these schwas as having secondary stress, and in the analysis in Chapter 7 these vowels will have a gridmark in a metrical grid corresponding to their higher prominence. It appears that for some speakers, this prominence is only phonological, while for others it is also present phonetically.

4.3.1 Minimal pairs

It is appropriate to begin with apparent minimal pairs for the presence vs. absence of schwa. Yanagisawa (2005) notes the following minimal pair. The two forms below consist of five morphemes, the first four of which are identical in both forms. The final morpheme in (13) a. is the past absolute suffix (see Chapter 1, Section 1.3.3.2 for additional discussion of this suffix), which has the form [-nə]. The final morpheme in (13) b. is a different past tense suffix which has the form [-n].[22] These two final suffixes

22 As I have attempted to indicate by the translation, this is a past tense form which cannot form a

appear to be minimal pairs: /-nə/ vs. /-n/. Later in this section I will argue that (13) a. should in fact be transcribed as [s-b-á-t͡ʃʷʰħa-nə̀], with a secondary stress on the schwa. Below I give Yanagisawa's (2005) transcriptions.

(13) An apparent minimal pair (Yanagisawa 2005: 35)

a. [s-b-á-t͡ʃʷʰħa-nə] сбацəҳаны 'me having scolded you'
1SA-2SFO-DAT-scold-PST.ABS

b. [s-b-á-t͡ʃʷʰħa-n] сбацəҳаны 'I scolded you and ... '
1SA-2SFO-DAT-scold-PST

Although the two morphosyntactic categories displayed in (13) are similar in meaning and function, it is not the case that they are simple phonological variants which linguists have erroneously given different translations. Several differences between them are shown in (14). The suffix [-nə] has the property of suppressing overt marking of ergative arguments, while [-n] does not (14) a. The suffix [-nə] can be used to form adverbs, while [-n] cannot (14) b. Forms with the suffix [-nə] cannot be relativized, while forms with the suffix [-n] can (14) c. In such relative forms, the [-n] surfaces as [-z], suggesting that it is the same morpheme as in several other past tense constructions in Abkhaz, all of which also have relative forms in [-z] (14) d.-e. The suffix [-nə] does not participate in any such alternations, and does not appear in any other past tense constructions. In conclusion, these are two different morphemes, which despite their sometimes similar uses, merely happen to be near-homophones.

complete sentence of its own, and which must be followed by another verb. An example sentence is from Yanagisawa (2010: 301) is [dt'ʷán dt͡ʃʷʰáʒʷejt'] '(S)he sat down and began to speak'. Here the first verb has the suffix /-n/, and it is translated as '(S)he sat down and...'. The second verb [dt͡ʃʷʰáʒʷejt'] '(s)he spoke' is the main verb; it uses a different past tense suffix which can form a complete sentence in Abkhaz.

(14) Differences between [-n] ‘PST’ and [-nə] ‘PST.ABS’

a. Yanagisawa (2010: 53-54)

i. [d-ba-nə́] дбаны ‘having seen him/her’
3SHA-see-PST.ABS

ii. [bə-z-bá-n] бызбан ‘I saw you and ... ’
[*b-b-án]
2SFA-1SE-see-PST

b. Yanagisawa (2010: 169)

i. [ji-bzíja-nə] ибзыианы ‘well’
3NA-good-PST.ABS

ii. *[ji-bzíja-n][23]
3NA-good-PST

c. Yanagisawa (2010: 54)

i. *[də-z-ba-zə́]
*[də-z-ba-nə́]
3SHA-E.REL-PST.ABS

ii. [də-z-bá-z] дызбаз ‘who saw him/her’
3SHA-E.REL-see-PST

d. Hewitt (2010: 304)

i. [s-gə́lo-n] сгылон ‘I was standing’
1SA-stand.DYN-PST

ii. [s-gə́la-rə-n] сгыларын ‘I would stand’
1SA-stand-COND1-PST

iii. [s-gə́la-ʂa-n] сгылашан ‘I would stand’
1SA-stand-COND2-PST

iv. [s-gə́la-χʲa-n] сгылахьан ‘I had stood’
1SA-stand-PRF-PST

e. Hewitt (2010: 304)

23 This form is grammatical as a stative verb meaning ‘it was good’, but crucially not as an adverb, making it different from (14) b. i.

i. [ji-gə́lo-z] игылоз ‘who was standing’
A.REL-stand.DYN-PST

ii. [ji-gə́la-rə-z] игыларыз ‘who would stand’
A.REL-stand-COND1-PST

iii. [ji-gə́la-ʂa-z] игылашаз ‘who would stand’
A.REL-stand-COND2-PST

iv. [ji-gə́la-χʲa-z] игылахьаз ‘who had stood’
A.REL-stand-PRF-PST

When one is faced with a perfect minimal pair, there is no escaping the conclusion that there must be some contrast accounting for the difference. In many cases that difference is identical to the one between the surface forms. For example, if [b] and [p] contrast in a language, forming minimal pairs, the simplest conclusion is that there is a phonemic contrast /b/-/p/. Unsurprisingly, Yanagisawa (2005) takes the data in (13) to be support for the existence of underlying schwa in Abkhaz. Colarusso’s (1988) arguments for the existence of underlying schwa in Northwest Caucasian languages are based on similar data, where some schwas, without any obvious motivation, remain in apparently unstressed positions.

However, sometimes minimal pairs do not require the postulation of additional phonemes. An example is the split involving the vowels in the lexical sets GOAT and GOAL in some varieties of English (Wells 1982: 312-313). These present the surface minimal pair [həʊli] ‘holy’ vs. [hoʊli] ‘wholly, holey’. However, they do not necessarily require a phonemic distinction /əʊ-oʊ/. Instead, the different surface representations arise from the fact that ‘holy’ is monomorphemic, while ‘wholly’ and ‘holey’ are transparently polymorphemic (from ‘whole’ and ‘hole’ respectively). The vowel phoneme /əʊ/ simply shows a different pronunciation before tautomorphemic /l/, which is independently seen in [hoʊɫ] 'whole, hole'. Here an independent contrast, that between mono- and polymorphemic words, can be used to explain minimal pairs without additional phonemes.

I will argue that a similar situation obtains in Abkhaz. The apparent minimal pairs for schwa are not due to a schwa phoneme, but due to an independently motivated contrast in the stress system. The language epenthesizes schwa based on the stress status of a morpheme. When the relevant morphemes appear without primary stress, the schwa is still epenthesized due to the morpheme's stress properties. Later in this section I will show that some speakers also have acoustic evidence for a secondary stress on these schwas.

4.3.2 Independent evidence from the stress system

In this subsection I will argue that there is indeed an independently needed contrast in the stress system of Abkhaz which correlates with the presence or absence of schwa in what some previous work takes to be unstressed position. I will show that the unexpected schwas in Section 4.3.1 above can all bear primary stress in morphologically related forms, while words which appear without schwa never bear primary stress in the same morphological environments. In Chapter 5 I will argue that Abkhaz has two underlying accentual categories, which I call accented and unaccented. Only the accented category allows for the unexpected schwas to appear.

Since their distribution appears tied to the stress system, it is unsurprising that the relevant schwas have been noted by several authors as carrying secondary stress. Later in this chapter I will discuss acoustic evidence for secondary stress in Abkhaz based on experimental data. In Chapter 5, Section 5.6 I will give a detailed description of the phonological environments in which secondary stress appears, which depends on an in-depth understanding of primary stress assignment in Abkhaz. Here I am content to talk only of 'stressable' and 'unstressable' morphemes.

I will argue that it is stressable morphemes which retain their schwas, while non-stressable morphemes do not. In (15) a. i., we see that the stem 'swim' is non-stressable, while (15) b. i. shows that the stem 'stand' is stressable in the same context. The contrast between (15) a. ii. and b. ii. shows that only the stressable morpheme 'stand' shows a schwa.

(15) Correlations between stressability and schwa

a. Spruit (1986: 48)

i. [á-d͡zsa-ra] аӡсара 'to swim'
DEF-swim-INF

ii. [á-t͡s'a-d͡zsa-ra] ацаӡсара 'to swim under'
*[á-t͡s'a-d͡zəsa-ra]
DEF-PREV(under)-swim-INF

b. Spruit (1986: 48)

i. [a-gə́la-ra] агылара 'to stand'
DEF-stand-INF

ii. [á-t͡s'a-gəla-ra] ацагылара 'to stand under'
*[á-t͡s'a-gla-ra]
DEF-PREV(under)-stand-INF

Similarly, (16) a. and b. show that 'fly' is non-stressable while 'know' is stressable. In (16) a. i., the citation form of 'fly' does have a schwa, but it is unstressed and motivated by phonotactics, as *[ápʰrra] with three adjacent consonants is not possible (see Section

4.1). When there is no phonotactic motivation, the schwa in 'fly' is not present (16) a. ii., while 'know' retains its schwa because it is a stressable morpheme (16) b. ii.

(16) Correlations between stressability and schwa

a.

i. [á-pʰər-ra] ацырра 'to fly'
DEF-fly-INF
Yanagisawa (2010: 350)

ii. [d-á-r-pʰr-ijt'] дарприт 'it made him/her fly'
*[d-á-r-pʰər-ijt']
3SHA-3SNE-CAUS-fly-DYN.FIN
Yanagisawa (2010: 371)

b.

i. [a-də́r-ra] адырра 'to know'
DEF-know-INF
Yanagisawa (2010: 107)

ii. [ħ-ajbá-m-dər-ijt'] ҳаибамдырит 'we did not get to know each other'
*[ħ-ajbá-m-dr-ijt']
1PA-RECIPROCAL-NEG-know-DYN.FIN
Yanagisawa (2010: 167)

In (17) a. and b. I show that 'meat' is stressable while 'old' is non-stressable, and only 'meat' retains its schwa.

(17) Correlations between stressability and schwa

a.

i. [á-ʒʷ] ажә 'old'
DEF-old
Spruit (1986: 40)

ii. [á-t͡sʰħa-ʒʷ] ацҳажә ‘old bridge’
*[á-t͡sʰħa-ʒʷə]
DEF-bridge-old
Spruit (1986: 43)

b.

i. [a-ʒə́] ажьы ‘meat’
DEF-meat
Yanagisawa (2010: 119)

ii. [á-d͡ʒma-ʒə] аџьмажьы ‘goat meat’
*[á-d͡ʒma-ʒ]
DEF-goat-meat
Yanagisawa (2010: 589)

In (18) a. and b. I show that the suffix [-nə] from the minimal pairs in (13) is stressable, while the suffix [-n] is not. As predicted, this also leads to a difference in whether the schwa is retained.

(18) Correlations between stressability and schwa

a.

i. [d-t͡sʰá-n] дцан ‘(s)he went and ... ’
3SHA-go-PST
Yanagisawa (2010: 494)

ii. [s-b-á-t͡ʃʷʰħa-n] сбацәҳаны ‘I scolded you and ... ’
*[s-b-á-t͡ʃʷʰħa-nə]
1SA-2SFO-DAT-scold-PST
Yanagisawa (2005: 35)

b.

i. [d-t͡sʰa-nə́] дцаны ‘him/her having gone’
3SHA-go-PST.ABS
Yanagisawa (2010: 494)

ii. [s-b-á-t͡ʃʷʰħa-nə] сбацәҳаны ‘me having scolded you’
*[s-b-á-t͡ʃʷʰħa-n]
1SA-2SFO-DAT-scold-PST.ABS
Yanagisawa (2005: 35)

Lomtatidze (1976: 300) discusses data which are perfectly analogous to (18) a.-b. These data may appear to lend themselves well to an analysis in terms of output-output correspondence: if a morpheme surfaces with an epenthetic schwa under primary stress, other forms containing the same morpheme must be faithful to such outputs and also contain a schwa even when they do not have primary stress. However, such an analysis is not viable for Abkhaz. As shown in Section 4.2 above, there are pervasive alternations in Abkhaz where a morpheme appears with a schwa under primary stress, but without a schwa when primary stress is elsewhere. In Chapter 5 I argue instead that the distribution of schwa epenthesis is tied to particular configurations of stressable and unstressable morphemes. Stress is assigned in one accentual configuration by an algorithm known as Dybo’s Rule (Dybo 1977). If there are multiple such configurations in the same word, the leftmost one receives primary stress, while others receive secondary stress. Crucially, both primary and secondary stresses trigger schwa epenthesis. This is all formalized in the theoretical analysis in Chapter 7. Here I merely note the empirical correlation between stressability and schwa, leaving the exact details of the analysis for later chapters.

There also appears to be some morphological conditioning for alternations like those in (15). Especially in final position, schwas are sometimes not found even when part of an otherwise stressable morpheme. For example, a word-final schwa appears to be optional in verb stems. The stem /k’/ ‘hold’ is stressable: [ji-k’ə́] икы ‘hold it!’

(Yanagisawa 2010: 208). Spruit (1986: 75) cites [j-an-tʰá-s-k'ə] ианҭаскы 'when I held it into it', which contains a schwa as expected. However, he states (Spruit 1986: 75) that this schwa "is easily omitted", and Yanagisawa's (2010: 208) forms of this verb do not contain schwa, e.g. [jí-lə-m-k'] илымк 'what she held, that which she held'.

Caveats like these do not change the conclusion from the data in (15): the distribution of schwa can be predicted from the stress status of the morpheme of which it is a part. On the assumption that predictable information does not generally need to be lexically stored, this means that that instead of contrastive schwa — /-nə/ vs. /-n/ — we can use the independently needed contrastive stress categories to predict the distribution of schwa.

The argument above is not novel. Spruit (1986: 73) makes essentially the same argument, and says in relation to these unstressed schwas that the stress status of morphemes "accounts for occurrences of ə so far called 'irrational' (i.e., unaccounted for) in the literature". Trigo (1992), who builds on Spruit's (1986) analysis, also relies on stress status to explain these schwas. However, it seems that this argument for the predictability of these unstressed schwas has not received much attention in the literature. Colarusso (1988) appears to have been unaware of Spruit's work when arguing that schwas of this type require a schwa phoneme, and Yanagisawa (2005) does not consider a stress-based explanation of the minimal pair in (13) either. I hope that readers will find the repetition of the argument and some of the data here helpful, to bring attention to the empirical correlation between stressability and the presence of schwa.

Since the schwas in question are motivated by the stress status of their host morphemes, one may wonder whether they are unstressed, as they are often transcribed, or if they instead bear a lower degree of prominence in the form of secondary stress. Spruit (1986: 73) states that "[t]he preservation of ə in these cases may result from an older secondary stress; in fact, the very presence of ə gives the impression of a secondary stress." Of similar vowels in Abaza, Colarusso (1988: 367) writes that "Genko (1955, 31) notes that there is an impression of secondary stress on the persistent /ə/'s in such words". Lomtatidze (1976: 298) states that word-final schwa always has secondary stress, except of course in words where it has primary stress. Word-final schwas without primary stress can only come from stressable morphemes under the generalizations I have argued for above. In word-final clusters, schwa is always epenthesized in the middle of a cluster, and never at the end (see Section 4.1).

It is even less clear from previous work whether the vowel /a/ in stressable morphemes bears a secondary stress. Spruit (1986: 73) claims not to hear one even though he does hear it on schwa. However, he argues that in imperative forms, the optionality [jí-f]~[jí-fa] 'Eat it/them!' (discussed in Section 4.2.1 above) is only possible for unstressable stems. Stressable morphemes retain [a] in imperatives, just as stressable morphemes retain [ə] in the data earlier in this section. In Chapter 3, Section 3.1.2 I noted that Arstaa et al. (2014: 97) transcribe multiple stresses on words like [á-tʰawád-t͡ʃʷʰa] 'princes'. This may be rendering the pronunciation [á-tʰawàd-t͡ʃʷʰa] with a secondary stress on a vowel which bears primary stress on morphologically related forms: [tʰawád-t͡ʃʷʰa-k'] 'some princes' (Arstaa et al. 2014: 97). However, the multiple stresses they report are irregularly distributed across morphological paradigms, a fact for which I have no explanation. Immediately below I report on an acoustic study of secondary stress in Abkhaz. There is evidence that at least some speakers have secondary stresses on stressable morphemes, both on [a] and [ə].

4.3.3 Acoustic data

In this section I look for acoustic evidence for secondary stresses in Abkhaz in the phonological positions where unexpected schwas are found. In Chapter 2, Section 2.1 I reported on the methodology for an experiment on secondary stress in Abkhaz. Here I report the stimuli, results, and analysis of this experiment. By way of repetition, the experiment involved four speakers of Abkhaz reading words with vowels in three conditions: primary stress, unstressed, and (possible) secondary stress. I examined F0, intensity, and duration of the relevant vowels, and analyzed the data statistically with nested linear mixed effects models, just as in Chapter 3, Section 3.2 on primary stress. At least two speakers show acoustic evidence for a distinction between unstressed vowels and vowels with secondary stress. However, secondary stress is much less reliably detectable than primary stress, and it seems that at least for the correlates investigated here, not all speakers make a distinction between secondary stress and absence of stress.

4.3.3.1 Stimuli

Note that the experiment looks for secondary stress both on [ə] and on [a]. As explained in Section 4.3.2, the segmental alternations between schwa and zero are suggestive of stress, and there are impressionistic reports of secondary stress on schwa. However, in light of some authors reporting multiple stresses on /a/ as well (see Section 4.3.2), both vowel qualities are investigated here. Stimuli were categorized in conditions based on their phonological behavior in dictionary material. In particular, words were placed in the secondary stress condition if the vowel of the relevant morpheme appeared with primary stress in other words, while they were placed in the unstressed condition if the vowel of the relevant morpheme appeared as unstressed or as zero (in the case of schwa) in other words.

For the low vowel, it was easiest to find parallel stimuli for all three conditions using vowels in word-final position. The same option was not available for schwa. Unstressed schwa only appears in the middle of consonant clusters (see Section 4.1), so word-final unstressed schwas do not exist. Instead the schwa stimuli are all word-medial, and words in the unstressed and secondary stress conditions have the form áCCəCCa. In the unstressed condition, a schwa appears in what would otherwise be a /CCCC/ cluster (see Section 4.1), and in morphologically related forms with fewer surrounding consonants, no schwa appears. In the secondary stress condition, a schwa appears in áCCəCCa because of the stress properties of the relevant morpheme, and in morphologically related forms with fewer surrounding consonants, there is also a schwa.

This is illustrated in (19) below. (19) a. shows the morpheme [p^hr]~[p^hər], which is in the unstressed condition since it is never stressed, and since a schwa only appears when motivated by consonantal phonotactics. (19) b. shows the morpheme [də́r]~[də̀r], which does show up with primary stress some of the time, and whose schwa (transcribed here with secondary stress) remains even when the morpheme is flanked by vowels. (19) a. i. and (19) b. i. are stimulus words included in the experiment.

(19) Secondary stress and schwa

a.

i. арцырра
[á-r-pʰər-ra]
DEF-CAUS-fly-INF
'let fly, make fly'
Yanagisawa (2010: 371)

ii. [á-pʰər-ra]
DEF-fly-INF
'fly'
Yanagisawa (2010: 350)

iii. дарцрит
[d-á-r-pʰri-jt']
3SHA-3SNE-CAUS-fly-DYN.FIN
'it made him/her fly'
Yanagisawa (2010: 371)

b.

i. амдырра
[á-m-də̀r-ra]
DEF-NEG-know-NMLZ
'ignorance'
Yanagisawa (2010: 290)

ii. адырра
[a-də́r-ra]
DEF-know-NMLZ
'knowledge'
Yanagisawa (2010: 107)

iii. ҳаибамдырит
[ħ-ajbá-m-də̀r-ijt']
1PA-RECIPROCAL-NEG-know-DYN.FIN
'we did not get to know each other'
Yanagisawa (2010: 167)

The fact that schwas are studied in medial position while low vowels are studied in final position means that the same word can be included in two different conditions. For example, [á-m-də̀r-ra] ‘ignorance’ appears both in the ‘secondary stress on schwa’ condition because of the medial vowel and in the ‘unstressed low vowel’ condition because of the final vowel. Below I list all stimulus items and the conditions they belong to. There are occasional exceptions where items were reclassified into different conditions for individual participants based on their stress pattern for the relevant word; all such cases are listed in detail in Chapter 2, Section 2.1.5. In the ‘Word’ column below I underline the vowels studied, which are also identified in parentheses in columns three and four. I transcribe all vowels in the secondary stress condition with secondary stress here.

As with Experiment 1 from Chapter 3 not all words were read by all participants. For example, after the pilot run I replaced [ápʰχənkʷʰà] ‘summers’ with the (metrically equivalent) [ápʰχənrà] ‘summertime’ based on speaker feedback about the word for ‘summers’ sounding unnatural. The fifth column in (20) below indicates which participants read which words.

(20) Figure 4.3

Word	Translation	Condition (one)	Condition two	Participants
[agʷə̲́ʁra̲]	'hope (n.)'	Primary (medial ə)	Unstressed (final a)	ABCD
[ot͡ʃʰamt͡ʃʰə̲́raq'a̲]	'to Ochamchira'	Unstressed (final a)		ABCD
[agʷə̲́ʁrà̲]	'hope (verb)'	Primary (medial ə)	Secondary (final a)	A
[ákʷʰk'ʲə̲̀srà̲]	'touch above'	Secondary (medial ə)	Secondary (final a)	ABCD
[adə̲́rrà̲]	'know'	Primary (medial ə)	Secondary (final a)	ABCD
[ɥə́nɥaʒʷaq'à̲]	'approximately forty'	Secondary (final a)		ABCD
[árdə̲drà̲]	'make thunder'	Unstressed (medial ə)	Secondary (final a)	ABCD
[ak'ʲə̲́srà̲]	'touch'	Primary (medial ə)	Secondary (final a)	ABCD
[ákʷʰtʰə̲χrà̲]	'redraw'	Unstressed (medial ə)	Secondary (final a)	ABCD
[ápʰχə̲nkʷʰà̲]	'summers'	Unstressed (medial ə)	Secondary (final a)	A
[adə̲́rra̲]	'knowledge'	Primary (medial ə)	Unstressed (final a)	A
[ámdə̲̀rrà̲]	'ignorance'	Secondary (medial ə)	Secondary (final a)	ABCD
[abəlrá̲]	'burn'	Primary (final a)[24]		ABC
[árpʰə̲rrà̲]	'let fly'	Unstressed (medial ə)	Secondary (final a)	ABCD
[ɥaʒʷaq'á̲]	'approximately twenty'	Primary (final a)		ABCD
[atʰə̲́χəmtʰa]	'drawing'	Primary (medial ə)		ABCD
[adʷə̲́ʁba]	'train'	Primary (medial ə)		BCD

24 This word was not elicited to be part of this experiment, since the dictionary gives it with initial stress as [ábəlra], and the low vowels studied in this experiment are all in final position. However, some speakers unexpectedly produced the word with final stress (see Chapter 2, Section 2.1.5 for discussion), and therefore I included their productions of this word here.

[agʷə̱́pʰkʷʰà̱]	‘groups’	Primary (medial ə)	Secondary (final a)	BCD
[ápʰχə̱nrà̱]	‘summertime’	Unstressed (medial ə)	Secondary (final a)	BCD
[at͡sʰəgʷkʷʰá̱]	‘cats’	Primary (final a)		B
[(j)esd͡zənrá̱]	‘every summer’	Primary (final a)		CD

Breakdown of which participants read which words (Experiment 2)

The table below shows how many vowels were analyzed for each participant. Due to the exclusions which were discussed in detail in Chapter 2, Section 2.1.5, Speaker C had no tokens with [ə] in the secondary stress condition.

(21) Figure 4.4

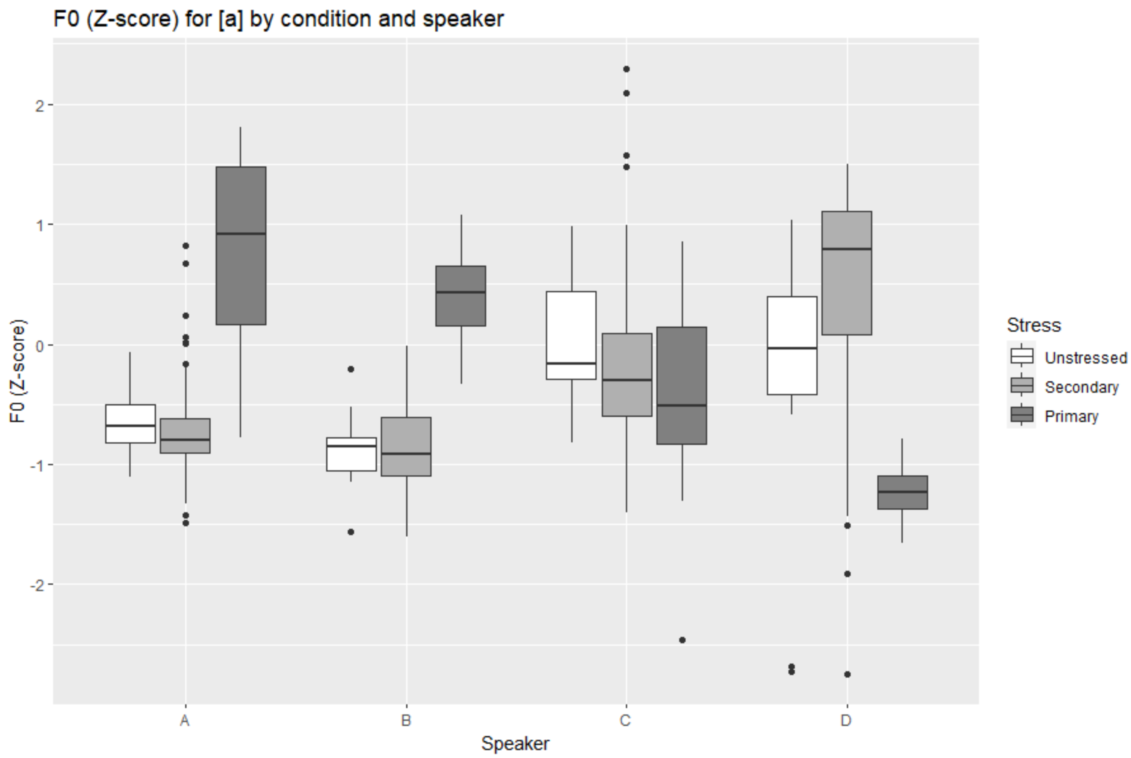
Speaker A	Speaker B	Speaker C	Speaker D	Total
234	234	195	205	868

Number of tokens per participant (Experiment 2)

4.3.3.2 Visualization of data

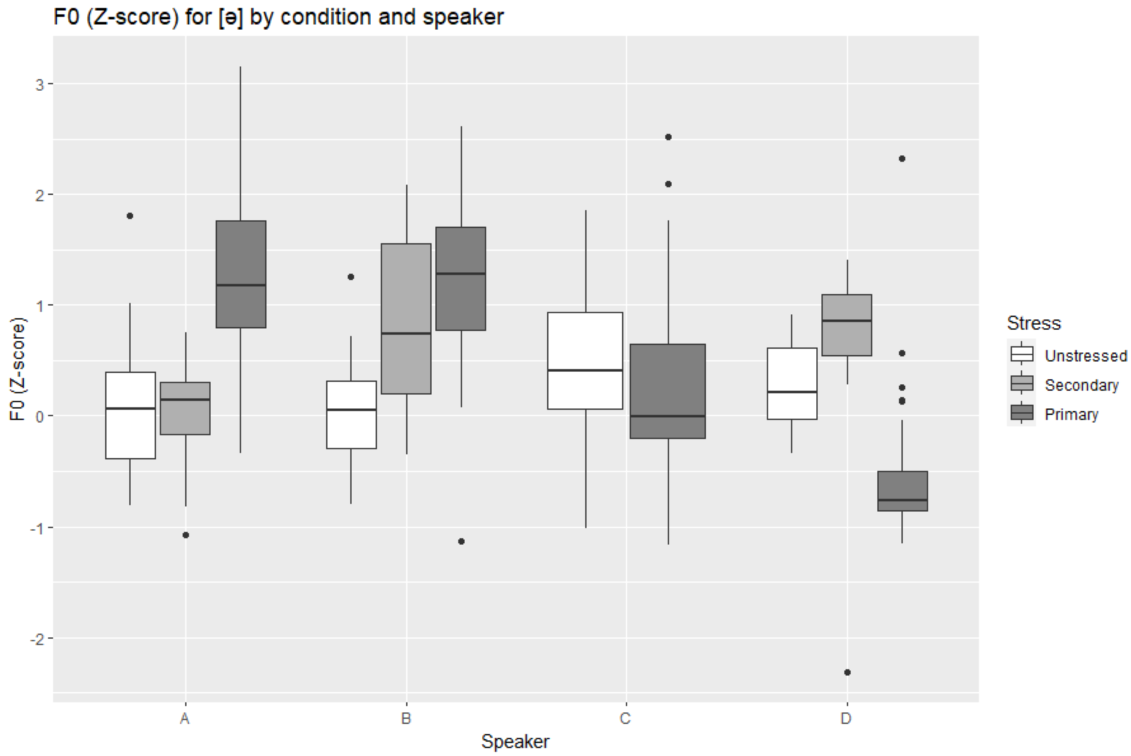
The graphs below visualize the effect of condition (unstressed, secondary, primary) on each of the three acoustic measures for stress (F0, intensity, duration). Each graph is split up by participant, and I include separate graphs for the low vowel and schwa. Focusing on any differences between the unstressed and secondary stress conditions, the data on F0 differ from that for primary stress in Experiment 1 in Chapter 3. Speaker D is the only one who shows a difference between unstressed and secondary conditions for both vowels. As is seen from their data in the primary stress condition, this participant shows a lower F0 on vowels with primary stress (as also reported in Experiment 1 in Chapter 3), but a higher F0 on vowels with secondary stress. Speaker B has an unstressed-secondary difference in F0 only for [ə], while speakers A and C do not appear to show any differences between the two conditions.

(22) Figure 4.5



F0 (Z-score) for [a] by condition and participant (Experiment 2)

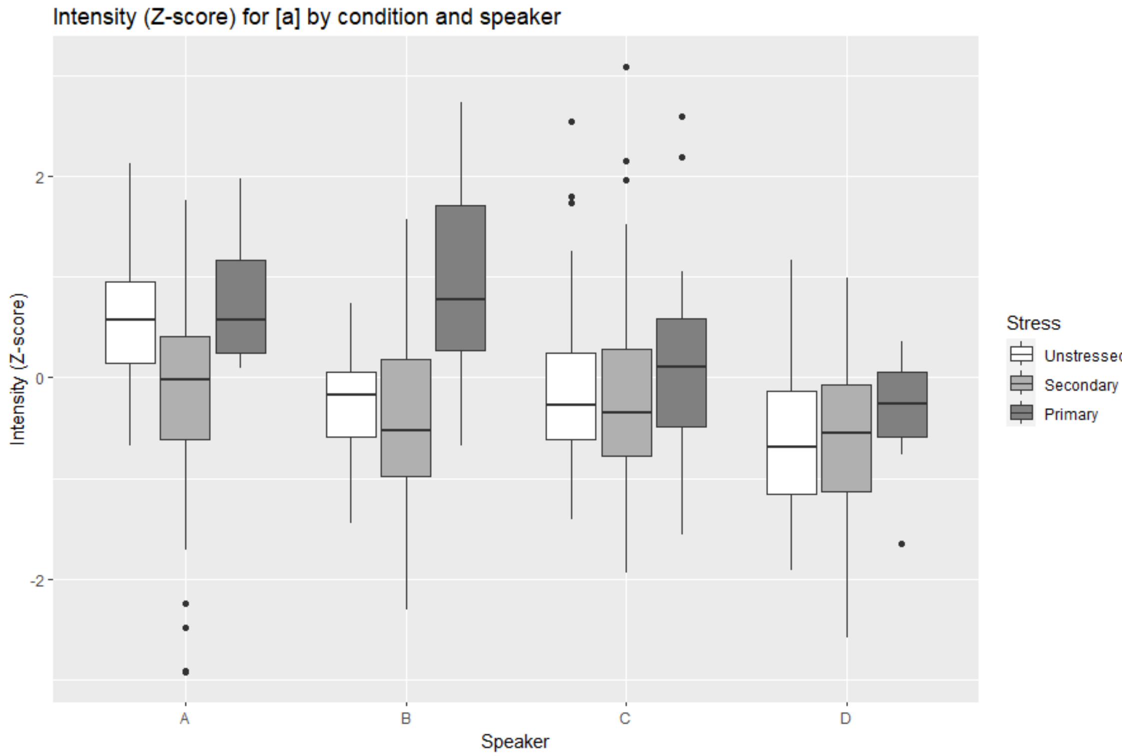
(23) Figure 4.6



F0 (Z-score) for [ə] by condition and participant (Experiment 2)

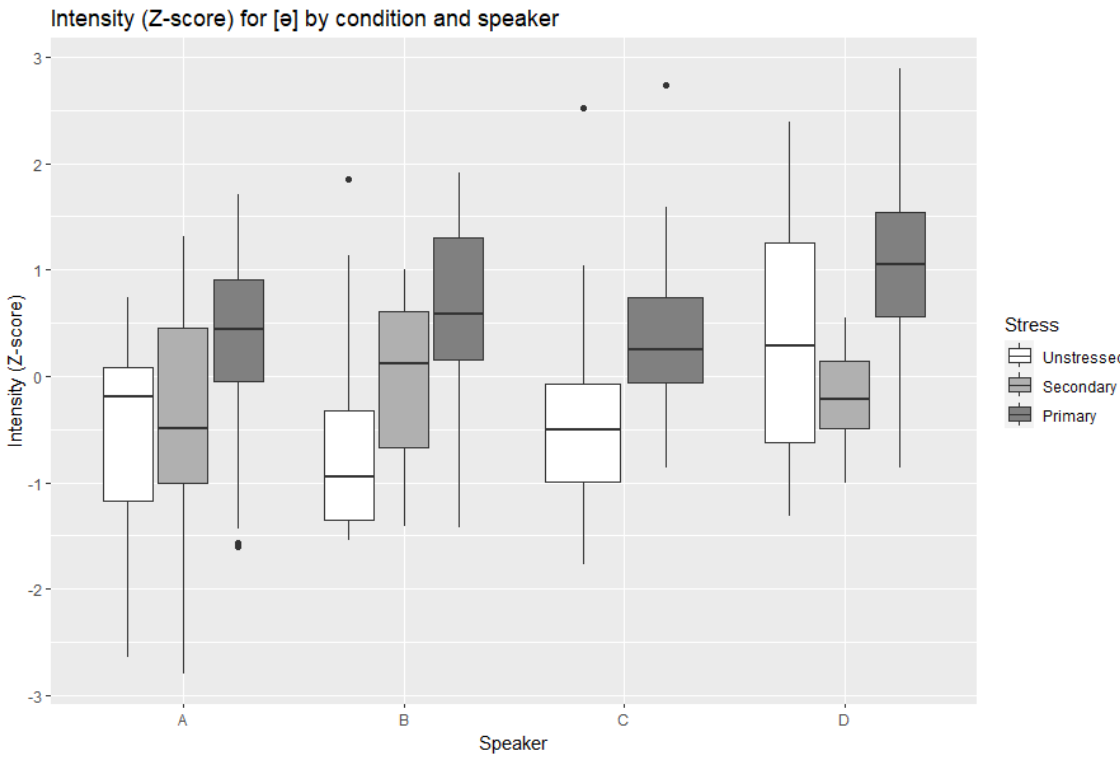
The graphs for intensity are difficult to interpret. For [a] speakers A and B show, if anything, a lower intensity on secondarily stressed vowels than on unstressed vowels. Speakers A and D show small effects in the same direction for [ə], while speaker B has higher intensity in the secondary stress condition for [ə]. Speaker C does not show any clear effect here.

(24) Figure 4.7



Intensity (Z-score) for [a] by condition and participant (Experiment 2)

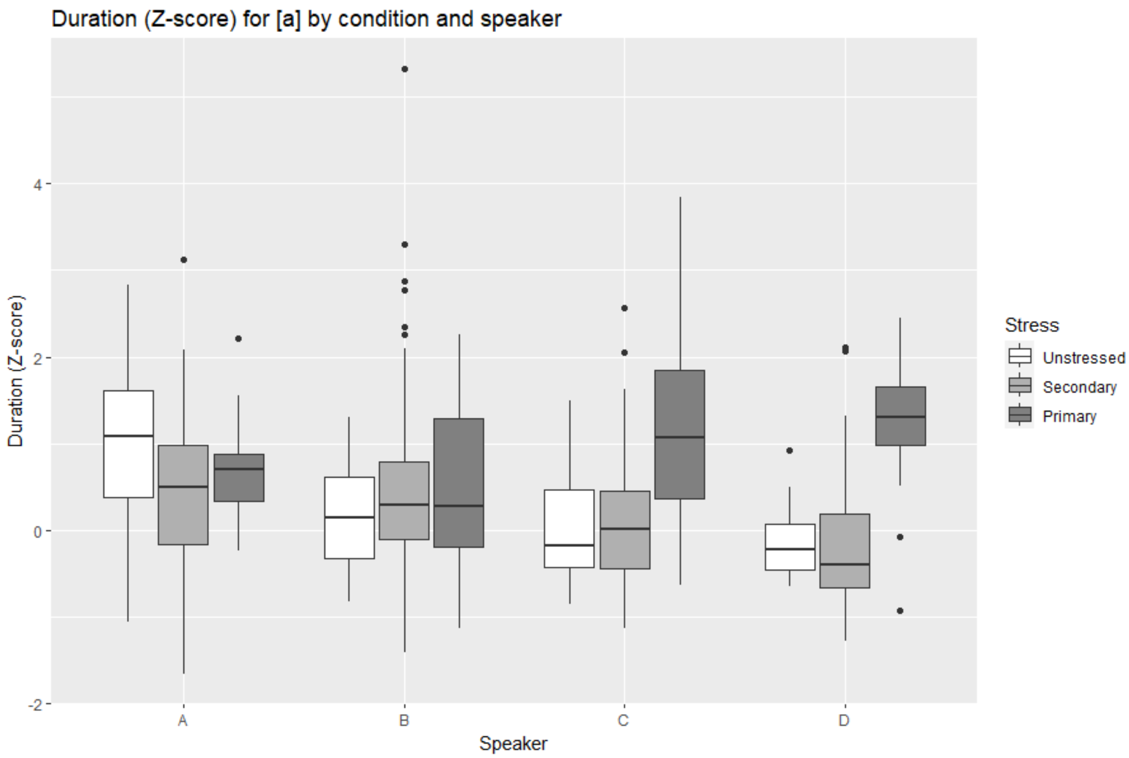
(25) Figure 4.8



Intensity (Z-score) for [ə] by condition and participant (Experiment 2)

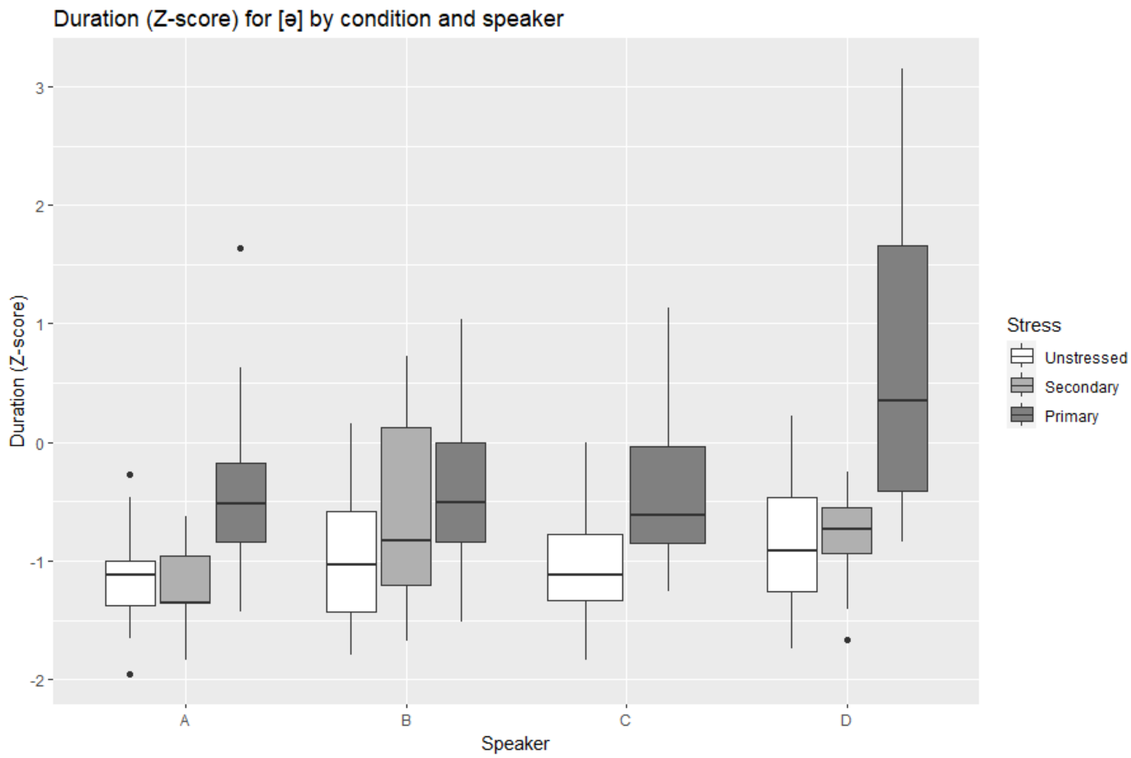
For duration there are no obvious effects, even though it was the duration differences between stressed and unstressed vowels in Chapter 3 which appeared to be the most reliable. Speaker A has a lower mean vowel duration on secondarily stressed vowels than unstressed vowels, an effect which is clearest for [a].

(26) Figure 4.9



Duration (Z-score) for [a] by condition and participant (Experiment 2)

(27) Figure 4.10



Duration (Z-score) for [ə] by condition and participant (Experiment 2)

4.3.3.3 Statistical analysis

I used very similar statistical models to those in Chapter 3 to study secondary stress. These are linear mixed effects models fitted in R, and compared to each other using ANOVAs. Each measure (F0, intensity, and duration) was analyzed with a separate model. All models were fit to one of the three measures for all vowels in the dataset. For each measure, I considered four models: 1) a baseline with no stress information whatsoever, 2) an intermediate model with a random slope for the effect of stress by participant, 3) a model which in addition to a random slope also considers a fixed effect of stress, and 4) a model like 3) but with an interaction term for stress and vowel. The model specifications are shown below using R syntax. I use F0 as an example, but the models for intensity and duration were identical. Vowel has the possible values {[ə], [a]}, while Stress may be {Unstressed, Secondary, Primary}.

(28) Figure 4.11

Model	Addition to previous model	Model specification
a.	N/A (baseline)	F0 ~ Vowel + (1|Word) + (1|Speaker)
b.	Random slope	F0 ~ Vowel + (1|Word) + (1+Stress|Speaker)
c.	Fixed effect	F0 ~ Stress + Vowel + (1|Word) + (1+Stress|Speaker)
d.	Interaction	F0 ~ Stress * Vowel + (1|Word) + (1+Stress|Speaker)

Model specifications (Experiment 2)

As in Chapter 3, it is primarily the comparison between (28) a. and (28) b. which is of interest. Stress may have separate effects on F0, intensity, and/or duration for each of the participants, but there are likely too few speakers to find a (participant-independent) fixed effect of stress on any of the three measures above and beyond the random slopes.

Again like in the previous chapter, fitting some of these models results in singular fits. I continue to report these models here, noting that the results should be interpreted with caution. As for Experiment 1 in Chapter 3, in the text below I report models fit separately for each participant in Appendix B, since such models do converge without singular fits. I note below which models had problems with singular fits, marking these with a dagger †.

(29) Figure 4.12

	Baseline	Random slope	Fixed effect	Interaction
F0	†	†	†	†
Intensity	†	†	†	†
Duration	†	†		

Models with singular fits (Experiment 2)

In (30) are model summaries for the interaction models from (28) d. Each row reports a separate model, for F0, intensity, and duration. The columns show the estimates for the fixed effects, plus or minus the standard error. The reference levels for the factors are Unstressed and [ə], so that the intercept reports results for unstressed schwas. Models with singular fits are marked with a dagger † in the Measure column.

(30) Figure 4.13

Measure	Intercept	Secondary	Primary	[a]	Secondary*[a]	Primary*[a]
F0†	0.27±0.15	0.24±0.22	0.24±0.47	-0.68±0.15	-0.11±0.19	0.01±0.22
Intensity†	-0.30±0.16	0.37±0.20	0.92±0.18	0.28±0.20	-0.67±0.24	-0.4±0.32
Duration	-1.01±0.14	0.37±0.19	0.91±0.30	0.97±0.19	-0.04±0.23	0.03±0.29

Model summaries (Experiment 2)

In (31) I report the AIC values for all models, which will be of use in the model comparisons immediately below.

(31) Figure 4.14

	Baseline	Random slope	Fixed effect	Interaction
F0	2,082.6	1,664.5	1,666.4	1,669.8
Intensity	2,156.0	2,118.5	2,114.3	2,110.6
Duration	2,158.7	2,012.5	2,008.5	2,012.4

AIC values (Experiment 2)

The ANOVA model comparisons between the four models from (28) are reported in (32). For each of the three acoustic measures, the pairs of models with adjacent numbers in (28) are compared to each other, i.e. baseline to random slope, random slope to fixed effect, and fixed effect to interaction. I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p) from each ANOVA.

(32) Figure 4.15

Measure	Baseline-random slope			Random slope-fixed effect			Fixed effect-interaction		
	χ^2	df	p	χ^2	df	p	χ^2	df	p
F0	428.09	5	$< 2.2 * 10^{-16}$	2.19	2	0.36	0.60	2	0.74
Intensity	47.48	5	$< 4.5 * 10^{-9}$	8.27	2	0.02	7.62	2	0.02
Duration	156.15	5	$< 2.2 * 10^{-16}$	8.10	2	0.02	0.09	2	0.96

ANOVA model comparisons (Experiment 2)

The models in (28) b. with a random slope for the effect of stress by speaker always significantly outperform the models in (28) a. without such a random effect, and all result in a lower AIC. In other words, all of F0, intensity, and duration are more successfully predicted by a model with stress information than one without it. This is a partial replication of the results from Chapter 3. However, the models fit lines to data on unstressed, secondarily stressed, and primarily stressed vowels. Recall from the visualizations in Section 4.3.3.2 that secondary stress appears to be unreliably distinguished from the absence of stress in Abkhaz. Below I will investigate the random slopes for the effect of stress by participant to see whether any participants have a reliable distinction between unstressed and secondary conditions.

Some of the more complex models for intensity and duration also come out as significant in these model comparisons, and result in lower AIC values, while none of the more complex models for F0 do. As in Chapter 3 this difference is likely due to the fact that participants vary in whether high or low F0 is found on vowels with primary stress. Note in (30) the high standard error of 0.47 for the fixed effect of primary stress in the F0 model, compared to the lower standard errors of 0.18 and 0.30 for intensity and duration in the same column in (30).

A fuller picture of the individual participants' realization of stress can be found by examining the by-speaker random slopes from the models in (28) b. These show separate estimates of the effect both primary (1ary) and secondary (2ndry) stress have on F0, intensity, and duration for each participant.

(33) Figure 4.16

	Speaker A		Speaker B		Speaker C		Speaker D	
	1ary	2ndry	1ary	2ndry	1ary	2ndry	1ary	2ndry
F0	1.06	-0.19	1.08	-0.02	-0.35	-0.06	-1.02	0.66
Intensity	0.44	0.04	1.04	0.23	0.43	0.11	0.77	-0.22
Duration	0.20	0.17	0.66	0.62	0.90	0.21	1.74	0.14

Random slopes for effect of participant (Experiment 2)

The biggest effects of secondary stress in (33) are for F0 for speaker D, and for duration for speaker B, both showing that vowels in the secondary stress condition have measures almost two-thirds of a standard deviation greater than vowels in the unstressed condition. This provides evidence that some speakers of Abkhaz do show acoustic evidence for a distinction between unstressed vowels and vowels with secondary stress. However, as is to be expected based on the visualizations in Section 4.3.3.2, there are also many estimates for secondary stress which are very close to zero, showing no difference between unstressed and secondary conditions at all.

The numbers in (33) which have a magnitude of around 0.2 are more difficult to interpret without first calculating what they refer to. Below I report the mean and standard deviation of F0, intensity, and duration for the four participants, numbers which allow for exactly these calculations. Note that while the models above are fitted based on Z-scored data, the numbers below are not normalized, and have the units Hertz, decibels, and milliseconds respectively. The notation X±Y refers to a mean of X, and a standard deviation of Y.

(34) Figure 4.17

	F0 (Hz)	Intensity (dB)	Duration (ms)
Speaker A	98.35±13.10	70.76±5.29	85.42±33.49
Speaker B	178.48±18.75	70.14±3.80	95.15±29.80
Speaker C	199.33±18.05	64.56±3.88	67.37±21.73
Speaker D	195.26±32.88	67.04±3.07	69.94±21.72

Summary statistics (Experiment 2)

In (33) Speakers A and C have estimates for the effect of secondary stress on duration which are somewhat difficult to interpret. Using the numbers from (34), we can calculate that speaker A has vowels which are 5.69 ms longer in the secondary condition compared to the unstressed condition, while the same number for speaker C is 4.56 ms. Phillips et al. (1994: 213) report that for a tone lasting 40 ms, an duration increase of somewhere between 10-15ms is needed is needed for participants to reliably begin judging the tone as longer in duration. This suggests that the differences around 5 ms observed between unstressed and secondary conditions are not reliably noticeable in perception. It is possible that speakers are using additional acoustic dimensions, including ones not measured in this experiment, and that a combination of several small differences is enough to be perceptible. However, based on the data collected here neither speaker A nor C show clear evidence of secondary stress. Speaker A's effect of F0 is only 2.49 Hz, which is also likely too small.

Speaker B and D have numbers of magnitude approximately 0.2 for intensity in (33). For speaker B this works out to an estimated 68.99 dB for unstressed vowels, and 69.88 dB for vowels in the secondary stress condition. This translates to vowels in the secondary condition being 10.8% louder. For speaker D the corresponding numbers are 67.26 dB and 66.54 dB, so that vowels in the secondary stress condition are 7.5% quieter than those in the unstressed condition.

4.3.4 Conclusions

In this section I have argued that there is phonological evidence that the accentual properties of a morpheme determine whether or not it will display a schwa in what is usually transcribed as unstressed position. Only stressable morphemes may display a schwa. This means that the distribution of the relevant schwas can be predicted, and they do not require an underlying schwa phoneme. In this section I have only noted that at least some schwas with primary stress remain in apparently unstressed positions, but in the next chapter I will describe a stress assignment algorithm for Abkhaz which predicts the exact environments in which schwas appear.

The phonological connection between schwa and accent will be formalized in Chapter 7, where I argue that consonants with a certain minimum degree of prominence are subject to schwa epenthesis. The 'prominence' referred to here is purely phonological, a mark on a particular line of a metrical grid in Idsardi's (1992) framework. In this section I have reported on a phonetic study to determine whether there is also an acoustically measurable prominence on the relevant vowels. The answer is that some speakers do show acoustic evidence for secondary stress, while others apparently do not. For speakers without clear evidence for secondary stress, there are some small numerical effects in the expected direction, such as longer vowel durations for vowels in the secondary stress condition compared to the unstressed condition. However, on their own these differences are likely too small to be perceptible.

Given the smaller effect sizes between unstressed and secondary conditions, it would be useful to study whether a distinction is made not only with more data, but also with more potential correlates of stress. In particular, I have not controlled the vowels in the experiment for the place of articulation or laryngeal specifications of surrounding consonants, and have therefore not investigated measures such as F1 and F2. Perhaps there is unstressed vowel reduction for /a/ based on stress, paralleling the stress-based alternations between schwa and zero. Andersson et al. (2023) report some differences between stressed and unstressed /a/ in Cwyzhy Abkhaz, and diachronically vowel reduction for /a/ is ubiquitous in Abkhaz as shown by Aršba (1979).

There are phonological debates about whether metrical representations of prominence in the phonology are always expected to correspond to some measurable prominence phonetically. Some rely on metrical feet which do not manifest as secondary stresses, for example (see González 2007 and references therein for discussion). Although the acoustic results in this chapter must be treated as preliminary due to a lack of data, the metrical representations I argue for in Chapter 7 may be an example of this for the speakers without clear evidence for secondary stress. Further studies will reveal how general the presence of secondary stress is acoustically in Abkhaz when additional speakers are studied and additional correlates for stress are considered.

Having surveyed schwas in unstressed position as well as schwas with both primary and secondary stress, I have argued that all three categories of schwa are predictably distributed. The first is sensitive to consonantal phonotactics, while the latter two depend on independently needed contrasts in the accentual system of Abkhaz. If these arguments are correct, there is no part of Abkhaz phonology where underlying schwas are needed. Before concluding the chapter, I provide some discussion of the consequences of assuming a schwaless vowel inventory for Abkhaz in Section 4.4.

4.4 Consequences of a schwaless vowel inventory

This section discusses two types of consequences of Abkhaz having a vowel inventory without schwa. The first is theoretical, and concerns the connection between schwa and stress. If schwa is not phonemic, this requires a phonological process of stress-induced epenthesis. Such a process has been argued to be impossible in previous work, making the Abkhaz case theoretically interesting. I discuss previous literature in Optimality Theory on what can and cannot serve as a trigger for epenthesis. I suggest that, rather than causing problems, the existence of a language like Abkhaz resolves a theoretical problem. By filling a typological gap, Abkhaz spares us from having to invent theoretical restrictions which rule out stress-induced epenthesis.

The second consequence I address is typological, and relates to the fact that a schwaless vowel inventory for Abkhaz leaves the language with /a/ as the only native vowel phoneme. Although such one-vowel systems have been proposed before, for Northwest Caucasian as well as other families, such analyses have never reached widespread acceptance. I discuss the typology of small vowel systems, critiques of previous analyses of this type for Northwest Caucasian, as well as the nature of the division between native and borrowed vocabulary in Abkhaz. I conclude that it may be best to treat Abkhaz as a five-vowel language, including the vowels only found in loanwords, since it is not clear whether the etymological distinctions between native and borrowed words are always a synchronic reality for speakers.

4.4.1 Theoretical analyses of epenthesis

Beginning with the theoretical discussion, there is previous literature on the question of what can serve as the triggering environment for epenthesis. Much of this discussion is couched in Optimality Theory, where the question is: Which markedness constraints can be ranked so highly that the optimal candidate epenthesizes a vowel in order to satisfy them? Broselow (1982) argues that only three types of markedness can trigger epenthesis crosslinguistically: syllable structure (e.g. epenthesize a vowel to avoid having syllables with a coda: /patak/ → [pa.ta.ki]), segmental phonotactics (e.g. epenthesize a vowel to avoid obstruent-obstruent clusters: /takta/ → [ta.ki.ta]), or word minimality (e.g.

epenthesize a vowel to avoid monosyllabic words: /tak/ → [ta.ki]). Blumenfeld (2006) argues for the same typological generalization, stating the following for metrically conditioned epenthesis:

> Among metrical factors, only one may play a role in epenthesis, viz. word minimality. No other constraint can force vowel insertion. As I will show in this section, epenthesis cannot be used as a repair strategy for violations of purely metrical constraints such as *Clash, *Lapse, *Non-Finality, and so forth. (Blumenfeld 2006: 157-158)

Blumenfeld (2006) and Moore-Cantwell (2016) treat this as a too-many-solutions problem. This term is used in Optimality Theory to refer to cases where a grammar can produce more possible repairs to a marked structure than are attested crosslinguistically. Both of these authors attempt to restrict the grammar so that it cannot generate languages where stress, or other metrical properties apart from minimality, trigger epenthesis. Blumenfeld (2006) achieves this with so-called procedural constraints, which state preferences over input-output mappings. This is a departure from the typical output-oriented nature of Optimality Theory, where markedness constraints penalize the output only. Moore-Cantwell (2016) instead imposes limitations on Gen, the function in Optimality Theory responsible for generating possible output candidates. Working in Harmonic Serialism, she suggests that epenthetic vowels cannot in one derivational step be incorporated into both syllables and feet, or words, or other higher prosodic structure. She shows that this correctly predicts languages where epenthesis resolves syllable structure violations, but predicts the absence of languages where higher metrical structure such as feet trigger epenthesis.

What these two approaches illustrate is the assumption that certain unattested patterns, those where metrical structure conditions epenthesis, are also unattestable. That is to say, the absence of stress-induced epenthesis is taken to be not an accident, but a consequence of the fact that such phonological processes are impossible in human language generally, so that our phonological theories must not generate them. The data from Abkhaz suggest that such an assumption in the case of stress-induced epenthesis is too hasty. Based on the data supporting stress-induced epenthesis of schwa in Abkhaz, it seems that such languages are possible, and must be generated by theories of phonology.

This is not a problem for Optimality Theory; in fact, it is quite the opposite. Without modifications or restrictions, Optimality Theory predicts that metrical structure should be able to condition epenthesis. This situation appears to be attested in Abkhaz, which is a predictive success for Optimality Theory. We do not have to add new constraint types, or new restrictions to Gen, in order to account for the data. The theory is empirically adequate as is, and the too-many-solutions problem disappears. It may be that other interactions between metrical structure and epenthesis really are unattestable, and that phonological theories should predict their impossibility. I leave this question for future work. However, based on the Abkhaz data, it seems that there is no general restriction against epenthesis triggered by metrical structure, and constraints against stress-triggered epenthesis seem to be premature. With this discussion out of the way, I turn now to another, more direct consequence of analyzing the Abkhaz vowel inventory as lacking schwa: is it possible for a human language to contain only a single vowel phoneme?

4.4.2 Typology of small vowel systems

When it comes to the typology of vowel inventories, the conventional wisdom is that the smallest inventories always contrast at least two phonemes. Such vowel systems are sometimes called vertical, as they typically involve contrasts of height rather than backness, rounding, or other phonetic dimensions. Languages with such vertical two-vowel systems include Kaytetye (Pama-Nyungan, Australia; Turpin & Ross 2012, Tabain & Breen 2011: 69) and Margi (Afro-Asiatic, West Africa; Maddieson 1987), as well as many Northwest Caucasian languages on the conventional analysis (see Arkadiev & Lander 2021). The view that vowel systems require at least a binary opposition goes back to Jakobson's work in the first half of the 20th century (Kuipers 1968).

Analyses with only one contrastive vowel phoneme have sometimes been suggested. For example, Martinet (1990) discusses one-vowel analyses of Proto-Indo-European,[25] Breen (1977) argues that Andegerebenha has only /a/ vs. /aː/ (which could be analyzed with a single phoneme as /a/ vs. /aa/), and Pulleyblank (1984: 27) posits schwa as the only syllabic element in Mandarin, deriving other vowels from underlying glides. The Northwest Caucasian languages have also seen one- or even zero-vowel analyses (Kuipers 1960, Allen 1965, Kuipers 1968, Anderson 1978). These have not become accepted for any language, and have often been criticized for involving notational tricks rather than substantial reanalyses of the vowel systems. Halle (1970) criticizes Kuipers' (1968) analysis of Kabardian as vowelless by noting that he essentially admits the contrastivity of /a/, but refers to it as an [open] feature rather than as a vowel:

25 Another alternative is a two-vowel reconstruction of Proto-Indo-European with only *e and *o (see Byrd 2018 for a recent overview of Proto-Indo-European phonology), typologically unusual in involving contrasts based only on backness or rounding rather than vowel height.

> Kuipers again has recourse to a purely terminological device. He distinguishes *ə* from *a* by observing that 'the second member of each pair is distinct from the first exclusively by *a feature of openness*' (p. 50). He then goes on to tell us that 'in phonemic notation the symbol *a* is retained, but its reference is redefined as "feature of openness" instead of "vowel"' (p. 51) (Halle 1970: 103, italics in original)

Colarusso (1988: 349) notes, in agreement with Halle (1970) and indeed with Kuipers' (1968: 71) himself, that the analysis contains a special juncture symbol which marks the absence of schwa. This does not seem different in any important way from admitting a new phoneme to the inventory, and marking its presence in the usual way.

It is understandable that analyses like these have not reached widespread acceptance. However, the data presented in this chapter argue for a schwaless analysis of Abkhaz, though not a vowelless one. There are no terminological redefinitions here, and the arguments are based only on phonotactic restrictions and phonological alternations. However, even if one accepts the arguments that Abkhaz lacks a phonemic schwa, this does not necessarily leave the language with only one vowel. Below I discuss the issue of native and borrowed vocabulary, and question whether these should be treated as separately as they have been in previous work.

The native Abkhaz vocabulary would indeed be left with /a/ as its only vowel if schwa is eliminated. However, Abkhaz has a long history of contact with other languages of the region where it is spoken (Schmidt 1950, Chirikba 2003: 14). This includes loanwords from Turkic, Kartvelian, and Indo-European languages, which have altered the vocalic inventory of the language. Chirikba (2003: 73) notes that while older loanwords were assimilated to the Abkhaz vowel inventory, newer ones tend to retain the vowels of their source languages.

Early borrowing strategies include diphthongization ([a-wáp^{h}s] ауаԥс ‘Ossetian, Ossetian person’ < Megrelian opsi; Chirikba 2003: 73) and the shifting of features like rounding onto nearby consonants ([á-t^{h}ərk^{wh}a] аҭырқәа ‘Turkish, Turk’ from a Turkic source türk with a rounded vowel; word from Yanagisawa 2010: 417). Chirikba (2003: 74) notes modern unassimilated loanwords such as [ak’inó] акино ‘cinema’ and [at’elefón] ателефон ‘telephone’. Abkhaz also has many neologisms (on which see Xecija 1988), which sometimes coexist with loanwords, e.g. [at’^{w}ə́lawaɥʃ^{w}q’^{w}ə] атәылауаҩшәҟәы (Apsua telex°apšra 2018, lesson 65) vs. [ap’ásp’ort’] апаспорт (Kaslandzija 2005: 544), both ‘passport’. The former is literally citizen-book, with ‘citizen’ itself being country-person.

For many recent loanwords, it is apparent from the foreign derivational morphology and phonotactics that they are not etymologically Northwest Caucasian in origin. This is especially the case for Russian loanwords, which tend to be more recent. Many Abkhazians are also native speakers of Russian, allowing for the easy identification of Russian loans. If this was true for all loanwords in Abkhaz, we could speak of a stratified lexicon, with Northwest Caucasian and Indo-European strata. It would then be easy to state separate phonotactic generalizations over native and borrowed vocabulary.[26] This is traditionally what is done in studies of Abkhaz, and it is what I have done in Chapter 1, Section 1.3.2 when I presented separate vowel inventories for native and borrowed words.

26 Amalia Skilton (p.c.) suggests that an approach with cophonologies (Orgun 1996, Anttila 1997 among others) may be viable, since cophonologies need not correspond to distinctions which native speakers are explicitly aware of. This is certainly a possibility, but I do not pursue this option here, since it seems that with the exception of containing different vocalic phonemes, the loanword phonology of Abkhaz is identical to the native phonology.

However, the fact is that there is overlap in surface vowel distributions between native and borrowed words due to vowel allophony, and sometimes it may not be clear synchronically that a given word was once borrowed into the language. Even if one sets aside the long vowels or diphthongs created by vowel-glide coalescence, there are examples like the vowel /a/ surfacing more like [e] in the environment of nearby palatal or palatalized consonants, as in [aʮéʒ] aꙩежь ‘yellow’, [áɡʲeʒ] агьежь ‘wheel, round’, [zeɡʲə́] зегьы ‘all’ or [eɡʲə́rtʰ] егьырҭ ‘other’ (Arstaa & Ç̣′ḳadua 2002: 23, Yanagisawa 2013: 22). The sequence /ja/, when pronounced more like [je], can create orthographic and phonological overlap with Russian words containing similar sequences. Compare for example [ájat͡ʃʼʷa]~[ájet͡ʃʼʷa] аиацәа~аецәа ‘star’ (Arstaa & Ç̣′ḳadua 2002: 23) with [jevróp’a] Европа ‘Europe’ (Yanagisawa 2010: 114).[27]

And although [aduwnéj] адунеи ‘world’ (Yanagisawa 2010: 104) contains ‘foreign’ vowels, it is not always obvious that modern Abkhaz speakers are aware that words like these are loans (compare Turkish dünya). As an example we may mention the word [adʷkʲʰán] адәқьан ‘shop’. It serves as the native replacement for [amagazín] амагазин ‘shop’, sometimes perceived as too foreign, even though [adʷkʲʰán] is in fact a Turkic loanword (Chirikba 2003: 74). In conclusion it is not clear that the strict separation of native words from loanwords on etymological grounds also corresponds exactly to some division in the synchronic lexicon of Abkhaz speakers. In the 21st century, it may be more appropriate to say that Abkhaz has a five-vowel inventory /a, e, i, o, u/ rather than a native one-vowel inventory /a/ and a five-vowel loanword inventory

27 In my experience Russian loanwords in Abkhaz can be pronounced with various degrees of faithfulness to the original Russian pronunciation, which is approximately [jɪvrópə]. I make no claims that the Abkhaz transcription I give here is the default or most common option.

/a, e, i, o, u/. I am not aware of any principled reason why a language like Abkhaz could not come into being without borrowing unassimilated loanwords from surrounding languages. In theory then, a one-vowel phonological system may be possible. However, given the loanword situation of Abkhaz, the language under discussion here, I suspect it is more appropriate to call it a five-vowel system than a one-vowel system.

4.5 Conclusions on schwa

In the previous sections I have investigated the distribution of schwa in Abkhaz, focusing on the issue of predictability. I have divided the data into three categories: 1) unstressed schwas, 2) schwas with primary stress, and 3) schwas with secondary stress. I have argued that the schwas in these three categories, which exhaust the space of possibilities, are all predictably distributed.

The schwas in 1) are predictable from phonotactics, a point of agreement across previous work. The schwas in 2) I have argued are predictably epenthesized when there is no lexical vowel to carry stress. Some previous work has concluded that such schwas are instead phonemic, explaining the connection between schwa and stress in terms of unstressed schwa deletion. I have argued against such an analysis on the basis of exceptionless phonotactic restrictions across the native and borrowed Abkhaz lexicon.

Finally, the schwas in 3) have proven recalcitrant as they can seemingly form perfect minimal pairs with the absence of schwa. I have repeated Spruit's (1986) arguments that even these are predictable, however, with additional data. The stressability of a morpheme can be used as a reliable predictor for which morphemes will show a schwa in unstressed position and which will not. Since stress is an independently motivated phonemic contrast in Abkhaz, and since it accounts for the distribution of schwas with secondary stress, there is no argument in these data for also postulating a phonemic schwa. Some but not all speakers show acoustic evidence for secondary stress on such schwas, and on the low vowel /a/ in similar phonological positions. In Chapter 5 I will argue for a stress assignment algorithm which predicts the location of both primary and secondary stresses.

To the extent that the arguments I have summarized above are valid, there do not appear to be any empirical problems in predicting fully the distribution of schwa in Abkhaz. Once both stress and surrounding phonotactic context are taken into account, the location of schwas in Abkhaz can be predicted from underlying forms which completely lack this vowel. There is, in other words, no need for a schwa phoneme. The remainder of this dissertation will proceed from underlying forms without schwa. As we will see, this has far-reaching implications for the stress system of the language, where vowelless stems nevertheless participate in a rich system of accentual contrasts. The empirical data on accent contrasts among stems with and without lexical vowels are laid out in Chapter 6, while Chapter 7 focuses on the formal phonological analysis and theoretical consequences of such a stress system.

I have also highlighted some theoretical and typological questions that arise from the elimination of schwa from the phonemic inventory of Abkhaz. Although the stress-induced epenthesis required to treat schwa as epenthetic is typologically unusual, I have argued that it solves theoretical problems rather than creating them. Previous work in Optimality Theory has had to invent new restrictions to account for the apparent lack of epenthesis triggered by metrical structure above the syllable level, such as stress. Abkhaz shows us that such new restrictions are probably not needed, thereby diminishing the too-many-solutions problems for epenthesis.

Finally I have highlighted the typologically unusual nature of the Abkhaz vowel inventory once schwa is not present. This appears to leave the language with a one-vowel system, at least in its native vocabulary. Such a vowel system, although it has been proposed before, has never gained widespread acceptance for any language. I have argued that Abkhaz may not constitute such a system either, as the influx of unassimilated loanwords in the language has blurred the etymological lines between native and borrowed vocabulary. At the synchronic level, it may be best to treat Abkhaz as having a typologically ordinary five-vowel system consisting of the contrastive phonemes /a, e, i, o, u/.

Chapter 5: Deriving an Algorithm for Abkhaz Stress Assignment

In this chapter I discuss an algorithm for how stress is assigned in Abkhaz, based on the accentual properties of the constituent morphemes of a word. I show that there are two underlying categories of accentual behavior in Abkhaz, which I call accented and unaccented, and give data-driven diagnostics for how to find the accentual category of a morpheme. Based on examining the stress placement in words with different combinations of accented and unaccented morphemes, I derive a stress assignment algorithm for Abkhaz from the bottom up: primary stress falls on the leftmost accent not immediately followed by an accent. I show that the algorithm I propose matches Dybo's Rule. This rule was proposed by Dybo (1977), so in a sense the results of this chapter are not new. However, by deriving Dybo's Rule directly from the stress alternations I place it on firmer empirical footing, showing that something like this method for assigning stress is not only a possibility but a necessity.

Dybo (1977) presents an analysis of Abkhaz stress which has become influential in subsequent work. He divides the lexicon into 'dominant' and 'recessive' morphemes, which show different behavior in stress assignment. He postulates Dybo's Rule (or Dybo's Law; Borise 2021b), which states that primary stress falls on the leftmost dominant not immediately followed by another dominant.[28] Subsequent work, particularly Spruit (1986), has analyzed additional data in terms of Dybo's Rule, and identified several categories of exceptions to the general rule.

This rule has become influential in later work on Abkhaz stress owing to its

28 Dybo's (1977: 43) formulation states "that the stress is always placed at the end of the first sequence of morphemes of the highest valence [i.e. dominants - SA]". Original Russian: "... что ударение всегда ставится в конце первой последовательности морфем высшей валентности" (my translation).

empirical success. Although there is no doubt that Dybo's Rule accurately predicts many of the patterns of stress alternation that exist in Abkhaz, it is not clear whether there are other mechanisms of stress assignment which would work equally well. In other words, do the data require Dybo's Rule, or is Dybo's Rule just one of the many possible analyses consistent with the data? In this chapter I argue for the former. I build up to Dybo's Rule by considering small datasets of stress alternations. In Chapter 6 I will argue that these small datasets are representative in general, and that Dybo's Rule fares well when applied to the nominal and verbal lexicon of Abkhaz. Towards the end of this chapter I discuss various cases where previous literature has noted deviations from Dybo's Rule. I provide empirical generalizations for these exceptions in Chapter 6, and analyze them theoretically in Chapter 7.

This chapter has multiple sections. I begin by arguing for the binarity of Abkhaz stress contrasts: there are only two categories of stress behavior. Dybo (1977) called these dominant and recessive, but I will anticipate the analysis in Chapter 7 and use the terms accented and unaccented respectively. This binarity sets Abkhaz apart from other languages with similar stress systems, where three or more stress categories (e.g. unaccented, accented, pre-accenting, post-accenting) can be found. I demonstrate several definitions for whether a morpheme is accented or unaccented, and argue that these different definitions pick out the same categories of morphemes without giving conflicting results. By applying the definitions I am able to derive from the bottom up the principles for stress assignment, stated in terms of underlying accents. I arrive at the following rule: primary stress falls on the leftmost accent not immediately followed by another accent. This is perfectly analogous to Dybo's Rule, with accents taking the place of dominants. In other words, I derive Dybo's Rule from empirical data on stress alternations in Abkhaz.

In this chapter I follow Dybo (1977) in talking of morphemes as belonging to one category or another. Later work has questioned this assumption, arguing that the unit of accentual contrast is the syllable (Trigo 1992) or the mora (Kathman 1992, Vaux & Samuels 2018). I do not choose between these alternatives here, discussing wherever possible morphemes which are both monosyllabic and monomoraic (e.g. /CV/). In the theoretical analysis in Chapter 7, I argue that it is not morphemes but individual segments which contrast for accent in Abkhaz. The generalizations which motivate a unit smaller than the morpheme as the locus of accentual contrast are found in Chapter 6. Chapter 8 is devoted to prosodic analyses, i.e. ones with syllables and moras as accent-bearing units, which I argue are inferior to the segmental analysis in Chapter 7.

I end the chapter by discussing several cases where stress is apparently not assigned by Dybo's Rule. This includes cases where there is only one accent in a word, but it still does not receive stress. A full analysis of Abkhaz stress assignment must be able to explain these exceptions. In Chapter 6 I formulate empirical generalizations for when exceptions arise, which I analyze theoretically in Chapter 7.

5.1 Binarity of accentual contrasts

In this section I will argue that the Abkhaz stress system is fundamentally binary, i.e. that there are only two types of accentual behavior. This makes Abkhaz different from languages with similar stress systems, where previous work has identified three or more underlying categories.

It is often the case in Abkhaz that if one constructs a morphological minimal pair, replacing only one morpheme with only one other morpheme, the stress will fall in different places in the two forms. In (1) I show several examples of this, with stress falling in different places when different stems, prefixes, and suffixes are substituted.

(1) Morphological stress alternations

a. Yanagisawa (2010: 331)

i.	[á-pʰa-ra] DEF-jump-INF	аҧара	‘to jump’
ii.	[a-pʰa-rá] DEF-knit-INF	аҧара	‘to knit’

b. Spruit (1986: 47)

i.	[a-χa-t͡s’a-rá] DEF-PREV(onto)-put-INF	ахацара	‘to put onto’
ii.	[a-χá-la-ra] DEF-PREV(onto)-go-INF	ахалара	‘to go onto’

c. Spruit (1986: 47)

i.	[a-χa-t͡s’a-rá] DEF-PREV(onto)-put-INF	ахацара	‘to put onto’
ii.	[á-va-t͡s’a-ra] DEF-PREV(next.to)-put-INF	авацара	‘to put next to’

d. Yanagisawa (2010: 405)

i.	[ji-bə́-s-tʰa-χʲe-jt’] 3NA-2SFO-1SE-give-PRF-DYN.FIN	ибыстахьеит	‘I’ve already given it to you’
ii.	[ji-b-ná-tʰa-χʲe-jt’] 3NA-2SFO-3SNE-give-PRF-DYN.FIN	ибнатахьеит	‘It has already given it to you’

e. Yanagisawa (2010: 494)

i. [d-t͡sʰá-ʂa-n] дцашан ‘(s)he would go’
3SHA-go-COND2-PST

ii. [d-t͡sʰa-χʲá-n] дцахьан ‘(s)he has already gone’
3SHA-go-PRF-PST

All of the examples from (1) are in pairs, where two different morphemes result in two different locations of primary stress. In other languages with similar data, it is also possible to find triplets, where substituting three different morphemes results in three different locations of primary stress. For example, in Greek (Revithiadou 1999: 93-94), stems can be accented, unaccented, or post-accenting. In the context of the suffix /-os/, these all show different stress. Accented stems have primary stress on their accented syllable (2) a., unaccented stems have default stress (2) b., and post-accenting stems have primary stress on the suffix (2) c. As Revithiadou (1999) shows, the forms in /-os/ are not quite sufficient to diagnose the stress category of a stem, for which other affixed forms are necessary. However, the forms below do belong to three different stress categories, and do all show different stress behavior. The same principle can be illustrated with the Russian dative forms in /-u/ in (3) (Halle 1997: 283), which are perfectly analogous to the Greek. Such stress systems are not limited to Indo-European languages. For example, Dąbkowski's (2019) analysis of A'ingae verbal stress operates with four categories of accentual behavior.

(2) Ternary accentual distinctions in Greek (Revithiadou 1999: 93-94)

a. [fantár-os] φαντάρος ‘soldier’
soldier-M

b. [ánθrop-os] ἄνθρωπος ‘man’
man-M

c. [uran-ós] ουρανός ‘sky’
sky-M

(3) Ternary accentual distinctions in Russian (Halle 1997: 283)

a. [gɐróx-u] гороху ‘pea, dative’
pea-DAT

b. [górəd-u] городу ‘town, dative’
town-DAT

c. [kərɐl^{j}-ú] королю ‘king, dative’
king-DAT

In Abkhaz, however, the fact that the data in (1) only show pairs is not an accident. Recalling the caveat from the beginning of this chapter that we are dealing only with short (monosyllabic, monomoraic) morphemes here, morpheme substitutions only result in one of two accentual behaviors in Abkhaz (see Chapter 6 for discussion of longer stems). This is easiest to see in contexts where the morpheme being substituted is a stem, since there are so many more stems than function morphemes which can appear in the same morphological environment. In (4) I show 18 different verb stems, all /Ca/ in phonotactic shape, surrounded by morphemes that mark the infinitive. All of these fall neatly into one of two classes: either stress falls on the prefix (4) a., or on the suffix (4) b. No infinitives show a third alternative, with stress falling on the stem.

(4) Binarity of accentual contrasts in Abkhaz

a.

i. [á-p^{h}a-ra] аԥара ‘to jump’
DEF-jump-INF
Yanagisawa (2010: 331)

ii.	[á-χa-ra] DEF-smoke-INF Yanagisawa (2010: 440)	ахара	‘to smoke’
iii.	[á-χʷa-ra] DEF-help-INF Yanagisawa (2010: 476)	ахәара	‘to help’
iv.	[á-fa-ra] DEF-eat-INF Yanagisawa (2010: 433)	афара	‘to eat’
v.	[á-t͡ʃʷʰa-ra] DEF-sleep-INF Yanagisawa (2010: 503)	ацәара	‘to sleep’
vi.	[á-tʰa-ra] DEF-give-INF Yanagisawa (2010: 404)	аҭара	‘to give’
vii.	[á-ħʷa-ra] DEF-request-INF Yanagisawa (2010: 489)	аҳәара	‘to request’
viii.	[á-ɡʷa-ra] DEF-push-INF Yanagisawa (2010: 80)	агәара	‘to push’
ix.	[á-va-ra] DEF-next.to-INF Yanagisawa (2010: 100)	авара	‘to be next to’

b.

i.	[a-ba-rá] DEF-see-INF Yanagisawa (2010: 53)	абара	‘to see’
ii.	[a-ɡa-rá] DEF-take-INF Yanagisawa (2010: 71)	агара	‘to take’
iii.	[a-ʁʲa-rá] DEF-heal-INF Yanagisawa (2010: 94)	аҕьара	‘to heal (intransitive)’

iv.	[a-d͡za-rá] DEF-steal-INF Yanagisawa (2010: 151)	аӡара	‘to steal’
v.	[a-q’ʲa-rá] DEF-squander-INF Yanagisawa (2010: 253)	аӄьара	‘to squander’
vi.	[a-sa-rá] DEF-shave-INF Yanagisawa (2010: 388)	асара	‘to shave’
vii.	[a-χʷa-rá] DEF-press-INF Yanagisawa (2010: 477)	ахәара	‘to press, squeeze’
viii.	[a-ħʷa-rá] DEF-say-INF Yanagisawa (2010: 489)	аҳәара	‘to say’
ix.	[a-ʃʷa-rá] DEF-fear-INF Yanagisawa (2010: 572)	ашәара	‘to fear’

I take these data to support a binary system of accentual contrasts for Abkhaz, where morphemes fall into one of two different categories. Anticipating the analysis in Chapter 7 I will call these accented and unaccented. We could decide arbitrarily to call the stems in (4) a. unaccented, and the stems in (4) b. accented, or vice versa, but this would not tell us much about the accentual status of other morphemes in the language. What is needed is a data-based definition of accentual categories which will allow us to make deductions about other morphemes. In the sections below I give a definition, or rather a set of definitions, which accomplish this goal. Reasoning through these definitions will take some time, and it will be a while before I arrive at any non-trivial conclusions about the Abkhaz stress system. Rest assured that all of the data discussed in these sections are necessary as background information before beginning to establish the principles of

Abkhaz stress assignment near the end of the chapter.

5.2 The suffix definition for underlying accents

In this section I will show that the accentual behavior of Abkhaz morphemes allows for the definition of two accentual categories in (5), accented and unaccented. I call it the suffix definition, since it depends on suffixing material to an existing word. This definition, and others like it discussed in the following sections, will be used to construct a stress assignment algorithm for Abkhaz in Section 5.5.

(5) The suffix definition for underlying accents

In order to find out whether a morpheme is accented or unaccented, suffix it to a word whose final segment is a stressed vowel.
1) If the location of stress is unaffected, the morpheme is unaccented
2) If stress falls on the morpheme added, that morpheme is accented

It is an observable fact about Abkhaz that if a word ends in a stressed vowel, there are two possibilities for stress when another morpheme is added to the end. Either the location of stress is unaffected, or else stress falls on the newly added morpheme. If the location of stress is unaffected, I will call the morpheme that was added unaccented. If the stress falls on the newly added morpheme, I will call that morpheme accented. All of these claims are easier to follow with empirical data. In (6) a., I begin with the word [a-ʮnə́] 'house', which ends in a stressed vowel. When the morpheme /-q'a/ 'to' is added, the location of stress in (6) a. ii. is unaffected, so I will classify this postposition as unaccented. When the morpheme /-k^{wh}a/ 'non-human plural' is added to [a-ʮnə́], stress appears on the plural suffix in (6) a. iii., so I will classify the plural as accented.[29] When

29 The plural of 'house' also lacks an epenthetic schwa in the stem, since unlike in the singular, stress does not fall on the stem (see Chapter 4).

the same morphemes are added to words which do not end in a stressed vowel, as shown in (6) b., primary stress is unaffected.

(6) Illustration of the suffix definition

a. Yanagisawa (2010: 582)

i.	[a-ʯnə́] DEF-house	аҩны	'house'
ii.	[a-ʯnə́-q'a] DEF-house-to	аҩныҟа	'to the house'
iii.	[a-ʯn-kʷʰá] DEF-house-N.PL	аҩнқәа	'houses'

b. Yanagisawa (2010: 71)

i.	[á-ɡa] DEF-coast	агa	'coast'
ii.	[á-ɡa-q'a] DEF-coast-to	агаҟа	'to the coast'
iii.	[á-ɡa-kʷʰa] DEF-coast-N.PL	агақәа	'coasts'

In (7) and (8) I give additional forms suffixed with either /-q'a/ 'to' or /-kʷʰa/ 'non-human plural'. These all support the generalizations I have made above: the unaccented morpheme /-q'a/ never affects the stress of what it is attached to, while the accented morpheme /-kʷʰa/ is stressed if and only if the word to which it attaches ends in a stressed vowel. Note that the phrasing here is crucial: /-kʷʰa/ does not bear stress whenever it attaches to a form with stress on its final syllable. What is important is that the final *segment* be a stressed vowel. The importance of this distinction is seen in the data in (8) c.-e., where forms like [a-t͡ʃʰkʲʰə́pʰ] 'fork', [a-t͡s'áa] 'ice', and [a-dúw] 'big' do not show stress on the plural morpheme. This is because their final segments — [pʰ], [a], and [w] respectively — are not stressed vowels. Only if the final segment is a stressed vowel, as in (8) a.-b., does stress show up on the plural.

(7) Additional data for suffix definition

a.

i.	[apʰsnə́] Abkhazia Yanagisawa (2010: 335)	Аҧсны	‘Abkhazia’
ii.	[apʰsnə́-q’a] Abkhazia-to Yanagisawa (2010: 246)	Аҧсныҟа	‘to Abkhazia’

b.

i.	[kʰártʰ] Tbilisi Yanagisawa (2010: 224)	Ҟарҭ	‘Tbilisi’
ii.	[kʰártʰ-q’a] Tbilisi-to Yanagisawa (2010: 246)	Ҟарҭҟа	‘to Tbilisi’

c.

i.	[k’avk’áz] Caucasus Yanagisawa (2010: 202)	Кавказ	‘Caucasus’
ii.	[k’avk’áz-q’a] Caucasus-to Yanagisawa (2010: 246)	Кавказҟа	‘to the Caucasus’

d.

i.	[áq’ʷa] Sukhum Yanagisawa (2010: 254)	Аҟәа	‘Sukhum’

ii.	[áq’ʷa-q’a] Sukhum-to Yanagisawa (2010: 246)	Аҟәаҟа	‘to Sukhum’
e.			
i.	[náa] Naa Yanagisawa (2010: 303)	Наа	‘Naa’
ii.	[náa-q’a] Naa-to Yanagisawa (2010: 283)	Нааҟа	‘to Naa’
f.			
i.	[ríjt͡s’a] Ritsa Yanagisawa (2010: 366)	Рица	‘Ritsa’
ii.	[ríjt͡s’a-q’a] Ritsa-to Yanagisawa (2010: 366)	Рицаҟа	‘to Ritsa’
g.			
i.	[tʰərkʷʰ-t’ʷə́la] Turk-country Yanagisawa (2010: 417)	Ҭырқәтәыла	‘Turkey’
ii.	[tʰərkʷʰ-t’ʷə́la-q’a] Turk-country-to Yanagisawa (2010: 417)	Ҭырқәтәылаҟа	‘to Turkey’

(8) Additional data for suffix definition

a. Yanagisawa (2010: 110)

i.	[a-dʷə́] DEF-field	адәы	‘field’
ii.	[a-dʷ-kʷʰá] DEF-field-N.PL	адәқәа	‘fields’

b. Yanagisawa (2010: 346)

i.	[a-p^{h}ʂá] DEF-wind	апша	‘wind’
ii.	[a-p^{h}ʂa-k^{wh}á] DEF-wind-N.PL	апшақәа	‘winds’
c.	Yanagisawa (2010: 528)		
i.	[a-t͡ʃ^{h}k^{jh}ə́p^{h}] DEF-fork	ачқьып	‘fork’
ii.	[a-t͡ʃ^{h}k^{jh}ə́p^{h}-k^{wh}a] DEF-fork-N.PL	ачқьыпқәа	‘forks’
d.	Yanagisawa (2010: 515)		
i.	[a-t͡s’áa] DEF-ice	ацаа	‘ice’
ii.	[a-t͡s’áa-k^{wh}a] DEF-ice-N.PL	ацаақәа	‘ices, units of ice’
e.	Yanagisawa (2010: 103)		
i.	[a-dúw] DEF-big	аду	‘big (singular)’
ii.	[a-dúw-k^{wh}a] DEF-big-N.PL	адуқәа	‘big (plural)’
f.	Yanagisawa (2010: 425)		
i.	[a-wáp’a] DEF-felt.cloak	ауапа	‘felt cloak’
ii.	[a-wáp’a-k^{wh}a] DEF-felt.cloak-N.PL	ауапақәа	‘felt cloaks’
g.	Yanagisawa (2010: 287)		
i.	[á-mat^{h}] DEF-snake	амаҭ	‘snake’
ii.	[á-mat^{h}-k^{wh}a] DEF-snake-N.PL	амаҭқәа	‘snakes’

The data in (9) below show, again with the word ‘house’ as the base, that other morphemes also fit in to this binary classification scheme. Any morpheme which is added to the end of the word ‘house’, or indeed to any other word ending in a stressed vowel, either leaves the stress unchanged (9) b., or else causes the stress to appear on itself (9) c. There is no third category of accentual behavior.

(9) Binary accentual categories for ‘house’

a.

i.	[a-ɥnə́] DEF-house Yanagisawa (2010: 582)	аҩны	‘house’

b.

i.	[a-ɥnə́-q’a] DEF-house-to Yanagisawa (2010: 582)	аҩныҟа	‘to the house’
ii.	[a-ɥnə́-mat^{wh}a] DEF-house-clothes Yanagisawa (2010: 583)	аҩнымаҭәа	‘furniture’
iii.	[a-ɥnə́-ʒ^{w}] DEF-house-old Yanagisawa (2010: 350)	аҩныжә	‘old house’
iv.	[a-ɥnə́-nt’^{w}] DEF-house-from Yanagisawa (2010: 317)	аҩнынтә	‘from the house’
v.	[a-ɥnə́-nd͡za] DEF-house-until Yanagisawa (2010: 115)	аҩнынӡа	‘up to the house’

c.

i. [a-ɥn-ɡʲə́] аҩнгьы ‘the house also’
DEF-house-also
Yanagisawa (2010: 582)

ii. [a-ɥn-ʈ͡ʂ’ə́t͡sʰ] аҩнҿыц ‘new house’
DEF-house-new
Yanagisawa (2010: 582)

iii. [a-ɥn-rá] аҩнра ‘dwelling, family’
DEF-house-NMLZ
Yanagisawa (2010: 582)

iv. [a-ɥn-kʷʰá] аҩнқәа ‘houses’
DEF-house-N.PL
Yanagisawa (2010: 582)

The data above motivate the definition for underlying accents in (10), repeated from (5) above. Since I will add additional definitions for these categories imminently, I will call this the suffix definition, since it is based on appending material to the end of a string.

(10) The suffix definition for underlying accents

In order to find out whether a morpheme is accented or unaccented, suffix it to a word whose final segment is a stressed vowel.
1) If the location of stress is unaffected, the morpheme is unaccented
2) If stress falls on the morpheme added, that morpheme is accented

As illustrated with the data above, it is an empirical fact about Abkhaz that when a word ends in a stressed vowel, this definition does yield two stress categories (and only two), as described. When a word that does not end in a stressed vowel is used instead, no stress differences are found. There are many other facts about Abkhaz stress which could be stated using similar definitions. I have chosen to focus on the set of facts that result in (10), because I have found that this is useful in deducing the stress assignment algorithm of Abkhaz.

Although I make absolutely no claims of mathematical levels of certainty in my reasoning, this is similar to what is done in some mathematical proofs. It may seem arbitrary at first to "let P be the point halfway between the center of the larger and smaller circles", or whatever it may be, but P may later be useful in proving some geometrical fact. Similarly, it may seem arbitrary to focus on such a specific and narrowly defined aspect of Abkhaz stress, but I will argue below that this definition, coupled with other definitions, is useful in drawing conclusions about Abkhaz stress assignment.

5.3 The prefix definition

It is difficult to get very far with the suffix definition for accentual categories in (10) alone. In particular, it would be useful to know whether a noun or adjective is accented or unaccented based only on its citation form, with the prefix /a-/. In this section I show that there is an empirical correlation between stress behavior according to the suffix definition and stress behavior of the citation form. This allows for the following alternative definition for underlying accents, which I call the prefix definition.

(11) The prefix definition for underlying accents

In order to find out whether a morpheme is accented or unaccented, attach it to the definite prefix /a-/
1) If the prefix is stressed, the morpheme is unaccented
2) If stress falls on the morpheme itself, that morpheme is accented

In (12) I provide ten examples of morphemes (the forms in ii.) which are diagnosed as unaccented by the suffix definition, which is to say that they do not affect the location of stress when added to a word ending in a stressed vowel (the forms in i.). All of these ten morphemes have stress on the prefix /a-/ in their citation forms (the forms in iii.). In (13)

I provide ten morphemes diagnosed as accented by the suffix definition. All ten have stress on the stem in their citation forms. In other words, the set of morphemes picked out as unaccented by the suffix definition are the same as the set of morphemes which are unstressed when attached to the definite prefix /a-/. And morphemes identified as accented by the suffix definition are stressed in the same morphological context.

(12) Correlation between suffix and prefix definitions

a.

i.	[a-ʈ͡ʂʰə́] DEF-horse Yanagisawa (2010: 539)	аҿы	‘horse’
ii.	[a-ʈ͡ʂʰə́-bʁa] DEF-horse-back Yanagisawa (2010: 539)	аҿыбӷа	‘horseback’
iii.	[á-bʁa] DEF-back Yanagisawa (2010: 56)	абӷа	‘back (noun)’

b.

i.	[a-fə́] DEF-lightning Yanagisawa (2010: 434)	афы	‘lightning’
ii.	[a-fə́-mt͡sʰa] DEF-lightning-fire Yanagisawa (2010: 434)	афымца	‘electricity’
iii.	[á-mt͡sʰa] DEF-fire Yanagisawa (2010: 294)	амца	‘fire’

c.

i.	[a-t͡ʂ’ə́] DEF-mouth Yanagisawa (2010: 549)	аҿы	‘mouth’
ii.	[a-t͡ʂ’ə́-t͡s’a] DEF-mouth-bottom Yanagisawa (2010: 552)	аҿыцӷа	‘palate’
iii.	[á-t͡s’a] DEF-bottom Yanagisawa (2010: 515)	атцӷа	‘bottom’

d.

i.	[a-ɥnə́] DEF-house Yanagisawa (2010: 582)	аҩны	‘house’
ii.	[a-ɥnə́-mat^{wh}a] DEF-house-clothes Yanagisawa (2010: 583)	аҩнымаҭәа	‘furniture’
iii.	[á-mat^{wh}a] DEF-clothes Yanagisawa (2010: 287)	амаҭәа	‘clothes’

e.

i.	[a-d^{w}ə́] DEF-field Yanagisawa (2010: 110)	адәы	‘field’
ii.	[a-d^{w}ə́-ʁba] DEF-field-ship Yanagisawa (2010: 110)	адәыҕба	‘train’
iii.	[á-ʁba] DEF-ship Yanagisawa (2010: 991)	аҕба	‘ship’

f.

i.	[a-wasá] DEF-sheep Yanagisawa (2010: 425)	ауаса	‘sheep’
ii.	[a-wasá-χʲt͡ʃʰa] DEF-sheep-herder Chirikba (2003: 26)	ауасахьча	‘shepherd’
iii.	[á-χʲt͡ʃʰa] DEF-herder Yanagisawa (2010: 471)	ахьча	‘herder’

g. Spruit (1986: 40-41)

i.	[a-ħʷá] DEF-pig	аҳәа	‘pig’
ii.	[a-ħʷá-χʷa] DEF-pig-gray	аҳәахәа	‘gray pig’
iii.	[á-χʷa] DEF-gray	ахәа	‘gray’

h.

i.	[a-waʮə́] DEF-person Yanagisawa (2010: 426)	ауаҩы	‘person’
ii.	[a-waʮə́-las] DEF-person-quick Spruit (1986: 43)	ауаҩылас	‘quick person’
iii.	[á-las] DEF-quick Yanagisawa (2010: 267)	алас	‘quick’

i.

i.	[ajχá] DEF.iron Yanagisawa (2010: 193)	аиха	‘iron’
ii.	[ajχá-mɥa] DEF.iron-road Yanagisawa (2010: 193)	аихамҩа	‘railway’
iii.	[á-mɥa] DEF-road Yanagisawa (2010: 299)	амҩа	‘road’

j.

i.	[a-t͡ʂʰə́] DEF-horse Yanagisawa (2010: 539)	аҽы	‘horse’
ii.	[a-t͡ʂʰə́-ʒʷla] DEF-horse-last.name Yanagisawa (2010: 539)	аҽыжәла	‘strain of horse’
iii.	[á-ʒʷla] DEF-last.name Yanagisawa (2010: 122)	ажәла	‘last name’

(13) Correlation between suffix and prefix definitions

a.

i.	[a-ħʷá] DEF-pig Yanagisawa (2010: 489)	аҳәа	‘pig’
ii.	[a-ħʷa-ʒə́] DEF-pig-meat Yanagisawa (2010: 489)	аҳәажьы	‘pork’
iii.	[a-ʒə́] DEF-meat Yanagisawa (2010: 119)	ажьы	‘meat’

b.

i.	[a-q’armá] DEF-hops Yanagisawa (2010: 250)	аҟарма	‘hops’
ii.	[a-q’arma-t͡s’ə́s] DEF-hops-bird Yanagisawa (2010: 250)	аҟарматцыс	‘nightingale’
iii.	[a-t͡s’ə́s] DEF-bird Yanagisawa (2010: 523)	атцыс	‘bird’

c.

i.	[a-mʈ͡ʂ’ə́] DEF-wood Yanagisawa (2010: 298)	амҿы	‘wood’
ii.	[a-mʈ͡ʂ’-lə́χ] DEF-wood-material Yanagisawa (2010: 298)	амҿлых	‘wooden ware’
iii.	[a-lə́χ] DEF-material Yanagisawa (2010: 280)	алых	‘material’

d.

i.	[a-ʃap’ə́] DEF-foot Yanagisawa (2010: 561)	ашьапы	‘foot’
ii.	[a-ʃap’-pʰə́nt͡s’a] DEF-foot-nose Yanagisawa (2010: 561)	ашьапцынтца	‘toe’
iii.	[a-pʰə́nt͡s’a] DEF-nose Yanagisawa (2010: 350)	ацынтца	‘nose’

e.	Spruit (1986: 40-41)		
i.	[a-d͡zə́] DEF-water	аӡы	‘water’
ii.	[a-d͡z-ʁ^{j}ə́] DEF-water-violent	аӡӷьы	‘swift water’
iii.	[a-ʁ^{j}ə́] DEF-violent	аӷьы	‘violent’
f.	Spruit (1986: 40-41)		
i.	[a-d͡zə́] DEF-water	аӡы	‘water’
ii.	[a-d͡z-t͡s^{h}á] DEF-water-hot	аӡца	‘hot water’
iii.	[a-t͡s^{h}á] DEF-hot	аца	‘hot’
g.			
i.	[a-labá] DEF-stick Yanagisawa (2010: 259)	алаба	‘stick’
ii.	[a-laba-p’á] DEF-stick-thin Spruit (1986: 42)	алаба па	‘thin stick’
iii.	[a-p’á] DEF-thin Yanagisawa (2010: 329)	апа	‘thin’
h.			
i.	[a-ɥnə́] DEF-house Yanagisawa (2010: 582)	аҩны	‘house’
ii.	[a-ɥn-ʈ͡ʂ’ə́t͡s^{h}] DEF-house-new Yanagisawa (2010: 582)	аҩнҿыц	‘new house’

iii.	[a-t͡ʂ’ə́t͡sʰ] DEF-new Yanagisawa (2010: 552)	аҿыц	‘new’
i.			
i.	[a-lá] DEF-dog Yanagisawa (2010: 259)	ала	‘dog’
ii.	[a-la-χʷt͡ʃ’ə́] DEF-dog-small Spruit (1986: 42)	ала хәҷы	‘small dog’
iii.	[a-χʷət͡ʃ’ə́] DEF-small Yanagisawa (2010: 483)	ахәыҷы	‘small’
j.	Spruit (1986: 40-41)		
i.	[a-t͡ʃʰá] DEF-bread	ача	‘bread’
ii.	[a-t͡ʃʰa-ɥá] DEF-bread-dry	ача ҩа	‘dry bread’
iii.	[a-ɥá] DEF-dry	аҩа	‘dry’

The fact that these stress patterns are correlated with each other, picking out the same set of morphemes, allows us to set up another definition for accented and unaccented morphemes. I call this the prefix definition, since it is based on the behavior of morphemes when appearing after the definite prefix.

(14) The prefix definition for underlying accents

In order to find out whether a morpheme is accented or unaccented, attach it to the definite prefix /a-/
1) If the prefix is stressed, the morpheme is unaccented
2) If stress falls on the morpheme itself, that morpheme is accented

Note that it is only because of the empirical correlation between stress behaviors illustrated for twenty morphemes in (12) and (13) that we are able to reuse the labels 'unaccented' and 'accented' here. If there was no correlation, (14) would still be valid, but for different accentual categories whose relationship to unaccented and unaccented morphemes from previous sections would be entirely unknown. As evidenced by the fact that both the suffix and the prefix definitions pick out the same morphemes in (12) and (13), these multiple definitions do not yield conflicting results.

Even though these two definitions, especially the prefix definition, will be useful to us later on, there is still a problem which requires yet another definition. At the moment both definitions depend on adding a morpheme at the end of some string. While this is useful for some morphemes, it does not allow us to categorize prefixes as accented or unaccented. In particular, although the prefix definition relies on the ubiquitous /a-/ prefix, we do not know its accentual category. This is addressed in the next section.

5.4 The optionality definition

In this section I will provide a third and final definition for underlying accents. I will use the same methodology as in Section 5.3 above: finding an empirical property which divides morphemes into two categories, and which is correlated with previous definitions. Specifically, it is of interest to find a property which can diagnose the accentual status of prefixes, and not only stems and suffixes. Optionality in stress placement among indefinite forms provides the crucial data, giving the optionality definition below. In the remainder of this section I motivate this definition, and show that it picks out the same morphemes as accented and unaccented as the suffix and prefix definitions do.

(15) The optionality definition for underlying accents

> In order to find out whether a morpheme is accented or unaccented, include it in an indefinite form. (If there are other morphemes, these must show the optionality in stress placement for the indefinite.)
> 1) If there is optionality in stress placement for the indefinite, the morpheme is unaccented
> 2) If there is no optionality, the morpheme is accented

The indefinite is marked with a suffix [-k’]~[k’ə́] in Abkhaz, attached to an unprefixed stem.[30] It is easy to observe that when attached to an unaccented morpheme, both [-k’] and [k’ə́] are possible, but when attached to an accented morpheme, only the [-k’] form appears. This empirical correlation is illustrated for unaccented morphemes in (16) and accented morphemes in (17). The i. forms diagnose the relevant stem as accented or unaccented by the prefix definition. The indefinite forms in ii. show that the indefinite optionality is possible only with the unaccented morphemes in (16).

One exception is found in (16) d. Some forms with multiple /a/ vowels do not allow indefinite optionality even though they are unaccented by the prefix definition. The conditions allowing the exception in (16) d. are complex. Forms with multiple /a/ vowels do show optionality if the /a/ vowels are adjacent, as in (16) e. Forms where one /a/ is initial also show optionality, as in (16) f.-g. The forms in (16) f.-g. are taken partly from texts in Abkhaz without stress marking. Since schwa in Abkhaz is only present in clusters and where required for stress (see Chapter 4), schwas outside of clusters bear stress. This is the only situation where the location of stress can be inferred from Abkhaz orthography, and I have added the stresses on the relevant forms in (16) f.-g. myself.

30 Indefinites are translated as ‘one X’ rather than ‘an X’ in this dissertation (see Chapter 2, Section 2.2.1.2 for discussion).

(16) Illustration of the optionality definition

a. Spruit (1986: 42)

i.	[á-mt͡s’] DEF-fly	амц	‘fly’
ii.	[mt͡s’ə́-k’] [mət͡s’-k’ə́] fly-INDF	мцык мыцкы	‘one fly’

b. Spruit (1986: 42)

i.	[á-t͡sʰħa] DEF-bridge	ацҳа	‘bridge’
ii.	[t͡sʰħá-k’] [t͡sʰħa-k’ə́] bridge-INDF	цҳак цҳакы	‘one bridge’

c. Spruit (1986: 42)

i.	[á-baχʷ] DEF-stone	абахә	‘stone’
ii.	[baχʷə́-k’] [baχʷ-k’ə́] stone-INDF	бахәык бахәкы	‘one stone’

d. Spruit (1986: 42)

i.	[á-mad͡za] DEF-secret	амаӡа	‘secret’
ii.	[mad͡zá-k’] *[mad͡za-k’ə́] secret-INDF	маӡак	‘one secret’

e. Spruit (1986: 45)

i.	[á-maa] DEF-handle	амаа	‘handle’
ii.	[maá-k’] [maa-k’ə́] handle-INDF	маак маакы	‘one handle’

f.

i.	[á-t͡s’la] DEF-tree Yanagisawa (2010: 521)	атҵла	‘tree’
ii.	[t͡s’lá-k’] [t͡s’la-k’ə́] tree-INDF Yanagisawa (2010: 521)	тҵлак тҵлакы	‘one tree’
iii.	[aa-t͡s’lá-k’] [aa-t͡s’la-k’ə́] eight-tree-INDF Meurer (2018) searched on 2022-09-12, Sputnik Apsny (2021), accessed 2023-08-04	аа-тҵлак аа-тҵлакы	‘eight trees’

g.

i.	[áʃʷa] DEF.song Yanagisawa (2010: 571)	ашәа	‘song’
ii.	[aʃʷá-k’] [aʃʷa-k’ə́] song-INDF Yanagisawa (2010: 571), Gabalia (2023: 87)	ашәак ашәакы	‘one song’

(17) Illustration of the optionality definition (Spruit 1986: 42)

a.

i.	[a-tʰə́pʰ] DEF-place	атып	‘place’
ii.	[tʰə́pʰ-k’] *[tʰəpʰ-k’ə́] place-INDF	тыпк	‘one place’

b.

i.	[a-t͡s’ə́χʷa] DEF-tail	атҵыхәа	‘tail’

ii.	[t͡s'ə́χʷa-k'] *[t͡s'əχʷa-k'ə́] tail-INDF	цыхәак	'one tail'
c.			
i.	[a-ʃʷáχ] DEF-foam	ашәах	'foam'
ii.	[ʃʷáχ-k'] *[ʃʷaχ-k'ə́] foam-INDF	шәахк	'one (unit of) foam'
d.			
i.	[a-dágʷa] DEF-deaf	адагәа	'deaf'
ii.	[dágʷa-k'] *[dagʷa-k'ə́] deaf-INDF	дагәак	'one deaf person'

Although I will rely on the indefinite forms here, since they are commonly given in dictionaries and in other linguistic work on Abkhaz, similar patterns can be observed with other affixes. For example, the essive suffix is [-s] or [-sə́] with unaccented 'eye', but only [-s] with accented 'dog'.

(18) Optionality in essives (Spruit 1986: 51)

a.			
i.	[á-la] DEF-eye	ала	'eye'
ii.	[lá-s] [la-sə́] eye-ESSIVE	лас ласы	'as an eye'
b.			
i.	[a-lá] DEF-dog	ала	'dog'

ii. [lá-s] лас ‘as a dog’
dog-ESSIVE

The optionality in the indefinite persists in words with additional morphemes, so long as all of those morphemes are unaccented. In (19) I show in i. and ii. forms which are diagnosed as unaccented by both the prefix definition and by the fact that they allow indefinite optionality. In iii. I give additional morphemes diagnosed as unaccented by the prefix definition. In iv. I show that even in longer forms, with multiple unaccented morphemes, the indefinite optionality is still present. (20) shows similar data in an identical format, but where iii. and iv. contain an accented morpheme instead, again diagnosed by the prefix definition. In iv. there is no indefinite optionality, since these words all contain accented morphemes. The conclusion is the same as for (16) and (17) above: if one introduces an accented morpheme to a word, the indefinite optionality will no longer be present.

(19) Correlation between optionality and prefix definitions

a.

i. [á-ʃʷ] ашә ‘door’
DEF-door
Yanagisawa (2010: 571)

ii. [ʃʷə́-k’] шәык ‘one door’
[ʃʷ-k’ə́] шәкы
door-INDF
Genko (1998: 361), Yanagisawa (2010: 571)

iii. [á-ʒʷ] ажә ‘old’
DEF-old
Yanagisawa (2010: 121)

iv.	[ʃʷ-ʒʷə́-k’] [ʃʷə-ʒʷ-k’ə́] door-old-INDF Spruit (1986: 41)	шә жәык шәы жәкы	‘one old door’
b.			
i.	[á-ʒʷ] DEF-cow Yanagisawa (2010: 121)	ажә	‘cow’
ii.	[ʒʷə́-k’] [ʒʷ-k’ə́] cow-INDF Yanagisawa (2010: 121)	жәык жәкы	‘one cow’
iii.	[á-χʷa] DEF-gray Spruit (1986: 40)	ахәа	‘gray’
iv.	[ʒʷ-χʷá-k’] [ʒʷ-χʷa-k’ə́] cow-gray-INDF Spruit (1986: 41)	жә хәак жә хәакы	‘one gray cow’
c.			
i.	[á-la] DEF-eye Spruit (1986: 40)	ала	‘eye’
ii.	[lá-k’] [la-k’ə́] eye-INDF Genko (1998: 147), Yanagisawa (2010: 258)	лак лакы	‘one eye’
iii.	[á-χʷ] Spruit (1986: 40)	ахә	‘wounded’
iv.	[la-χʷə́-k’] [la-χʷ-k’ə́] eye-wounded-INDF Spruit (1986: 41)	ла хәык ла хәкы	‘one wounded eye’

d.

i.	[á-t͡ʃʷʰ] DEF-bull Spruit (1986: 40)	ацә	‘bull, ox’
ii.	[t͡ʃʷʰə́-k’] [t͡ʃʷʰ-k’ə́] bull-INDF Yanagisawa (2010: 501)	цәык цәкы	‘one bull’
iii.	[á-ʁra] Yanagisawa (2010: 91)	аҕра	‘multicolored’
iv.	[t͡ʃʷʰə-ʁrá-k’] [t͡ʃʷʰə-ʁra-k’ə́] bull-multicolored-INDF Spruit (1986: 42)	цәы ҕрак цәы ҕракы	‘one multicolored bull’

(20) Correlation between optionality and prefix definitions

a.

i.	[á-d͡ʒ] DEF-oak Genko (1998: 372)	аџь	‘oak’
ii.	[d͡ʒə́-k’] [d͡ʒ-k’ə́] oak-INDF Genko (1998: 372)	џьык џькы	‘one oak’
iii.	[a-ɥá] DEF-dry Spruit (1986: 40)	аҩа	‘dry’
iv.	[d͡ʒ-ɥá-k’] *[d͡ʒ-ɥa-k’ə́] oak-dry-INDF Spruit (1986: 41)	џь ҩак	‘one dry oak’

b.

i.	[á-t͡s’la] DEF-tree Yanagisawa (2010: 521)	ацла	‘tree’

ii.	[t͡s’lá-k’] [t͡s’la-k’ə́] tree-INDF Yanagisawa (2010: 521)	цлак цлакы	‘one tree’
iii.	[a-dúw] DEF-big Yanagisawa (2010: 103)	аду	‘big’
iv.	[t͡s’la-dúw-k’] *[t͡s’la-duw-k’ə́] tree-big-INDF Spruit (1986: 43)	цла дук	‘one big tree’
c.			
i.	[á-d͡z] DEF-louse Yanagisawa (2010: 149)	аӡ	‘louse’
ii.	[d͡zə́-k’] [d͡z-k’ə́] louse-INDF Yanagisawa (2010: 149)	ӡык ӡкы	‘one louse’
iii.	[a-dúw] DEF-big Yanagisawa (2010: 103)	аду	‘big’
iv.	[d͡z-dúw-k’] *[d͡z-duw-k’ə́] louse-big-INDF Hewitt (2010: 34)	ӡ дук	‘one big louse’
d.			
i.	[á-t͡s’la] DEF-tree Yanagisawa (2010: 521)	ацла	‘tree’
ii.	[t͡s’lá-k’] [t͡s’la-k’ə́] tree-INDF Yanagisawa (2010: 521)	цлак цлакы	‘one tree’

iii.	[a-χʷət͡ʃ’ə́] DEF-small Yanagisawa (2010: 483)	ахәычҵы	‘small’
iv.	[t͡s’la-χʷt͡ʃ’ə́-k’] *[t͡s’la-χʷət͡ʃ’-k’ə́] tree-small-INDF Spruit (1986: 43)	ҵла хәҵык	‘one small tree’

These data allow us to formulate a third and final definition for underlying accents, the optionality definition.

(21) The optionality definition for underlying accents

In order to find out whether a morpheme is accented or unaccented, include it in an indefinite form. (If there are other morphemes, these must show the optionality in stress placement for the indefinite.)
1) If there is optionality in stress placement for the indefinite, the morpheme is unaccented
2) If there is no optionality, the morpheme is accented

As above, we only know that this definition picks out accented and unaccented morphemes because the indefinite optionality is correlated with the accentual category as defined by other definitions. The preceding sections have presented much data whose purpose was perhaps not immediately clear. I have proposed three different definitions for the same accentual categories, which I have called accented and unaccented, without using these to make any conclusions about stress assignment. However, armed with these three definitions, it is now possible to construct a large set of Abkhaz words where the accentual category of every morpheme is known. This in turn will allow for the identification of the principles of Abkhaz stress assignment, as I show in Section 5.5 immediately below.

5.5 Deriving an algorithm

With three definitions for accentual categories in place, it is time to make use of the definitions to state the principles of Abkhaz stress assignment in terms of underlying accents. In this section I argue that the data provide evidence for the following rule: primary stress falls on the leftmost accent not immediately followed by an accent. This is perfectly analogous to Dybo's Rule as formulated in Dybo (1977), with 'accent' taking the place of 'dominant'. In other words, this section derives Dybo's Rule from the data-driven definitions from preceding sections.

It is useful to begin by building up a small lexicon of morphemes whose accentual category is known. I will then use these morphemes to construct words with particular sequences of accents to observe where stress falls. All morphemes in (22) a. are unaccented by the prefix definition, while all morphemes in (22) b. are accented by the same definition. Recall from Section 5.3 that according to this definition, a morpheme is unaccented if in the definite form (the citation form) stress falls on the definite prefix, and accented if stress falls elsewhere (i.e. on the morpheme itself).

(22) Diagnosing nominal stems

a.

i.	[á-la] DEF-eye Yanagisawa (2010: 258)	ала	'eye'
ii.	[á-bla] DEF-eye Yanagisawa (2010: 62)	абла	'eye'

iii. [á-ʃχa] ашьха ‘mountain’
DEF-mountain
Yanagisawa (2010: 568)

iv. [á-χʷ] ахә ‘wounded’
DEF-wounded
Spruit (1986: 40)

v. [á-bʁa] абҕа ‘back’
DEF-back
Yanagisawa (2010: 56)

vi. [á-χʲa] ахьа ‘chestnut’
DEF-chestnut
Yanagisawa (2010: 467)

vii. [á-t͡s’la] атцла ‘tree’
DEF-tree
Yanagisawa (2010: 521)

viii. [á-ʁba] аҕба ‘ship’
DEF-ship
Yanagisawa (2010: 91)

b.

i. [a-lá] ала ‘dog’
DEF-dog
Yanagisawa (2010: 259)

ii. [a-t͡ʃʷʰá] ацәа ‘skin’
DEF-skin
Yanagisawa (2010: 501)

iii. [a-dʷə́] адәы ‘field’
DEF-field
Yanagisawa (2010: 110)

iv. [a-t͡ʂʰə́] аҽы ‘horse’
DEF-horse
Yanagisawa (2010: 539)

We can use these content morphemes to deduce the stress category of various important function morphemes. The numeral prefixes /ɥ-/ ‘two’ and /χ-/ ‘three’ are unaccented by the optionality definition. Forms with these prefixes allow optionality in the indefinite. This will be illustrated with the unaccented stems 'mountain' and 'eye'. I have just shown their accentual status in (22) above, but below we see that the indefinite forms of these stems also allow indefinite optionality, again supporting their classification as unaccented.

(23) Diagnosing numeral prefixes

a. Spruit (1986: 51-52)

i.	[ʃχá-k'] [ʃχa-k'ə́] mountain-INDF	шьхак шьхакы	'one mountain'
ii.	[ɥə-ʃχá-k'] [ɥə-ʃχa-k'ə́] two-mountain-INDF	ꙩы-шьхак ꙩы-шьхакы	'two mountains'

b.

i.	[lá-k'] [la-k'ə́] eye-INDF Genko (1998: 147)	лак лакы	'one eye'
ii.	[χ-lá-k'] [χ-la-k'ə́] three-eye-INDF Spruit (1986: 51)	х-лак х-лакы	'three eyes'

The indefinite suffix itself is also unaccented by the suffix definition: when it is attached to a form ending in a stressed vowel, the location of stress is unchanged.

(24) Diagnosing the indefinite suffix (Yanagisawa 2013: 85)

a.	[χ-ɥə́] three-H	хꙩы	'three (human)'

b. [χ-ɥə́-k’] хꚕык ‘three (human)’
*[χ-əɥ-k’ə́]
three-H-INDF

The forms above use the human suffix [-ɥə́], which is accented by the suffix definition: when attached to a form ending in a stressed vowel, stress surfaces on this suffix.

(25) Diagnosing the human suffix (Yanagisawa 2010: 554-555)

a. [ʂaq’á] шаҟа ‘how much’
how.much

b. [ʂaq’a-ɥə́] шаҟаꚕы ‘how many’
how.much-H

The same definition can be used to show that the non-human plural suffix /-k^{wh}a/ and the infinitival suffix /-ra/ are also accented.

(26) Diagnosing inflectional suffixes

a. Yanagisawa (2010: 259)

i. [a-lá] ала ‘dog’
DEF-dog

ii. [a-la-k^{wh}á] алақәа ‘dogs’
DEF-dog-N.PL

b.

i. [a-bá] аба ‘dried up’
DEF-dry
Yanagisawa (2010: 51)

ii. [a-ba-rá] абара ‘to dry (intransitive)’
DEF-dry-INF
Yanagisawa (2010: 54)

The first-person singular possessive prefix /s-/ is accented by the optionality definition. If one attaches this prefix to a form which allows indefinite optionality, the possibility for such optionality disappears. As I have argued in Section 5.4, this only happens for accented morphemes.

(27) Diagnosing a possessive prefix (Spruit 1986: 51-52)

a.	[ɥ-lá-k’] [ɥ-la-k’ə́] two-eye-INDF	ҩ-лак ҩ-лакы	‘two eyes’
b.	[sə́-ɥ-la-k’] *[sə-ɥ-la-k’ə́] 1S.POSS-two-eye-INDF	сыҩ-лак	‘my two eyes’

A similar argument shows that the definite prefix /a-/ is accented, since its addition to a word causes indefinite optionality to disappear (28) a. ii. and (28) b. ii. (See section 4.4 on indefinite optionality in words with multiple /a/ vowels.)

(28) Diagnosing the definite prefix (Spruit 1986: 52)

a.

a.	[ɥ-lá-k’] [ɥ-la-k’ə́] two-eye-INDF	ҩ-лак ҩ-лакы	‘two eyes’
b.	[á-ɥ-la-k’] *[a-ɥ-la-k’ə́] DEF-two-eye-INDF	аҩ-лак	‘the two eyes’

b.

ii.	[ɥə-ʃχá-k’] [ɥə-ʃχa-k’ə́] two-mountain-INDF	ҩы-шьхак ҩы-шьхакы	‘two mountains’
ii.	[á-ɥə-ʃχa-k’] *[a-ɥə-ʃχa-k’ə́] DEF-two-mountain-INDF	аҩы-шьхак	‘the two mountains’

In (29) I give the accentual status of the function and content morphemes surveyed thus far. Below I will use these morphemes to construct words consisting of particular sequences of accents.

(29) A dictionary of the accentual status of various morphemes

Content morphemes

Unaccented		Accented	
/la/	'eye'	/la/	'dog'
/bla/	'eye'	/t͡ʃʷʰa/	'skin'
/ʃχa/	'mountain'	/dʷ/	'field'
/χʷ/	'wounded'	/t͡ʂʰ/	'horse'
/bʁa/	'back'		
/χ̫ʲa/	'chestnut'		
/ts'la/	'tree'		
/ʁba/	'ship'		

Function morphemes

Unaccented		Accented	
/ɥ-/	'two'	/-ɥ/	'H'
/χ-/	'three'	/-kʷʰa/	'N.PL'
/-k'/	'INDF'	/-ra/	'INF'
		/s-/	'1S.POSS'
		/a-/	'DEF'

With this background, I will now show how stress is assigned in Abkhaz based on the accentual categories of the constituent morphemes of a word. This will, at long last, lead to an algorithm for stress assignment. First of all, if a word contains only a single accented morpheme, that morpheme receives the stress. Below I use 'A' for 'accented', and 'U' for 'unaccented'.

(30) Stress with a single underlying accent

a. [á-la] ала 'eye'
A-U
DEF-eye
Yanagisawa (2010: 258)

b.	[χ-ʮə́] U-A three-H Yanagisawa (2013: 85)	хԥы	'three (human)'
c.	[á-la-χʷ] A-U-U DEF-eye-wounded Spruit (1986: 41)	алахə	'wounded eye'
d.	[ʮ-lá-k'] U-A-U two-dog-INDF Spruit (1986: 52)	ԥ-лак	'two dogs'
e.	[sə́-ʮ-ʃχa-k'] A-U-U-U 1S.POSS-two-mountain-INDF Spruit (1986: 52)	сыԥ-шьхак	'my two mountains'

If there are multiple accented morphemes which are not immediately adjacent to each other, stress falls on the leftmost accent.

(31) Stress with multiple non-adjacent accents

a.	[á-la-kʷʰa] A-U-A DEF-eye-N.PL Yanagisawa (2010: 258)	алақәа	'eyes'
b.	[á-χʲa-t͡s'la-kʷʰa] A-U-U-A DEF-chestnut-tree-N.PL Yanagisawa (2010: 468)	ахьацлақәа	'chestnut trees'
c.	[sə́-ʮ-la-k'] A-U-A-U 1S.POSS-two-dog-INDF Spruit (1986: 52)	сыԥ-лак	'my two dogs'

If there are multiple accented morphemes which are immediately adjacent to each other, stress instead falls on the rightmost accent.

(32) Stress with multiple adjacent accents

a. [a-lá] ала ‘dog’
A-A
DEF-dog
Yanagisawa (2010: 259)

b. [a-ba-rá] абара ‘to dry (intransitive)’
A-A-A
DEF-dry-INF
Yanagisawa (2010: 54)

c. [a-t͡ʂ^{h}ə́-bʁa] аҽыбӷа ‘horseback’
A-A-U
DEF-horse-back
Yanagisawa (2010: 539)

Finally, if there are multiple accented morphemes, some of which are immediately adjacent to each other while others are not, stress falls on the rightmost accent within the leftmost contiguous span of accents.

(33) Stress with multiple spans of accents

a. [á-la-t͡ʃ^{wh}a-k^{wh}a] алацәақәа ‘eyelids’
A-U-A-A
DEF-eye-skin-N.PL
Yanagisawa (2010: 270)

b. [a-d^{w}ə́-ʁba-k^{wh}a] адәыгбақәа ‘trains’
A-A-U-A
DEF-field-ship-N.PL
Yanagisawa (2010: 110)

The description of where stress falls in (33) is in fact also true of the previous data we have seen, so that all of the datasets above have stress assigned as follows:

(34) Generalization about stress assignment

Primary stress falls on the leftmost accent not immediately followed by another accent

This rule ensures that, as the data show, stress is rightmost within a span of contiguous accented morphemes (as in (32) and (33)), while also surfacing on the leftmost such span if multiple are present in a word (as in (31) and (33)). This rule for stress assignment, which I have derived by considering stress data alone, happens to be identical to Dybo's Rule (Dybo 1977) for assigning stress in Abkhaz. The only difference is that I use the term 'accent' or 'accented morpheme' where Dybo (1977) used 'dominant'.

As I have shown, the rule in (34) can be derived in a bottom-up fashion only by using empirically motivated definitions for accented and unaccented morphemes. Because of this, the remainder of this dissertation will use this rule to assign stress. In Chapter 6, Section 6.2 I will evaluate this rule against two corpora of Abkhaz stress alternations, and show that it performs well across the nominal and verbal lexicon. Since the rule itself is not novel, although its derivation is, I will continue to call it Dybo's Rule. Above I have discussed primary stress, but below I will argue that Dybo's Rule and the accent specifications it relies on are also useful in characterizing the distribution of secondary stress.

5.6 Secondary stress

In Chapter 4, Section 4.3 I discussed secondary stress in Abkhaz from a phonetic and phonological perspective. There I noted that vowels which sometimes carry primary stress often have secondary stress when primary stress surfaces elsewhere in the word. I talked of 'stressable morphemes' in that chapter, with a promise to discuss in Chapter 5 the exact phonological contexts in which secondary stress is assigned. It is now time to make good on that promise. In preceding sections I have described how primary stress falls on the leftmost accent not immediately followed by an accent. In this section I will show that if there are multiple instances in a word of accents not immediately followed by accents, the leftmost receives primary stress, while others receive secondary stress. As in Chapter 4, this is the line of argumentation found in Spruit (1986: 73-75), repeated here with new data.

I will reuse the morphemes whose accentual category was already determined in previous sections. I will then use these to create words with multiple accents not immediately followed by accents, and show that these words contain secondary stresses as well as epenthetic schwas which are not motivated by phonotactics (see Chapter 4). Recall the following accentual categories from previous sections:

(35) Accentual status of various morphemes

a.	Accented	b.	Unaccented
/a-/	'DEF'	/χ-/	'three'
/-ɥ/	'H'	/-k'/	'INDF'
/-gʲ/	'also'	/sas/	'guest'

In the words below, primary stress falls on the prefix /a-/, since it is the leftmost accent not immediately followed by an accent. However, each word has another accent not immediately followed by an accent, which is marked by the presence of a schwa, and in my transcriptions based on the data in Chapter 4, also a secondary stress. The word in (36) a. has a secondary stress in word-final position, since a word-final accent is not immediately followed by an accent, or indeed by anything at all. The word in (36) b. has a secondary stress in word-medial position, corresponding to an accented morpheme immediately followed by an unaccented morpheme. In (36) b. it is important to note that the schwa is not present only because an ungrammatical three-consonant cluster *[χʮk’] would result if it were absent. In such clusters, epenthesis is between the first and second consonant (see Chapter 4, Section 4.1.2), which would give *[á-χəʮ-k’] rather than the attested [á-χ-ʮə̀-k’] with a schwa between the second and third consonants.

(36) Environments for secondary stress

a. асасгьы
[**á**-sas-**gʲə̀**]
A-U-**A**
DEF-guest-also
‘a guest also’
Dybo (1977: 42)

b. ахԥык
[**á**-χ-**ʮə̀**-k’]
A-U-**A**-U
DEF-three-H-INDF
‘the three people’
Yanagisawa (2010: 35)

This helps us formalize the relatively vague intuition behind the term ‘stressable morpheme’ in Chapter 4, Section 4.3. These are actually accented morphemes. Since Dybo’s Rule preferentially assigns stress to accented morphemes, this explains why morphemes which can appear with secondary stress have primary stress on morphologically related forms. It also provides a formalization of the exact phonological environment in which secondary stress is assigned to these morphemes. This environment is also very similar to the environment in which primary stress is assigned. Accents which are not immediately followed by accents are assigned stress in Abkhaz. The leftmost such accent receives primary stress, while others receive secondary stress.

Despite the successes of Dybo’s Rule for both primary and secondary stress, there are also shortcomings of this algorithm. These are discussed in the next section.

5.7 Exceptions to Dybo's Rule

It is interesting to note that Dybo's Rule, as defined in Dybo (1977) and in (34), does not directly reference unaccented morphemes. Such morphemes are not invisible to stress assignment, and are in fact crucial in determining the placement of stress in forms like A-A [a-lá] 'dog' with final stress vs. A-U-A [á-la-k^{wh}a] 'eyes' with initial stress. However, the absence of unaccented morphemes in the rule means that no predictions are made about where stress will fall in words consisting only of unaccented morphemes. This appears to be determined at least in part by the morphological category. Spruit (1986: 38) concludes that for words with only unaccented morphemes, "the position of stress has to be stated for each morphological type".

However, I believe that a useful general statement is that in these words, stress is stem-final by default. Some forms instead show absolute word-final stress, often optionally alternating with stem-final stress. I discuss the empirical situation below, arguing that stem-final is the default. Unaccented verb stems sometimes appear with stem-final stress, but never with word-final stress. The stem /sas/ '(be a) guest' is unaccented by the prefix definition (37) a. and the optionality definition (37) b. In (37) c., I show that when it appears in the unaccented-only verb form /d-...-jt'/ '(s)he VERBed' stress is stem-final but not word-final. The accentual category of the two affixes is motivated in (38). The verbal suffix /-jt'/ 'DYN.FIN' is unaccented, as shown by the suffix definition in (38) a. i.-ii. The prefix /d-/ must be unaccented (38) b. i., since if it were accented, it would incorrectly receive stress by Dybo's Rule in (38) b. ii.[31] In (37) and

31 In reality the situation is more complicated. In Chapter 6 I argue that some verbs with this prefix are

(38) stems are underlined.

(37) Diagnosing affixes

a.	[á-<u>sas</u>] DEF-<u>guest</u> Yanagisawa (2010: 389)	асас	'guest'
b.	[<u>sasə́</u>-k'] [<u>sas</u>-k'ə́] <u>guest</u>-INDF Trigo (1992: 204)	сасык саскы	'one guest'
c.	[d-<u>sasí</u>-jt'], *[d-<u>sasi</u>-jt'ə́] 3SHA-<u>guest</u>-DYN.FIN Yanagisawa (2010: 389)	дсасит	'(s)he was a guest'

(38)

a.

i.	[b-<u>k^{jh}ə́</u>] 2SFA-<u>sigh</u> Yanagisawa (2010: 226)	Бқьы!	'sigh!'
ii.	[b-<u>k^{jh}í</u>-jt'] 2SFA-<u>sigh</u>-DYN.FIN Yanagisawa (2013: 137)	бқьит	'you sighed'

b.

i.	[d-<u>sasí</u>-jt'] U-U-U 3SHA-<u>guest</u>-DYN.FIN Yanagisawa (2010: 389)	дсасит	'(s)he was a guest'
ii.	*[də́-<u>sasi</u>-jt'] A-U-U 3SHA-<u>guest</u>-DYN.FIN		

pre-accenting, and do not have stress assigned by Dybo's Rule at all. In those cases, the prefix /d-/ can bear stress: [də́-p^ho-jt'] 3SHA-jump.DYN-DYN.FIN '(s)he jumps'. In fact Dybo (1977: 43) assumes that absolute prefixes are accented because of such pre-accenting forms. I follow subsequent literature (Spruit 1986, Hewitt 2010) in assuming the unaccented forms are the default. This is not relevant here, since the point stands that '(s)he was a guest' does not have absolute word-final stress. For a full theoretical analysis of pre-accentuation as well as Dybo's Rule, see Chapter 7.

For nominals the situation is more complicated, with some variation existing between stem-final and word-final stress. As shown in Section 5.4, the indefinite suffix can optionally be stressed in words consisting only of unaccented morphemes, and there is interspeaker variation with other unstressed suffixes (see Spruit 1986: 51 and Section 5.4 on /-s/ ‘essive’, and Trigo 1992: 204 fn. 11 on postpositions). Below are two forms of ‘by ship’ varying in stress even though they come from the same source:

(39) Optionality with postpositions

a. ҕбала
[ʁbá-la]
/ʁba-la/
ship-by
‘by ship’
Yanagisawa (2010: 323)

b. ҕбала
[ʁba-lá]
/ʁba-la/
ship-by
‘by ship’
Yanagisawa (2010: 91)

Contra Trigo (1992) I treat stem-final stress as the default, since it appears to be always be at least a possibility in such configurations, unlike word-final stress which may or may not result in ungrammaticality. I have shown this for verbs above, but the same is true of some nominals. For example, for /mad͡za-k’/ ‘one secret’, only [mad͡zá-k’] is found and never *[mad͡za-k’ə́] (Spruit 1986: 41, Trigo 1992: 229 fn. 20; see Section 5.4 for discussion). A fuller account of Abkhaz stress would need to account for the patterns of optionality discussed above. Given the data present in the database corpora studied in Chapter 6, where optionality in stress placement is seldom reported, the generalization that the default for all-unaccented words is stem-final stress will be sufficient for the purposes of this dissertation.

There are also situations where even words with accented morphemes do not follow Dybo’s Rule. Here I give just one example. Additional exceptions to Dybo’s Rule are discussed in more detail in Chapter 6, Sections 6.1.9 and 6.3. The stem /pʰtʰa/ ‘cloud’ is unaccented by the prefix definition (40) a. The suffix /-gʲ/ is accented by the suffix definition (40) b. Since the indefinite suffix /-k’/ is unaccented (see Section 5.4), an underlying form like /pʰtʰa-k’-gʲ/ cloud-INDF-also ‘even one cloud’ is accentually U-U-A. Since there is only a single accented morpheme, it is predicted to bear primary stress. However, *[pʰtʰa-k’-gʲə́] is ungrammatical, and stress falls instead on the unaccented stem, [pʰtʰá-k’-gʲə] (40) c. But it is not the case that accented suffixes are ignored by Dybo’s Rule. The form /pʰtʰa-kʷʰa-k’/ cloud-N.PL-INDF ‘some clouds’ is U-A-U (see Section 5.5 for the plural suffix as accented), and here Dybo’s Rule applies as usual (40) d.

(40) Exceptions to Dybo’s Rule

a. [á-pʰtʰa] — апҭа — ‘cloud’
DEF-cloud
Yanagisawa (2010: 339)

b.

i. [a-lá] — ала — ‘dog’
DEF-dog
Dybo (1977: 42)

ii. [a-la-gʲə́] — алагьы — ‘and the dog’
DEF-dog-also
Dybo (1977: 42)

c. [p^{h}t^{h}á-k’-ɡ^{j}ə], *[p^{h}t^{h}a-k’-ɡ^{j}ə́] пҭакгьы ‘even one cloud’
U-U-A
cloud-INDF-also
Yanagisawa (2010: 451)

d. [p^{h}t^{h}a-k^{wh}á-k’] пҭақәак ‘some clouds’
U-A-U
cloud-N.PL-INDF
Yanagisawa (2010: 339)

The generalization appears to be that stress is stem-final instead of following Dybo’s Rule if a) the form contains only unaccented morphemes and accented suffixes, and b) the suffix is not immediately adjacent to the stem. The accented suffix /-ɡ^{j}/ is (40) c. is not adjacent to the stem, so the form is an exception to Dybo’s Rule. But in (40) d. the accented suffix /-k^{wh}a/ is adjacent to the stem, so Dybo’s Rule applies as usual. The exceptionality of forms like those in (40) c. has been noted in previous literature (Spruit 1986: 43, Trigo 1992: 214). In Chapter 7, Section 7.2 I show that the analysis I propose for default stem-final stress predicts exactly this type of exception to Dybo’s Rule, and only in cases like (40) c. rather than (40) d.

I will return to additional types of exceptions in Chapter 6. In particular, Chapter 6, Section 6.3.1 discusses the environments in which verbs are pre-accenting rather than having stress assigned by Dybo’s Rule. Before then, since the path of argumentation that has led to the conclusion of Dybo’s Rule has been long and winding, I will summarize the steps in the concluding section of this chapter immediately below. There I also discuss the significance of this conclusion for work on stress assignment in Abkhaz.

5.8 Conclusions

In this chapter I have illustrated the principles of stress assignment in Abkhaz. I began by arguing that Abkhaz stress contrasts are fundamentally binary in nature, involving a split into two categories which I have called accented and unaccented. I have given several definitions which allow us, in various contexts, to identify the stress category of a morpheme. I have also argued that these different definitions are consistent with each other, and do not yield conflicting results.

Since the lack of conflicting results is so important, I have attempted throughout this chapter to give more data than is typically done in work on theoretical phonology, to ensure that the empirical patterns I highlight are robust. With these definitions in hand, I have shown how it is possible to diagnose the stress category of many important function morphemes in the language, and thereby construct words consisting of particular sequences of accented and unaccented morphemes. The conclusion of this project was the identification of a simple rule, which predicts where stress will fall in Abkhaz: primary stress falls on the leftmost accent not immediately followed by another accent.

The stress assignment rule I have derived on the basis of stress alternations and the definitions for categoryhood that I have given is already known in the literature on Abkhaz, under the name Dybo's Rule. It has been known from previous literature that this rule is predictively successful when applied to Abkhaz stress, so it is not surprising that the data point in exactly this direction. However, since previous work has merely assumed Dybo's Rule to be valid, it is reassuring to know that this rule can be derived in a bottom-up fashion from stress alternations alone. It is possible to begin with nothing other than a large corpus of stress alternations, and to show that the data require Dybo's

Rule, as I have done in this chapter.

As evidenced by the length of this chapter, such a derivation takes some time to construct, and begins with several definitions whose relevance is not immediately obvious. For this reason I have attempted to make these definitions, the data supporting them, as well as the arguments which follow from the definitions, as clear as possible. The aim of this chapter has been to place Dybo’s Rule on a more solid empirical foundation. I hope, even though the arguments for this mechanism of stress assignment are long and require many steps, that the progression from one step to the next is nevertheless logical and sound.

Before moving on to the next chapter, it is worth repeating some of the caveats with the approach I have taken to Abkhaz stress here. I have written throughout of particular morphemes having one accentual category or the the other, and of morphemes as being the locus of this binary stress division in Abkhaz. This is true for monosyllabic and monomoraic morphemes, but as I argue in Chapters 6 and 7, it is not true in general. In Chapter 7 I argue that individual segments, rather than morphemes, carry accentual contrasts in Abkhaz.

It is also necessary to mention that the data I have considered are rather limited in scope. In particular, almost all of the data in this chapter come from either nouns or adjectives, whose morphology is considerably simpler than that of Abkhaz verbs. The definitions for accentual categories that I have used are primarily useful outside of the verbal domain. Previous work, especially by Spruit (1986), has shown that verbs exhibit many exceptions to Dybo’s Rule, some of which are easier to state and describe than others. Even for nouns and adjectives there are combinations of morphemes which do not have the stress that is expected based on the accentual categories of each morpheme in the word. In Chapter 6 I examine larger datasets, including highly agglutinative verb forms, to study and classify these exceptions in greater detail. These data, including the exceptions, are analyzed theoretically in Chapter 7.

Chapter 6: Corpus Studies of Abkhaz Stress

In this chapter I provide an empirical and quantitatively grounded overview of Abkhaz stress alternations based on the database corpora described in Chapter 2, with two inflected forms of 545 nominals, and seven inflected forms of 445 verbs. I show that for both nominals and verbs, the number of stress patterns found on a given stem depends on the stem shape and stem length. Surprisingly the number of vowels in a stem is irrelevant, with vowelless stems such as /CC/ showing the same patterns of stress alternations as /CVCV/ stems.

These data are helpful in evaluating theories of Abkhaz stress assignment. I use Python 3 to evaluate the theory from Chapter 5, Dybo's rule with stem-final stress, against both the nominal and verbal corpora. This theory is highly successful, resulting in 97% of nominal stress alternations, and 77% of verbal stress alternations, being correctly predicted. Despite this, there are gaps especially for the verbs, where some verb types have almost none of their forms correctly predicted. I propose several revisions to the theory of Abkhaz stress assignment based on patterns in where Dybo's Rule fails, and show that these lead to greater empirical coverage. The revised theory modifies assumptions about underlying representations, positing that some affixes have a different accentual status in particular morphophonological contexts. I also revise the mechanism of stress assignment in places, arguing for a class of pre-accenting verb forms where stress falls immediately before the stem rather than being assigned by Dybo's Rule. The revised theory improves the coverage by almost ten percentage points, accounting for 86% of the verbal stress alternations.

The verbs in Abkhaz are morphosyntactically complex, and it is extremely challenging to study verbal stress alternations using only (near-)minimal pairs for phonological factors such as stem shape and accentual behavior. I show that computer-based evaluations of a previous hypothesis, here the stress assignment algorithm from Chapter 5, can be helpful in such circumstances. I am able to make iterative improvements to the algorithm from Chapter 5 using the verbal corpus, producing a more empirically successful theory through a combination of human- and computer-guided work. The methodology I employ in this chapter may be useful to other linguists working on datasets with great phonological and morphosyntactic complexity.

In order to use computer programming to evaluate a phonological theory, it is necessary to be explicit about all theoretical assumptions, including representations. The previous chapter used morphemes as accent-bearing units, but the data presented in this chapter suggest that accents are carried by smaller units, since longer stems have more patterns of stress alternation. In Chapter 7 I argue that it is individual segments which carry underlying accents in Abkhaz, but in this chapter the evaluations are based on a slightly larger, language-specific unit known as an 'element' (Spruit 1986), which most often have the shape CV or C. I motivate this choice by showing that all stems with the same number of 'elements' have the same number of stress alternations, and that these representations predict all and only the most common types of stress alternations on Abkhaz nominals. Chapters 7 and 8 provide in-depth discussion of non-language-specific replacements for the 'element', and Chapter 9 discusses the typology of the size of accent-bearing units in the languages of the world.

In Section 6.1 I discuss patterns of nominal and verbal stress alternations in detail, including a survey of the patterns of stress alternation as well as data on how frequent each pattern is. In Section 6.2 I evaluate Dybo's Rule with stem-final stress against both nominal and verbal corpora. I introduce Spruit's (1986) 'elements', which successfully predict the number of stress alternations for each stem shape. In Section 6.3 I present the revised theory of Abkhaz stress assignment, and argue for each of the modifications I make, all of which are in the verbal domain. I show that it improves the empirical coverage for the verbal data considerably. In Section 6.4 I offer some concluding remarks.

6.1 Patterns of stress alternation: an empirical overview

In this section I report on the stress data from the database corpora discussed in Chapter 2, consisting of 545 nominal stems and 445 verbal stems. I begin by exemplifying the regular stress patterns for stems of various lengths and shapes. Following this, I report on the frequencies of the various stress patterns, showing that the patterns I call 'regular' are indeed representative. An exhaustive list of the small number of exceptional stress patterns is also given. The word 'exceptional' is used pre-theoretically here to refer to patterns of alternation which are much rarer than others, not to patterns which are exceptions to some particular set of rules for stress assignment. The later subsections focus on nominals since verbs are divided into such a large number of morphosyntactic categories, precluding a quantitative analysis of particular verb types.

Several generalizations emerge from the comparison of data in this section. Longer stems show more patterns of stress alternation than shorter ones, and while many different types of alternations exist, there are also striking restrictions. Stress alternations within the stem are not regularly found in Abkhaz, nor are alternations between prefix and stem-initial stress.

The data here are organized by stem length as well as stress behavior. The examples below begin with the shortest stems, and end with the longest. However, some stem shapes show identical forms of stress behavior despite having different numbers of vowels and syllables. For example, /CC, /CVC/, /CCV/, and /CVCV/ stems all behave alike. In these cases, the forms are grouped such that similar patterns of stress alternation are presented next to each other, even though the stem lengths may differ. In Section 6.2.1, however, I show that the stems which pattern together are indeed all of the same length, if length is defined in terms of 'elements', an Abkhaz-specific unit postulated by Spruit (1986). Finally, note that based on the arguments in Chapter 4, surface schwas are assumed to be absent from underlying representations. Both [a-k'asə́] 'shawl' and [a-k'ʲát'] 'rod' are treated as /CVC/ stems, with the underlying form of 'shawl' being /k'as/.

6.1.1 Nominal C(V) stems

Recall from Chapter 2, Section 2.2.1.2 that definite forms are prefixed with [a-], while indefinite forms have a suffix [-k'(ə)]. As there is no nominal stem /a/ in the language (Spruit 1986: 44), the shortest stem type consists of a single consonant /C/, with an epenthetic schwa appearing where it is required for stress (see Chapter 4). As I will show immediately below, these stems behave the same as /CV/ stems, both having two possibilities for stress alternation. Because of this parallelism I use the notation C(V) to refer to these stems collectively. One possibility is stress on the stem in both definite and indefinite forms. This is shown in (1) for the C stem /d͡z/ 'water' and the CV stem /la/

‘dog’. Stressed vowels are bolded for clarity in this and coming sections.

(1) Stem stress on C(V) stems (Yanagisawa 2010: 155, 259)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/d͡z/	[a-d͡z**ə́**]	[d͡z**ə́**-k’]	аӡы, ӡык	‘water’
b.	/la/	[a-l**á**]	[l**á**-k’]	ала, лак	‘dog’

The second possibility is an alternation between prefix stress in the definite and either stem stress or suffix stress in the indefinite. This is shown in (2) for stems which are segmentally homophonous but accentual minimal pairs with the stems in (1), namely /d͡z/ ‘flea’ and /la/ ‘eye’.

(2) Alternating stress for C(V) stems (Genko 1998: 147, Yanagisawa 2010: 149)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/d͡z/	[á-d͡z]	[d͡z-k’ə́]~[d͡zə́-k’]	аӡ, ӡкы~ӡык	‘flea’
b.	/la/	[á-la]	[la-k’ə́]~[lá-k’]	ала, лакы~лак	‘eye’

It is interesting that underlyingly vowelless stems /C/ and stems with a vowel /CV/ behave the same, as is captured by the terminological choice of calling them C(V) stems. This parallelism continues for longer stems discussed in the following sections, and I therefore continue to use the same terminology, talking of C(V)C(V) stems and C(V)C(V)C(V) stems. Before this, however, I discuss verbal C(V) stems, which show similar but not identical stress behavior to the nominals from this subsection.

6.1.2 Verbal C(V) stems

Studying patterns of stress alternation in Abkhaz verbs is much more difficult than studying similar alternations in nouns and adjectives. Many verbs have thousands of possible inflected forms, and verbs are also subdivided into many more categories than nouns, based on factors like whether or not there is a preverb, whether or not there is a causative prefix, and the argument structure of the verb (i.e. which sets of person prefixes are present). This morphosyntactic complexity makes it difficult to study how phonological factors like stem length or the accentual specifications of the stem influence stress assignment without introducing morphosyntactic confounds due to different affixes being present.

However, using simple intransitive verbs, which only have an absolutive prefix, it is possible to show that verbal stress alternations closely resemble their nominal counterparts. In particular, just like the nominal stems in Section 6.1.1 above, C(V) verb stems have two patterns of stress alternation.

The data below come mainly from Yanagisawa (2010), but not directly from the verbal corpus. As mentioned above there are so many verbal categories that even in a corpus of 3,115 verb forms it is difficult to find (near-)minimal pairs illustrating all contrasts. For the alternations in this section, I cite two forms for each verb stem: the infinitive and the aorist. Aorists, which are perfective past tense forms, are not found in the verbal corpus, but are often given by Yanagisawa (2010). I did not include them in the corpus because they often behave accentually just like the (already included) present tense or imperative forms. By discussing stress alternations on aorists in this subsection, however, I am able to fill occasional paradigm gaps in Yanagisawa's (2010) data with forms from other dictionaries. In particular, Kaslandzija (2005) often gives inflected aorist forms of verbal headwords in his dictionary.

The infinitive is marked with the prefix /a-/ 'DEF' just like nouns, but also with the suffix /-ra/ 'INF'. The aorist forms I cite all have a person prefix /j-/ '3NA', and the suffix /-jt'/ 'DYN.FIN'. Glides like /j/ cause vowel coloring in Abkhaz (see Chapter 1, Section 1.3.2 for a description of the patterns). If a schwa is epenthesized near a /j/, one finds [ji] and [ij] instead of *[jə] and *[əj]. Similarly, the sequence /aj/ surfaces as [ej]. Many of the forms cited in this subsection will therefore have the surface vowels [i] and [e], often in alternation with the absence of a vowel and [a] respectively.

Both /C/ and /CV/ verb stems have two patterns of stress alternation. In one pattern (3), stress is on the suffix in the infinitive, but it is stem-final in the aorist. In the other (4), stress is on the prefix in the infinitive and in the aorist.

(3) Final stress on C(V) stems (Yanagisawa 2010: 72, 557)

	Stem UR	Infinitive	Aorist	Orthography	Translation
a.	/ʂ/	[a-ʂ-r**á**]	[ji-ʂ**í**-jt’]	ашра ишит	‘boil’
b.	/ɡa/	[a-ɡa-r**á**]	[ji-ɡ**é**-jt’]	агара игеит	‘be heard’

(4) Prefix stress on C(V) stems (Yanagisawa 2010: 153, 503)

a.	/d͡z/	[**á**-d͡z-ra]	[j**í**-d͡zi-jt’]	аӡра иӡит	‘disappear’
b.	/t͡ʃʷʰa/	[**á**-t͡ʃʷʰa-ra]	[j**í**-t͡ʃʷʰe-jt’]	ацәара ицәеит	‘fall asleep’

The C(V) nominal stems in Section 6.1.1 also had two stress patterns. They showed either final or prefix stress in the definite forms ([a-lá] ‘dog’ vs. [á-la] ‘eye’), and this is like the patterns of final or prefix stress in the infinitives above. However, while the indefinite forms of the nominals showed stem-final stress in both accentual types ([lá-k’] ‘one dog’, ‘one eye’), the aorist forms above only have stem-final stress in one accentual pattern, with the other showing stress on the person prefix. In Section 6.3.3 I will argue that the verbs in (4) are exceptions to the nominal-verbal parallelism in stress assignment because they are not assigned stress by Dybo’s Rule, and are instead pre-accenting, such that stress always falls immediately before the stem. This does not challenge the general binarity of the Abkhaz stress system discussed in Chapter 5, since the data above show only two classes of verbal behavior. One is pre-accenting rather than following Dybo's Rule, but it is not the case that there are two patterns of alternation plus a third pre-accenting class separate from these.

6.1.3 Nominal C(V)C(V) stems

For longer nominal stems, of the size C(V)C(V), there are three patterns of stress alternation rather than two. These are shown below for the four stem types CC, CCV, CVC, and CVCV, with all data from Yanagisawa (2010). In (5) I show consistent stem-final stress for all four stem types, and in (6) consistent stem-initial stress for all four stem types. (7) illustrates an alternation between prefix stress in the definite and stem-final stress in the indefinite, again for all four stem types. In each dataset, a. shows underlying /CC/ stems, b. shows /CCV/ stems, c. shows /CVC/ stems, and d. shows /CVCV/ stems.

(5) Consistent stem-final stress on C(V)C(V) stems (Yanagisawa 2010: 205, 259, 346, 576)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/ʃʷʃ/	[a-ʃʷʃ**ə́**]	[ʃʷʃ**ə́**-k']	ашәшьы, шәшьык	'cloud'
b.	/pʰʂa/	[a-pʰʂ**á**]	[pʰʂ**á**-k']	аҧша, ҧшак	'wind'
c.	/k'as/	[a-k'as**ə́**]	[k'as**ə́**-k']	акасы, касык	'shawl'
d.	/laba/	[a-lab**á**]	[lab**á**-k']	алаба, лабак	'stick'

(6) Consistent stem-initial stress on C(V)C(V) stems (Yanagisawa 2010: 202, 217, 252, 395)

a.	/q'z/	[a-q'**ə́**z]	[q'**ə́**z-k']	аҟыз, ҟызк	'goose'
b.	/t'ʂa/	[a-t'**ə́**ʂa]	[t'**ə́**ʂa-k']	атыша, тышак	'hole'
c.	/k'ʲat'/	[a-k'ʲ**á**t']	[k'ʲ**á**t'-k']	акьат, кьатк	'rod'
d.	/k'aba/	[a-k'**á**ba]	[k'**á**ba-k']	акаба, кабак	'shirt'

(7) Alternating stress on C(V)C(V) stems
(Yanagisawa 2010: 63, 269, 389, 472)

a.	/χʲʃ/	[**á**-χʲʃ]	[χʲʃ**ə́**-k’]	ахшь, хшьык	‘hawk’
b.	/bna/	[**á**-bna]	[bn**á**-k’]	абна, бнак	‘forest’
c.	/sas/	[**á**-sas]	[sas**ə́**-k’]	асас, сасык	‘guest’
d.	/laħʷa/	[**á**-laħʷa]	[laħʷ**á**-k’]	алаҳәа, лаҳәак	‘raven’

Several aspects of the division in (5)-(7) need to be motivated. It may seem arbitrary to call (5) d. stem-final stress and (6) d. stem-initial stress, since they both have fixed stress on a syllable of the stem in both definite and indefinite forms. However, throughout this section I treat such cases as different patterns. This is motivated by the fact that (5) d. and (6) d. undergo different stress alternations if one looks beyond the definite and the indefinite. In the plural, for example, stress surfaces on the plural suffix only for the stem in (5) d., and not for the stem in (6) d.

(8) Motivating the stem-final vs. stem-initial distinction

a. Yanagisawa (2010: 259)

i. алаба
[a-lab**á**]
DEF-stick
‘stick’

ii. алабақәа
[a-laba-kʷʰ**á**]
DEF-stick-N.PL
‘sticks’

b. Yanagisawa (2010: 202)

i. акаба
[a-k’**á**ba]
DEF-shirt
‘shirt’

ii. акабақәа
[a-k’**á**ba-k^{wh}a]
DEF-shirt-N.PL
‘shirts’

Even though these /CVCV/ stems show different stress behavior, it might seem unmotivated to extend the stem-initial vs. stem-final classification to vowelless /CC/ stems from (5)-(7) above. If the schwa is in absolute stem-final position, as in (5) a., I call this stem-final stress, since the schwa appears after the stem-final consonant. If the schwa is epenthesized between the two consonants, as in (6) a., I call this stem-initial stress, since the schwa appears after the stem-initial consonant. However, this type of classification is motivated by the same stress alternations as in (8), which are also found for vowelless stems. Below are the forms from (5) a. and (6) a. with their plural forms, showing the same type of differentiation of stress behavior as the /CVCV/ stems did in (8). Only in (9) a., with what I call stem-final stress, does the stress appear on the plural suffix.

(9) Motivating the stem-final vs. stem-initial distinction

a. Yanagisawa (2010: 576)

i. ашәшьы
[a-$ʃ^w$**ʃə́**]
DEF-storm.cloud
‘storm cloud’

ii. ашәшьқәа
[a-$ʃ^w$ʃ-k^{wh}**á**]
DEF-storm.cloud-N.PL
‘storm clouds’

b. Yanagisawa (2010: 252)

i. aҟыз
[a-q’ə́z]
DEF-goose
‘goose’

ii. aҟызқәа
[a-q’ə́z-kʷʰa]
DEF-goose-N.PL
‘geese’

The division in (5)-(7) is therefore motivated entirely by stress alternations, even if in some cases it is necessary to consider other forms than the definite and indefinite to discover this. In the remainder of this chapter, I continue to treat stems with stress in different locations of the stem as separate patterns, even for underlyingly vowelless stems.

A final point about (5)-(7) requires comment. For the shorter C(V) stems, the forms with prefix stress in the definite showed optionality in the indefinite, appearing either with stem-final stress or absolute word-final stress (see Chapter 5, Section 5.7 for additional discussion). Based on this, one might expect the same from the C(V)C(V) stems above, e.g. [sasə́-k’] ‘one guest’ alternating with [sas-k’ə́]. Yanagisawa (2010) does not consistently report such optionality in indefinite forms, nor does any dictionary of Abkhaz that I am aware of. However, for the word ‘guest’, both indefinite forms are found in Trigo (1992: 204), and Spruit (1986: 42) reports similar optionality for other C(V)C(V) words. Since dictionaries do not consistently report these distinctions, I give only the forms found in Yanagisawa (2010), which generally have stem-final stress as in [sasə́-k’] rather than word-final stress as in [sas-k’ə́].

6.1.4 Verbal C(V)C(V) stems

Verbal C(V)C(V) stems have three patterns of stress alternation, just like their nominal counterparts above. Moreover, the three types of stress alternation on C(V)C(V) stems are identical to the alternations found on nominals. I exemplify and describe these patterns below. In the first pattern, in (10), stress is word-final (on the suffix) in the infinitive, and it is stem-final in the aorist. In the second, in (11), stress is consistently stem-initial. In the third, in (12), there is an alternation between prefix stress in the infinitive and stem-final stress in the aorist. Just as for nominals, all three stress patterns exist on all four stem shapes CC, CCV, CVC, and CVCV, as shown below.

(10) Word-final and stem-final stress on C(V)C(V) stems
Kaslandzija (2005: 353), Yanagisawa (2010: 56, 130, 330)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/p’t’/	[a-p’t’-r**á**]	[ji-p’t’**í**-jt’]	аптра, иптит	‘bloom’
b.	/bga/	[a-bga-r**á**]	[ji-bg**é**-jt’]	абгара, ибгеит	‘collapse’
c.	/k’at͡ʃ’/	[a-k’at͡ʃ’-r**á**]	[ji-k’at͡ʃ’**í**-jt’]	акаҷра, икаҷит	‘wrinkle’
d.	/zaza/	[a-zaza-r**á**]	[ji-zaz**é**-jt’]	азазара, изазеит	‘sway’

(11) Stem-initial stress on C(V)C(V) stems
Kaslandzija (2005: 193), Yanagisawa (2010: 95, 217, 531)

a.	/ʁ^{w}r/	[a-ʁ^{w}**ə́**r-ra]	[ji-ʁ^{w}**ə́**ri-jt’]	аҕәырра, иҕәырит	‘grunt’
b.	/gla/	[a-g**ə́**la-ra]	[ji-g**ə́**le-jt’]	агылара, игылеит	‘stand up’
c.	/t͡ʃ’ab/	[a-t͡ʃ’**á**b-ra]	[ji-t͡ʃ’**á**bi-jt’]	аҷабра, иҷабит	‘become sticky’
d.	/k’^{j}at^{h}a/	[a-k’^{j}**á**t^{h}a-ra]	[ji-k’^{j}**á**t^{h}e-jt’]	акьаҭара, икьаҭеит	‘go out (fire)’

(12) Alternating stress on C(V)C(V) stems
Kaslandzija (2005: 427, 780), Yanagisawa (2010: 94, 575)

a.	/ʃ^{w}t^{h}/	[**á**-ʃ^{w}t^{h}-ra]	[ji-ʃ^{w}t^{h}**í**-jt’]	ашәҭра, ишәҭит	‘blossom’
b.	/χ^{w}la/	[**á**-χ^{w}la-ra]	[ji-χ^{w}l**é**-jt’]	ахәлара, ихәлеит	‘fall (night)’
c.	/q’^{j}aʃ/	[**á**-q’^{j}aʃ-ra]	[ji-q’^{j}aʃ**í**-jt’]	аӄьашьра, иӄьашьит	‘become dirty’
d.	/ʁ^{j}at͡s^{h}a/	[**á**-ʁ^{j}at͡s^{h}a-ra]	[ji-ʁ^{j}at͡s^{h}**é**-jt’]	аҕьацара, иҕьацеит	‘grow’

The stress patterns in (11) and (12) are exactly the same as those for nominals in Sections 6.1.2. The patterns in (10), like [a-zaza-rá]~[ji-zazé-jt’] ‘sway’ can also be described in the same way as the alternations for nominals like [a-labá]~[labá-k'] 'stick'. There is one form with word-final stress, and another with stem-final stress before a suffix. In Section 6.1.2 I described the nominal pattern as fixed stem-final, and this exact wording does not carry over to the verbs, since the infinitive of 'sway' has word-final stress [a-zaza-rá], and not stem-final stress *[a-zazá-ra]. For the unsuffixed nominals like [a-labá] 'stick', there is no difference between word- and stem-final stress.

6.1.5 Nominal C(V)C(V)C(V) stems

For longer stems, C(V)C(V)C(V), the lexicon is too sparse to illustrate all stress patterns with all stem types. I only discuss nominal stems of this length, where for CVCVCV stems, it is possible to demonstrate the existence of five stress patterns. The data below come from Yanagisawa (2010), except for the forms for 'toastmaster', which were provided by Zaira Khiba via George Hewitt (p.c.). Although there may be some interspeaker variation for stress, Zaira Khiba and Yanagisawa's consultant Anna Tsvinaria-Abramishvili are both native speakers of Abzhywa Abkhaz, and they grew up in the same district of Abkhazia (Ochamchira) 10 miles apart from each other. Both Khiba and Tsvinaria-Abramishvili have stem-final stress on the definite form of 'toastmaster', but Yanagisawa (2010) does not give the indefinite form.

Note also that the form for 'underwear' is a compound of /t͡ʃ^{wh}a/ 'skin' and /mat^{wh}a/ 'clothes'. Long monomorphemic stems are rare in Abkhaz, and I have not been able to find an example with this stress pattern which is not morphologically complex. Note that Spruit (1986: 41-42) shows that with the exception of patterns of indefinite optionality, the same stress patterns are found when C(V) nouns combine with C(V) adjectives as on morphologically simplex C(V)C(V) nominals. Both follow Dybo's Rule.

(13) Stress patterns on CaCaCa stems
Yanagisawa (2010: 131, 388, 494, 503), Zaira Khiba via George Hewitt (p.c.)

	Definite	Indefinite	Orthography	Translation
a.	[a-tʰamad**á**]	[tʰamad**á**-k']	аҭамада ҭамадак	'toastmaster'
b.	[a-t͡sʰal**á**q'ʲa]	[t͡sʰal**á**q'ʲa-k']	ацалаҟьа цалаҟьак	'floorboard'
c.	[a-t͡ʃʷʰ**á**-matʷʰa]	[t͡ʃʷʰ**á**-matʷʰa-k']	ацәамаҭәа цәамаҭәак	'underwear'
d.	[**á**-zamana]	[zam**á**na-k']	азамана заманак	'excellent'
e.	[**á**-sak'asa]	[sak'as**á**-k']	асакаса сакасак	'stretcher'

In these patterns stress is fixed on either the first, second, or third syllable of the stem in the first three rows.[32] The last two rows show that prefix stress in the definite can alternate with either stem-medial or stem-final stem stress in the indefinite.

The same five patterns are illustrated in (14) for CCC stems, with no underlying vowels. Due to phonotactic restrictions, (14) d.-e. appear with unstressed schwas in what would otherwise be CCC clusters (see Chapter 4, Section 4.1 for discussion). The data again come from Yanagisawa (2010), with the indefinite of 'nail' from Genko (1998). As in Section 6.1.2, I use the location of schwa epenthesis to diagnose where in the stem stress falls. For example, I treat (14) a.-c. as showing stem-final, stem-medial, and stem-initial stress respectively, based on whether the schwa is after the stem-final, stem-medial, or stem-initial consonant.

32 Recall from the discussion in Section 6.1.3 that 'fixed' refers only to the stress in the two forms shown here, and that other forms of these stems may show stress alternations.

(14) Stress patterns on CCC stems
Yanagisawa (2010: 291, 298, 341, 526, 558)

	Definite	Indefinite	Orthography	Translation
a.	[a-pʰχd͡z**ə́**]	[pʰχd͡z**ə́**-k’]	аԥхӡы ԥхӡык	‘sweat’
b.	[a-mʂ**ə́**n]	[mʂ**ə́**n-k’]	амшын мшынк	‘sea’
c.	[a-t͡ʃ’ʷ**ə́**mʁ]	[t͡ʃ’ʷ**ə́**mʁ-k’]	аҵәымҕ ҵәымҕк	‘nail’
d.	[**á**-mp’əl]	[mp’**ə́**l-k’]	ампыл мпылк	‘ball’
e.	[**á**-ʂəkʷʰs]	[ʂəkʷʰs**ə́**-k’]	ашықәс шықәсык	‘year’

There are not enough simple intransitive verb stems with shape C(V)C(V)C(V) to allow for systematic study, but based on the patterns in preceding sections I predict that these would also show a five-way contrast in stress patterns.

6.1.6 Sonority

In the preceding subsections I have treated all consonants together, collapsing 58 distinct phonemes under the single symbol ‘C’. This makes the implicit assumption that factors such as consonantal sonority do not affect stress assignment. I am not aware of any work on Abkhaz stress where sonority is argued to play a role, and the forms in (15)-(17) below suggest that sonority is not relevant for Abkhaz stress assignment. All three stress patterns on C(V)C(V) stems from Section 6.1.2 are found on /CC/ stems with all four combinations of obstruents and sonorants as C_1 and C_2. The form in (16) d. is a demonstrative, and therefore does not have an indefinite form. Its /a-/ is a proximal demonstrative prefix, rather than the definite prefix found on all other forms below. The stems in a. are obstruent-obstruent, those in b. obstruent-sonorant, those in c. sonorant-obstruent, and those in d. sonorant-sonorant.

(15) Consistent stem-final stress
Genko (1998: 254), Yanagisawa (2010: 294, 494, 582)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/t͡sʰgʷ/	[a-t͡sʰgʷ**ə́**]	[t͡sʰgʷ**ə́**-k’]	ацгәы, цгәык	‘cat’
b.	/fɥ/	[a-fɥ**ə́**]	[fɥ**ə́**-k’]	афҩы, фҩык	‘smell (n.)’
c.	/mχ/	[a-mχ**ə́**]	[mχ**ə́**-k’]	амхы, мхык	‘field’
d.	/ɥn/	[a-ɥn**ə́**]	[ɥn**ə́**-k’]	аҩны, ҩнык	‘home, house’

(16) Consistent stem-initial stress
Genko (1998: 158), Yanagisawa (2010: 76, 365, 492)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/ħʷħʷ/	[a-ħʷ**ə́**ħʷ]	[ħʷ**ə́**ħʷ-k’]	аҳәыҳә, ҳәыҳәк	‘pigeon, dove’
b.	/gʲl/	[a-gʲ**ə́**l]	[gʲ**ə́**l-k’]	агьыл, гьылк	‘rose’
c.	/lg/	[a-l**ə́**g]	[l**ə́**g-k’]	алыг, лыгк	‘foolish’
d.	/rj/	[a-r**í**j]	-	ари	‘this (proximal demonstrative)’

(17) Alternating stress
Marr (1926: 54), Genko (1998: 363), Yanagisawa (2010: 156, 280, 298, 574)

	Stem UR	Definite	Indefinite	Orthography	Translation
a.	/ʃʷtʰ/	[**á**-ʃʷtʰ]	[ʃʷtʰ**ə́**-k’] [ʃʷtʰ-k’**ə́**]	ашәҭ, шәҭык~шәҭкы	‘flower’
b.	/d͡zn/	[**á**-d͡zən]	[d͡zn**ə́**-k’] [d͡zən-k’**ə́**]	аӡын, ӡнык~ӡынкы	‘winter’
c.	/mʂ/	[**á**-mʂ]	[mʂ**ə́**-k’] [məʂ-k’**ə́**]	амш, мшык~мышкы	‘day’
d.	/lm/	[**á**-ləm]	[l**ə́**m-k’][33] [ləm-k’**ə́**]	алым, лымк~лымкы	‘lion’

6.1.7 Quantitative data on Abkhaz nominal stress

In the preceding subsections I have shown example words illustrating particular stress patterns. The presentation of the data illustrates the nature of Abkhaz stress alternations, and much phonological work has been built on datasets like the ones above. When phonologists only present small datasets of carefully selected forms like the ones in this section, the reader is forced to trust the author that these patterns are representative of the language in general. This involves a risk of both intentional cherry-picking of datapoints

33 This word is expected to have stem-final stress, like in [á-χʲʃ]~[χʲʃə́-k’] ‘hawk’ from Section 6.1.3. However, the form for ‘one lion’ is not given as *[lmə́-k’] with stem-final stress in any sources I am aware of (Marr 1926: 54, Yanagisawa 2010: 280, Meurer 2018 searched on 2023-08-09, Andersson et al. 2023). For additional discussion, see (29) and surrounding text in Section 6.1.9.

as well as accidental exclusion of important data. Since this paper builds on a larger corpus of alternations, this risk can be mitigated, and the need for trust severely reduced. Below I will report quantitative results for Abkhaz stress alternations, arguing that all and only the types of alternations shown in the mini-datasets in this section are robustly attested in the language.

I focus on nominal stems data here, since verbs are subdivided into too many morphosyntactic categories to allow for quantitative study. Both nominal and verbal data will be used, however, in the corpus evaluations of theories of Abkhaz stress assignment in later sections of this chapter. I begin by reporting how many of the 545 definite-indefinite pairs in the nominal corpus exhibit each of the stress patterns from Sections 6.1.1-6.1.5. Below are the data for C(V) stems. Both stress patterns are represented by at least 8 C and CV stems. There are fewer examples of the patterns in (19), where stress falls on the prefix in the definite.

(18) Pattern frequencies for stem stress on C(V) stems

	Definite	Indefinite	Frequency
a.	[a-C**ә́**]	[C**ә́**-k’]	19
b.	[a-C**á**]	[C**á**-k’]	17

(19) Pattern frequencies for alternating stress on C(V) stems

	Definite	Indefinite	Frequency
a.	[**á**-C]	[Cә́-k’]	8
b.	[**á**-Ca]	[C**á**-k’]	9

For the longer C(V)C(V) stems, the frequency results are shown below. I present all possible stem shapes, in the order CC, CCV, CVC, CVCV. Recall that some of these stems may show optionality in the placement of stress in the indefinite form, but that this is not consistently reported. Since some of these words contain consonant clusters, they may or may not exhibit schwa epenthesis. For example, the word for ‘winter’ in (17) b. has an unstressed schwa between the stem consonants /d͡z/ and /n/ in the definite, but not in the indefinite: [á-d͡zən]~[d͡znə́-k’]. Such unstressed schwas are treated as if they were absent in the numbers below. The word ‘winter’ is therefore included in (22) a. as an example of [á-CC]~[CCə́-k’], even though its definite form is [á-CəC] rather than [á-CC].

(20) Pattern frequencies for stem-final stress on C(V)C(V) stems

	Definite	Indefinite	Frequency
a.	[a-CCə́]	[CCə́-k’]	16
b.	[a-CCá]	[CCá-k’]	14
c.	[a-CaCə́]	[CaCə́-k’]	9
d.	[a-CaCá]	[CaCá-k’]	17

(21) Pattern frequencies for consistent stem-initial stress on C(V)C(V) stems

	Definite	Indefinite	Frequency
a.	[a-Cə́C]	[Cə́C-k’]	25
b.	[a-Cə́Ca]	[Cə́Ca-k’]	15
c.	[a-CáC]	[CáC-k’]	22
d.	[a-CáCa]	[CáCa-k’]	26

(22) Pattern frequencies for alternating stress on C(V)C(V) stems

	Definite	Indefinite	Frequency
a.	[á-CC]	[CCə́-k’]	17
b.	[á-CCa]	[CCá-k’]	41
c.	[á-CaC]	[CaCə́-k’]	15
d.	[á-CaCa]	[CaCá-k’]	11

Most numbers above are in the 10-30 range, with a clear outlier being the [á-CCa]~ [CCá-k’] pattern, of which there are 41 examples.

For C(V)C(V)C(V) stems, there are five possible stress patterns on eight possible stem shapes, leading to a total of 40 patterns, 37 of which are attested in the corpus. I show the frequency of all 40 patterns in a table below instead of writing them all out as I have done for shorter stems. The column names refer to the five stress patterns from Section 6.1.5, illustrated in (13) and (14) above. Recall that the columns a.-c. refer to consistent stem-final, stem-medial, and stem-initial stress respectively. Column d. is alternating between prefix stress in the definite and stem-medial stress in the indefinite, while column e. is alternating between prefix stress in the definite and stem-final stress in the indefinite.

As shown by the bottom row, all five stress patterns appear to be relatively well-attested despite gaps for particular stem shapes. Five of the eight stem shapes show all five stress patterns on at least one stem in the corpus. The most common stress pattern is (23) c. (fixed stem-initial stress), and the least common is (23) d. (prefix stress in the definite alternating with stem-medial stress in the indefinite). Unsurprisingly, the three stem shapes which show gaps (i.e. at least one of the five stress patterns is not attested for that stem shape) are also the three least commonly attested stem shapes: /CVCVCV/ with seven stems, /CCVCV/ with nine, and /CVCVC/ with fifteen.

(23) Figure 6.1

	a.	b.	c.	d.	e.	Total
/CCC/	7	9	4	2	1	23
/CCCa/	9	2	15	1	7	34
/CCaC/	3	5	1	5	2	16
/CCaCa/	2	0	1	3	3	9
/CaCC/	3	8	6	3	1	21
/CaCCa/	11	2	14	2	5	34
/CaCaC/	1	8	1	0	5	15
/CaCaCa/	0	3	2	2	1	8
Total	36	37	44	18	25	160

Pattern frequencies for stress alternations on C(V)C(V)C(V) stems

Adding up the frequency counts presented in this subsection gives 53 C(V) stems, 228 C(V)C(V) stems, and 160 C(V)C(V)C(V) stems, for a total of 441 stems. As I have shown in this subsection, all stress patterns discussed in Sections 6.1.1-6.1.5 are robustly attested. However, since the nominal corpus contains a total of 545 stems, the remaining 104 must either represent longer stems, or else have patterns of stress alternation which I have not yet discussed. In Section 6.1.8 below I present generalizations about the stress patterns surveyed thus far, and I present an exhaustive list of all stems which violate those generalizations in Section 6.1.9. There I will show that there are only twelve stems of length C(V)C(V)C(V) or shorter which do not fit into any of the categories I have identified in this subsection.

6.1.8 Generalizations

As illustrated above, Abkhaz exhibits many patterns of stress alternation, for many different sizes and shapes of stem. A key finding from the quantitative investigation above is that the number of stress patterns varies by stem size: longer stems have more patterns. The data on the number of stress patterns for different stems are shown below, summarizing information from the preceding subsections. Both (24) a. and b. can be shown for nominals and verbs, while (24) c. is based only on nominal data. The text below uses nominal definite-indefinite alternations as examples.

(24) Summary of stress patterns varying by stem size

	Stem length	Number of stress patterns
a.	C(V)	2
b.	C(V)C(V)	3
c.	C(V)C(V)C(V)	5

Within each stem size, there are some patterns with fixed stress (in the definite-indefinite pairs), and others where stress alternates. It is also worth taking stock of which patterns of stress alternation do not exist. In particular, none of the patterns from previous subsections show alternations between stem-initial and prefix stress. Nor do they show stress shifts within parts of the stem, e.g. stem-initial stress in the definite and stem-final stress in the indefinite. The table in (25) summarizes these patterns. Note that the 'fixed' cases only show fixed stress in the definite-indefinite pairs, and invariably do show alternating stress if placed in the appropriate morphological environment.

(25) Figure 6.2

Stem shape	Stress pattern						
	Fixed			Alternating (definite-indefinite)			
	1st C(V)	2nd C(V)	3rd C(V)	Prefix-1st C(V)	Prefix-2nd C(V)	Prefix-3rd C(V)	Alternating within stem
C(V)	✔	N/A	N/A	✕[34]	N/A	N/A	✕
C(V)C(V)	✔	✔	N/A	✕	✔	N/A	✕
C(V)C(V)C(V)	✔	✔	✔	✕	✔	✔	✕

Generalizations about Abkhaz stress assignment

There is no a priori reason to expect Abkhaz to lack the unattested patterns, which are attested in other languages of the world with lexical stress. Alternations between prefix stress and stem-initial stress are found in Ho, as shown in (26) a. for the stem 'field.' (26)

34 All such forms alternate with stress on the indefinite suffix, e.g. [la-k'ə́]~[lá-k'] 'eye' (see Section 6.1.1 for discussion).

b. illustrates similar alternations in Cupeño for the stem ‘give’.

(26) Ho (Heath 1977: 27), Cupeño (Yates 2017: 51, 56)

a.	i.	[páːsa]	‘field’
	ii.	[ʔɨ́-ʰpàsa]	‘your (singular) field’
b.	i.	[máx-wənə]	‘give (customary aspect, plural subject)’
	ii.	[pə́-max]	‘give (third-person singular)’

Stress shifts within a stem are easy to generate with pre-accenting suffixes, as in Yakima Sahaptin and English:

(27) Yakima Sahaptin (Hargus & Beavert 2005: 67) and English

a.	i.	at͡ɬ’áwi-	‘ask for, beg, request’
	ii.	at͡ɬ’awí-łam	‘beggar’
b.	i.	párent	
	ii.	parént-al	

Another important generalization about Abkhaz is that the number of stress patterns stays constant as the number of underlying vowels in the stem varies. For example, the same number and type of stress patterns exist on all C(V)C(V) stems, whether they are of the shape CC, CCV, CVC, or CVCV. Independently of whether these stems have zero, one, or two vowels, they all have three patterns: stem-final stress, stem-initial stress, and alternating between prefix and stem-final stress.

The generalizations highlighted in this subsection are based on the categorization of the stress alternations for different stems discussed earlier in this chapter. Although I have shown in Section 6.1.7 that all of the patterns I have discussed are robustly attested, I have not yet discussed whether there are additional patterns of stress alternation which do not fit into the categorization from previous sections. In Sections 6.1.8-6.1.9 immediately below I argue that the generalizations presented above hold, and that there are only a handful of exceptional stems.

6.1.9 Exceptional stems

There are several types of less common patterns which can arise in a database corpus like the one considered here. A stem may show suppletive allomorphy so that the definite and indefinite are segmentally different from each other. In this case they may not show the same stress behavior as other stems. Stems may also show one of the types of stress alternation which I have excluded from the categorization in previous subsections. I show that examples of both of these situations can be found in the nominal lexicon of Abkhaz, although they are both rare. I argue that the generalizations from Section 6.1.8 can be maintained, and that the rare patterns discussed in this subsection are due to either segmental or accentual allomorphy. In Section 6.1.8 I identified two patterns of stress alternation which are absent from my categorization of the nominal stress alternations, based on 441 of the 545 stems in the nominal corpus. One involves alternations between stem-initial and prefix stress, and the other stress alternations within the stem. Below I give lists of the number of stems of which show any form of rare behavior. Of the 545 stems in the corpus, there are a total of seventeen such stems.

There are five stems whose segmental content is not the same in definite and indefinite forms. These represent cases where the definite and indefinite simply have segmentally different allomorphs. All five cases are listed below, with data from the corpus. Note that all involve alternations between unstressed [a] and Ø. While such alternations are not productive,[35] different Abkhaz dialects often have forms which differ

35 For example, the word ‘way of playing’ in (28) e. consists of the stem /χʷmar/ ‘game, play’ and the suffix /-ʃa/ denoting the manner in which an action is performed. This suffix does not usually show allomorphy between [-ʃa] and [-ʃ], cf. [á-d͡zaχə-ʃa]~[d͡zaχə́-ʃa-k’] ‘manner of sewing’ (Yanagisawa 2010: 152).

only by the presence or absence of unstressed [a] due to historical patterns of vowel reduction (Aršba 1979). Some of these forms also have regular forms without allomorphy. For example, the definite of ‘brand (of cattle)’ can also be [a-damə́ʁa] (Yanagisawa 2010: 97), and the indefinite of ‘woman’ can also be [pʰħʷə́s-k’] (Hewitt 2010: 34, Yanagisawa 2010: 344).

(28) Segmental allomorphy

	Definite	Indefinite	Orthography	Translation
a.	[a-damə́ʁ]	[damə́ʁa-k’]	адамыҕ, дамыҕак	‘brand (of cattle)’
b.	[a-nə́ʃ]	[nə́ʃa-k’]	анышь, нышьак	‘boat’
c.	[a-pʰħʷə́s]	[pʰħʷsá-k’]	апҳәыс, пҳәсак	‘woman’
d.	[á-χʷ]	[χʷá-k’]	ахә, хәак	‘anchor’
e.	[á-χʷmarʃa]	[χʷmárʃ-k’]	ахәмаршьа, хәмаршьк	‘way of playing’

The remaining twelve unusual stems show stress alternations which are not captured by the categorization from previous subsections. Some show alternations between stem-initial and prefix stress, while others show stress alternations within the stem. I give all twelve below, grouped by the type of behavior they exhibit.

(29) Rare stress alternations

a. Alternations between stem-initial and prefix stress

i.	[á-kʰalakʲʰ]	[kʰálakʲʰ-k’]	ақалақь, қалақьк	‘city’
ii.	[á-kʷʰt͡ʃʷʰ]	[kʷʰə́t͡ʃʷʰ-k’]	ақәцә, қәыцәк	‘top, summit’
iii.	[á-ləm]	[lə́m-k’]	алым, лымк	‘lion’
iv.	[á-tʰərkʷʰa]	[tʰə́rkʷʰa-k’]	аҭырқәа, ҭырқәак	‘Turk’
v.	[á-χ̠ʷəlpʰa]	[χ̠ʷə́lpʰa-k’]	ахәылпа, хәылпак	‘evening’
vi.	[á-t͡ʃʷʰartʰa]	[t͡ʃʷʰártʰa-k’]	ацәарҭа, цәарҭак	‘bedroom’
vii.	[á-t͡ʃ’ʷt͡sʰa]	[t͡ʃ’ʷə́t͡sʰa-k’]	аҵәца, ҵәыцак	‘glass’

b. Stress alternations within stem

i.	[a-d͡zə́s]	[d͡zsə́-k’]	аӡыс, ӡсык	‘kid (goat)’
ii.	[a-nə́q’ʷaɥ]	[nəq’ʷaɥə́-k’]	аныҟәаҩ, ныҟәаҩык	‘traveler’
iii.	[a-tʰák’ʷaʒʷ]	[tʰak’ʷaʒʷə́-k’]	аҭакәажә, ҭакәажәык	‘old woman’
iv.	[a-χárpʰ]	[χarpʰə́-k’]	ахарԥ, харԥык	‘shirt’
v.	[a-χáħʷ]	[χaħʷə́-k’]	ахаҳә, хаҳәык	‘stone, rock’

Some of the forms in (29) may represent typos. For example, ‘one city’ is also given as [kʰalákʲʰ-k’], with an unexceptional alternation between stem-medial and prefix stress, even though the dictionary entry for the word gives [kʰálakʲʰ-k’] with initial stress (Yanagisawa 2010: 224). However, other words are attested elsewhere with the stress patterns Yanagisawa (2010) gives. For example, Meurer (2018, searched on 2023-08-10) has five examples of ‘one kid’ as [d͡zsə́-k’], with a stress alternation in the stem, and only one example of [d͡zə́s-k’], without such a stress alternation. Although there may be some variability here, there is no reason to doubt that Abkhaz has a small number of stems which show stress alternations violating the generalizations from Section 6.1.8 above.

I argue that the words in (29), like those in (28), have suppletive allomorphs for the definite and the indefinite. In (28) the suppletive allomorphy was segmental, but the differences in (29) are only accentual. To take a concrete example, I propose that the word ‘kid’ has two suppletive allomorphs. Anticipating the analysis in Chapter 7 with segmental stress, I assume that the allomorph found in the definite has an accented /d͡z/ but an unaccented /s/, whereas both stem segments are accented in the allomorph found in the indefinite. Here I show accented segments with +, and unaccented segments with -. The exact theoretical mechanism generating this allomorphy is unimportant, and any theory which is capable of explaining English ‘go’ vs. ‘went’ (or ‘leaf’ vs. ‘leaves’) is appropriate here, including an analysis with two different Vocabulary Items in Distributed

Morphology (Harley & Noyer 1999: 5).

(30) Suppletive allomorphy for underlying accents

a. UR of definite allomorph of 'kid'

d͡z s
\+ -

b. UR of indefinite allomorph of 'kid'

d͡z s
\+ +

In Section 6.2.1 below I show that there is a theory of Abkhaz stress from previous literature (Dybo 1977, Spruit 1986) which predicts all and only the accentual patterns from Sections 6.1.1-6.1.5, capturing the generalization that within-stem stress alternations and alternations between stem-initial and prefix stress are generally not found in Abkhaz, with the twelve exceptions in (29). This theory is based on Dybo's Rule, which I have argued is necessary to account for Abkhaz stress in Chapter 5. The price to pay for adopting this theory is that the words in (29) must be dealt with using suppletive allomorphy. However, the alternations in (29) are less frequent than any of those from previous subsections. Since there are only twelve exceptions, compared to 441 regular stems (see Section 6.1.7), I argue that this is not a high price to pay.

It may seem unmotivated to say that the patterns in (29) are unusually rare, since some of the patterns in Section 6.1.7 are also only represented by a handful of stems. For example, there are seven examples of alternations between stem-initial and prefix stress in (29), and in Section 6.1.7 I reported that there were nine examples of the stress pattern [a-CaCə́]~[CaCə́-k']. However, this comparison is misleading. The data in (29) are collapsed across all stem lengths and shapes, while the data in Section 6.1.7 are not. The stress pattern in [a-CaCə́]~[CaCə́-k’] is just one of many examples of fixed stem-final stress. In Section 6.1.7 there are a total of 128 examples of fixed stem-final stress,[36] if different stem lengths and shapes are collapsed. Since 128 is much greater than seven, there is a quantitative argument to separate out the patterns in (29) as exceptions.

The conclusion I draw from the data in this subsection is that the generalizations in Section 6.1.8 remain valid. Abkhaz does not generally allow alternations between stem-initial and prefix stress, nor stress alternations within stems. There are a handful of words which do show these patterns, but they are much rarer than the more robustly attested patterns of alternation discussed earlier in this section. There is also a small number of words which show segmental differences between their definite and indefinite stems.

In Section 6.2 immediately below I turn from the discussion of empirical patterns in Abkhaz stress alternations to an evaluation of theories which are capable of explaining the generalizations from previous section.

6.2 Evaluating a theory of Abkhaz stress assignment

In Chapter 5 I built up a theory of Abkhaz stress assignment based on near-minimal comparisons across small datasets of carefully selected words, resulting in Dybo’s Rule with stem-final stress. In this section I will test this theory against nominal and verbal corpus data in Python 3 to see whether it can account for the patterns of stress alternation surveyed above. I apply the theory to the nominal corpus, and find that over 97% of the

36 This number is the sum of the frequencies in (18) a.-b., (20) a.-d., and the frequencies in the a. column of (23).

alternations are accounted for, while the corresponding figure for the verbal corpus is 77%. Because of its empirical successes, the remainder of this dissertation uses a version of this theory. However, in Section 6.3 I will modify several assumptions about Abkhaz stress assignment to better account for verbal stress alternations.

In order to use computer programming to evaluate a phonological theory, it is necessary to be completely explicit about all theoretical assumptions, including the representations. In Chapter 5 I assumed morphemes carried accent specifications, but since longer stems have more patterns of stress alternation it appears that some smaller units are carrying accentual contrasts. In Chapter 7 I argue that individual segments can be accented or unaccented, but in this chapter I use a slightly larger, language-specific unit from previous work known as an 'element' (Spruit 1986).

In Spruit's (1986) theory, 'elements' can take the maximal shape CV. When there is no preceding consonant, V(V) constitutes an element; when there is no following vowel, C constitutes an element. Spruit (1986) assumes that each 'element' in a morpheme may be accented or unaccented. I motivate the use of 'elements' in my theoretical evaluations by showing that when Dybo's rule is applied to Spruit's (1986) representations, all and only the regular stress patterns from Sections 6.1.1-6.1.5 are generated. There is reason to think, therefore, that these representations will be a fruitful accent-bearing unit to explore. Almost all previous work on theoretical approaches to Abkhaz stress assignment builds on 'elements', although some have relabeled them as prosodic units like syllables or moras (see Chapter 8 for extensive discussion). It is therefore of interest to determine quantitatively how successful such a theory is, even though Chapter 7 will argue that it is not 'elements' but segments which carry underlying accents in Abkhaz.

6.2.1 Elements

In order to evaluate theories of Abkhaz stress assignment empirically against the corpus data, it is necessary to commit to some accent-bearing unit. In this subsection I describe how Spruit (1986) divides words into 'elements', and illustrate how such a theory is able to predict the regular patterns of Abkhaz accentuation. I adopt the theory of stress assignment argued for in Chapter 5, namely Dybo's Rule amended with default stem-final stress if no lexical accents are present. This means that in this section, stress will be assigned as follows:

(31) Summary of stress assignment algorithm

a. If there is at least one accented element, stress falls on the leftmost accented element not immediately followed by an accented element
b. If there is no accented element, stress falls on the final element of the stem

An 'element', in Spruit's (1986) terminology, is maximally a CV unit, and maximal elements are constructed whenever possible. An element can be a C if and only if no vowel follows, as for a word-final consonant or a consonant in a cluster. V(V) may be an element if and only if no consonant precedes, as in absolute word-initial position. The latter condition will only be important for the word-initial /a-/ 'DEF' prefix. (32) shows different sequences of consonants and vowels divided up into elements according to these rules. Element boundaries are indicated with a period.

(32) Division of strings into elements

a. One-element sequences

i. V

ii. C

iii. CV

b. Two-element sequences

i. CV.C

ii. C.CV

c. Three-element sequences

i. V.CV.C

ii. CV.C.C

iii. V.C.CV

One indication that 'elements' may be appropriate units for Abkhaz stress assignment is that stems with the same number of stress alternations in Sections 6.1.1-6.1.5 all have the same number of elements. In other words, the statement in previous subsections that longer stems have more stress patterns can be clarified by adding 'where stem length refers to the number of elements in the stem'. Recall that both /C/ and /CV/ stems show two stress patterns (Sections 6.1.1-6.1.2), all of /CC, CCV, CVC, CVCV/ show three (Sections 6.1.3-6.1.4), and all of /CCC, CCCV, CCVC, CCVCV, CVCC, CVCCV, CVCVC, CVCVCV/ show five (Section 6.1.5 on nominals, although here some gaps exist in the corpus). These stem shapes, their division into elements, and the number of stress patterns, are displayed in (33).

(33) Figure 6.3

Stem shape	Number of elements	Number of stress patterns
C	1	2
CV	1	2
C.C	2	3
C.CV	2	3
CV.C	2	3
CV.CV	2	3
C.C.C	3	5
C.C.CV	3	5
C.CV.C	3	5
C.CV.CV	3	5
CV.C.C	3	5
CV.C.CV	3	5
CV.CV.C	3	5
CV.CV.CV	3	5

Correlation between number of elements and number of stress patterns

If each element is capable of being accented or unaccented, as Spruit (1986) argues, one might expect the rightmost column in (33) to contain two, four, eight (powers of two), rather than two, three, five. If a /CVCV/ stem has two elements, each of which has two accentual possibilities, this results in 2^2 or four accentual possibilities for those stems, but they only have three stress patterns. Similarly, if a /CVCVCV/ stem has three elements, each of which has two accentual options, then this results in 2^3 or eight possibilities, but the stems only have five stress patterns. This discrepancy is resolved by the algorithm for stress assignment in (31). Specifically, by applying Dybo's Rule with default stem-final stress, the four underlying possibilities for two-element stems neutralize to three surface stress patterns, which correspond exactly to the three stress patterns from Sections 6.1.1-

6.1.2. And the eight underlying possibilities for three-element stems neutralize to five surface stress patterns, which correspond exactly to the five stress patterns from Section 6.1.5.

Before seeing these neutralizations in longer stems, however, it is convenient to illustrate Dybo's Rule with stem-final stress on single-element stems. A stem with one element only has two accentual possibilities: accented or unaccented. In Chapter 5 I argued that the definite prefix /a-/ is accented, while the indefinite suffix /-k'/ is unaccented. In (34) I show Dybo's Rule with stem-final stress applied to definite and indefinite forms of an accented stem /la/. Accented elements are marked with a plus sign +, while unaccented elements are marked with a minus sign -. In the definite form in (34) a., there are two adjacent accented elements. Since Dybo's Rule assigns stress to the leftmost accented element *not immediately followed by an accented element*, stress will fall on the stem. The prefix is immediately followed by an accented element, and therefore cannot be stressed. In the corresponding indefinite in (34) b., there is only one accented element, and it receives stress. I show the element assigned stress by Dybo's Rule with an arrow ↑.

(34) Stress on accented /la/

a.	[a-	lá]
	+	+
		↑
b.	[lá	-k']
	+	-
	↑	

In (35) I show similar forms for an unaccented stem /la/. In the definite form in (35) a., the only accented element is the prefix, and it receives stress by Dybo's Rule. In the indefinite form in (35) b., there is no accented element. In such cases stress is on the final element of the stem by default.

(35) Stress on unaccented /la/

a. [á- la]
+ -
↑

b. [lá -k']
- -
↑

The forms in (34) and (35) correspond to the stress patterns of real Abkhaz words. (34) derives the forms for 'dog', while (35) derives the forms for 'eye'. In Section 6.1.1 I pointed out that 'one eye' can also absolute word-final stress, on the suffix, which is then realized with schwa epenthesis: [la-k'ə́]. This possibility is not generated by Dybo's Rule with default stem-final stress. Since dictionary sources do not reliably report when such optionality is possible, I do not attempt to generate the optional forms with absolute word-final stress in this dissertation.

For longer, two-element stems, Spruit's (1986) theory predicts four underlying accentual specifications: ++, +-, -+, and --. As I show below, these yield the three stress patterns attested on stems of this length when Dybo's Rule with default stem-final stress is applied. The pattern ++ gives fixed stem-final stress, +- gives fixed stem-initial stress, and -+ and -- neutralize, both giving alternations between stem-final and prefix stress. I show definite and indefinite forms of the example words from (5)-(7) d. in Section 6.1.3.

The word ‘raven’ is shown twice, once with the underlying pattern -+, and once with --. The neutralization arises because the stem-final stress on indefinites like [laħ^{w}á-k’] ‘one raven’ could either come from an accented stem-final element and Dybo’s Rule, or else from default stem-final stress on an unaccented stem-final element.

(36) Stress on CVCV stems

a. Accented-accented stem /laba/ ‘stick’ (++)

i.	[a-	la	bá]
	+	+	+
			↑

ii.	[la	bá	-k’]
	+	+	-
		↑	

b. Accented-unaccented stem /k’aba/ ‘shirt’ (+-)

i.	[a-	k’á	ba]
	+	+	-
		↑	

ii.	[k’á	ba	-k’]
	+	-	-
	↑		

c. Unaccented-accented stem /laħ^{w}a/ ‘raven’ (-+)

i.	[á-	la	ħ^{w}a]
	+	-	+
	↑		

ii.	[la	ħ^{w}á	-k’]
	-	+	-

d. Unaccented-unaccented stem /laħʷa/ 'raven' (--)

i.	[á-	la	ħʷa]
	+	-	-
	↑		
ii.	[la	ħʷá	-k']
	-	-	-
		↑	

In theory it should be possible to distinguish between (36) c. and (36) d. Recall from Chapter 5, Section 5.4 that optionality between stem- and word-final stress is found only for words with exclusively unaccented elements. This is true of the indefinite in (36) d., but not in (36) c. One might predict, then, that some stems with the relevant stress pattern do allow optionality (accent pattern --), while others do not (accent pattern -+). Again I have not been able to investigate this with dictionary data, where optionality is rarely reported. However, Spruit (1986: 39-42) does give optional forms, but reports that there is no contrast between two stem types here. All stems with the relevant stress pattern do show indefinite optionality, suggesting that they all have a final unaccented element as in (36) d.

Secondary stress and schwa epenthesis (see Chapter 4) point in the same direction, favoring underlying forms with only unaccented elements over underlying forms with stem-final accents. As discussed in Chapter 5, Section 5.6, secondary stresses and epenthetic schwas appear when a word has more than one accent which is not immediately followed by an accent. The leftmost receives primary stress (Dybo's Rule), while others receive secondary stress, but all stresses can trigger schwa epenthesis as discussed in Chapter 4.

Two-element stems of the shape CV.C are therefore predicted to have a final secondary stress and a final epenthetic schwa with the accent pattern -+, but not with the accent pattern --. Dictionaries do not transcribe secondary stresses, but the final schwa ought to create an observable contrast between [á-CaC] (no schwa with accent pattern --) and [á-CaCə̀] (schwa with accent pattern -+). However, no such contrast is attested. There are fifteen CVC stems in the corpus which surface as [á-CaC], but no words in the corpus or anywhere in Yanagisawa's (2010) dictionary which surface as [á-CaCə̀] with a final schwa. This again suggests that all such stems have a final unaccented element.

For three-element stems, there are eight underlying possibilities for accents (+++, ++-, +-+, +--, -++, -+-, --+, ---). These neutralize to the five stress patterns observed on stems of this length. I illustrate all eight underlying possibilities below, using the example words from Section 6.1.5. Fixed stem-final stress comes from +++ (37) a., fixed stem-medial stress from ++- (37) b., fixed stem-initial stress from +-+ or +-- (37) c.-d., alternations between stem-medial and prefix stress from -+- (37) e., and alternations between stem-final and prefix stress from -++, --+, or --- (37) f.-h. As above I am not aware of any arguments from indefinite optionality, secondary stress, or schwa epenthesis which support additional underlying accents in monomorphemic stems beyond those necessary to derive the stress patterns in the neutralizing cases.[37]

37 The exact accentual underlying form of a three-element noun is only known if the noun has three morphemes, whose accent statuses are independently known from alternations. For example, in [a-tʰə́-ʒ-ɥə̀] DEF-PREV(out)-throw-H 'publisher, lit. out-thrower' (Yanagisawa 2010: 416), the accent pattern must be +-+. In particular, note the final schwa and (as I have transcribed it) secondary stress due to the accented human suffix /-ɥ/.

(37) Stress on CVCVCV stems

a. /t^{h}amada/ ‘toastmaster’ +++

i.

[a-	t^{h}a	ma	dá
+	+	+	+
			↑

ii.

[t^{h}a	ma	dá	-k’]
+	+	+	-
		↑	

b. /t͡s^{h}alaq’^{j}a/ ‘floorboard’ ++-

i.

[a-	t͡s^{h}a	lá	q’^{j}a]
+	+	+	-
		↑	

ii.

[t͡s^{h}a	lá	q’^{j}a	-k’]
+	+	-	-
	↑		

c. /t͡ʃ^{wh}amat^{wh}a/ ‘underwear’ +-+

i.

[a-	t͡ʃ^{wh}á	ma	t^{wh}a]
+	+	-	+
	↑		

ii.

[t͡ʃ^{wh}á	ma	t^{wh}a	-k’]
+	-	+	-
↑			

d. /t͡ʃ^{wh}amat^{wh}a/ ‘underwear’ +--

i.

[a-	t͡ʃ^{wh}á	ma	t^{wh}a]
+	+	-	-
	↑		

ii.

[t͡ʃ^{wh}á	ma	t^{wh}a	-k’]
+	-	-	-
↑			

e. /zamana/ ‘fine’ -+-

i.	[á-	za	ma	na]
	+	-	+	-
	↑			
ii.	[za	má	na	-k’]
	-	+	-	-
		↑		

f. /sak’asa/ ‘stretcher’ -++

i.	[á-	sa	k’a	sa]
	+	-	+	+
	↑			
ii.	[sa	k’a	sá	-k’]
	-	+	+	-
			↑	

g. /sak’asa/ ‘stretcher’ --+

i.	[á-	sa	k’a	sa]
	+	-	-	+
	↑			
ii.	[sa	k’a	sá	-k’]
	-	-	+	-
			↑	

h. /sak’asa/ ‘stretcher’ ---

i.	[á-	sa	k’a	sa]
	+	-	-	-
	↑			
ii.	[sa	k’a	sá	-k’]
	-	-	-	-
			↑	

Since all theoretical possibilities for accent in this theory give one of the alternations from Sections 6.1.1-6.1.5, it is impossible to generate other alternations. In particular, no underlying form gives stress alternations within stems or alternations between stem-initial and prefix stress, which is found on twelve stems, as reported in Section 6.1.9. In order to account for such forms, it is necessary to assume that these exceptional patterns are generated by definite and indefinite stems which have different accentual specifications. I independently argued against including these patterns in the regular phonology of Abkhaz in Section 6.1.9 based on their rarity.

Spruit's (1986) 'elements' yield all and only the regular stress patterns on Abkhaz stems, when applying the stress assignment algorithm which I argued for in Chapter 5. A theory based on 'elements' predicts the number and type of stress alternations that a given stem shape will have. This makes it a highly successful theory of Abkhaz stress assignment worthy of further exploration. This motivates its use in the theoretical evaluation of Abkhaz stress assignment in the next sections.

6.2.2 Evaluations for the nominal corpus data

I report on an evaluation in Python 3 of the theory of Abkhaz stress presented in the previous section. The methodology of this evaluation was reported in Chapter 2, although I summarize important details here. I wrote a Python 3 script which assigns stress to Abkhaz forms by means of Dybo's Rule with default stem-final stress, the stress assignment algorithm from Chapter 5. The script divides up each stem in the nominal corpus into 'elements' as detailed in the previous subsection. Each element in a stem may be accented or unaccented, and for each stem, the script tries all options to find which underlying accent specification works best for that stem. The script logs the total number of stems where the stress placement on both the definite and indefinite is correctly predicted. The empirical coverage is 97.78%, showing that, Dybo's Rule with stem-final stress from Chapter 5 is a successful theory of Abkhaz stress assignment. There are only twelve stems which cannot be accounted for, and these are the same as the twelve stems discussed as exceptions in Section 6.1.9.

The nominal corpus contains 545 stems, but recall from Section 6.1.9 that five of these show segmentally different allomorphs between the definite and indefinite. The script assumes that the definite and indefinite stem are the same underlyingly, as is the case for the vast majority of morphemes, so these five stems are discarded. The remaining 540 stems are evaluated. As shown in (38), 528 of these stems have their stress alternations correctly predicted. In other words, there is some single underlying sequence of accents for the stem such that when Dybo's Rule with default stem-final stress is applied, both the stress on the definite and the indefinite are predicted. For the remaining twelve stems, either the definite or the indefinite can be predicted, but there is no single underlying accentual specification which predicts both. These twelve stems add one to the count of correctly predicted (definite or indefinite) forms in (38), but zero to the count of correctly predicted stems (i.e. both definite and indefinite forms). This explains why the percentage of correct forms is higher than the percentage of correct stems.

(38) Figure 6.4

Correct / total (forms)	Correct predictions (forms, %)	Correct / total (stems)	Correct predictions (stems, %)
1,068 / 1,080	98.89%	528 / 540	97.78%

Evaluation results (algorithm from Chapter 5, nouns and adjectives)

The script outputs all stems which did not have both definite and indefinite forms correctly predicted. These twelve stems are the same as those reported as having rare patterns of stress alternation in Section 6.1.9. This is not surprising. Based on the generalizations about Abkhaz stress in Section 6.1.8, I counted exceptional forms as those which showed stress alternations within the stem or alternations between stem-initial and prefix stress. And in Section 6.2.1 I showed that no underlying accentual specifications yield those stress patterns when Dybo's Rule with default stem-final stress is applied to Spruit's (1986) representations with 'elements'. Since the theory cannot generate these stress alternations, words which display them are naturally unaccounted for.

Since the only stems the theory cannot account for are those which I independently argued represented exceptional stress patterns in Section 6.1.9, it seems that Dybo's Rule with default stem-final stress, combined with Spruit's (1986) elements, is an empirically successful theory of nominal stress alternations in Abkhaz. However, I have only tested the theory on the simplest cases of stress alternation possible: each stem has only two forms (definite and indefinite), and each form has only one affix each (/a-/ 'DEF' and /-k'/ 'INDF'). This is hardly representative of the morphosyntactic and phonological complexity of Abkhaz stress alternations. In Section 6.2.3 below I discuss whether the same theory can account for stress alternations in verbs.

6.2.3 Evaluations for the verbal corpus data

So far this chapter has mostly been concerned with only one of the two corpora of Abkhaz stress alternations described in Chapter 2. I have described the patterns of stress alternation in nominals, and shown that a version of the stress assignment algorithm from Chapter 5 is highly successful at accounting for these alternations. In this section I ask whether the same theory of stress assignment is useful for verbs. While this theory accounts for 97% of nominal stress alternations, the corresponding proportion of verbal stress alternations correctly accounted for is 77%. This suggests that the theory is on the right track, but for some verbal categories almost no stress alternations are correctly predicted. The patterns of successful and unsuccessful stress predictions are used to guide a theoretical revision of Abkhaz stress assignment in Section 6.3, which is implemented in a theoretical framework in Chapter 7.

Recall from Chapter 2, Section 2.2.1.3 that the verbal corpus has seven inflected forms for each of 445 Abkhaz verbs. These verbs have different combinations of person prefixes (absolutive, oblique, ergative), and some have preverbs (which generally convey spatial or directional information) and/or causative prefixes. The verbs also differ phonologically in their stress patterns and stem lengths.

The evaluation proceeds exactly as in Section 6.2.2. For each verb, a Python 3 script assigns stress to all seven forms using Dybo's Rule with default stem-final stress. The script tries all possible combinations of accented and unaccented 'elements' in the stem as well as the preverb, if one is present. The accentual status of the functional morphemes in the verbal corpus are based on arguments by Spruit (1986; see Chapter 2, Section 2.2.3 for a detailed list of all affixes and their assumed accent status). The script selects whichever underlying accentual representation is most successful for each verb. It keeps track of how many verbs have all seven of their forms correctly predicted (the 'verbs' columns in (39) below). If a verb has fewer than seven forms correctly predicted, the number of correctly predicted forms is still added to a separate counter (the 'forms' column in (39) below). (39) shows the result of this evaluation.

(39) Figure 6.5

Correct / total (forms)	Correct predictions (forms, %)	Correct / total (verbs)	Correct predictions (verbs, %)
2,816 / 3,115	90.40%	343 / 445	77.08%

Evaluation results (algorithm from Chapter 5, verbs)

For just over three quarters of the verbs in the corpus, the theory correctly predicts the location of stress on all seven inflected forms. For the remaining verbs, some forms are still correctly predicted, resulting in 90% over the 3,115 total verb forms having stress assigned correctly. These numbers and percentages are difficult to interpret without any reference point or baseline. Since approximately two-thirds of English words have initial stress (Cutler 2005: 271), perhaps a theory with a system of abstract underlying accents and a stress assignment rule with an elsewhere clause, is a dramatic overcomplication if it only accounts for 77% of the verbal lexicon. The table in (40) shows that this is not the case, by displaying statistics for very simple alternative stress assignment algorithms: consistent initial/final stress, and consistent stem-initial/stem-final stress. None of these alternatives are anywhere near the empirical coverage of Dybo's Rule.

(40) Figure 6.6

Theory	Correct / total (forms)	Correct predictions (forms, %)	Correct / total (verbs)	Correct predictions (verbs, %)
Initial stress	256 / 3,115	8.22%	4 / 445	0.90%
Final stress	539 / 3,115	17.30%	0 / 445	0.00%
Stem-initial stress	387 / 3,115	12.42%	26 / 445	5.84%
Stem-final stress	485 / 3,115	15.57%	0 / 445	0.00%

Evaluation results for nonsensical theories (verbs)

However, there are still many gaps in the empirical coverage of Dybo's Rule with default stem-final stress, combined with Spruit's (1986) 'elements'. Below I break down the evaluation results from (39) above by verb type. The table illustrates the fact that some verbal categories are predicted nearly perfectly, while others are nearly as bad as the nonsensical theories from (40) above.

(41) Figure 6.7

Person prefixes	Causative	Preverb	Correct / total (forms)	Correct predictions (forms, %)	Correct / total (verbs)	Correct predictions (verbs, %)
Absolutive	N/A	N	489 / 504	97.02%	68 / 72	94.44%
		Y	147 / 168	87.50%	18 / 24	75.00%
Absolutive-oblique	N/A	N	61 / 84	72.62%	1 / 12	8.33%
		Y	495 / 504	98.21%	65 / 72	90.28%
Absolutive-ergative	N	N	407 / 413	98.55%	56 / 59	94.92%
	Y		321 / 448	71.65%	38 / 64	59.38%
	N	Y	340 / 378	89.95%	36 / 54	66.67%
	Y		82 / 98	83.67%	3 / 14	21.43%
Absolutive-oblique-ergative	N	N	N/A	N/A	N/A	N/A
	Y		20 / 49	40.82%	0 / 7	0.00%
	N	Y	392 / 399	98.25%	50 / 57	87.72%
	Y		62 / 70	88.57%	8 / 10	80.00%

Breakdown of evaluation results by verb category (algorithm from Chapter 5)

By examining the statistics in a table like (41), it is possible to identify which types of verbs should be investigated further. For example, verbs with an absolutive and oblique person marker have a high proportion of verbs correctly accounted for when there is a preverb (65 / 72, 90.28%), but a much lower proportion when there is no preverb (1 / 12, 8.33%). In its current implementation, Dybo's Rule also appears to perform poorly on many causative verbs, and the proportion of causative verbs correctly predicted is always lower than the proportion of non-causative verbs with the same person prefixes and preverb status. In Section 6.3 I examine the verb forms behind the statistics in (41), and attempt to use the patterns that emerge from the data to create a revised theory of stress assignment in Abkhaz.

6.3 Creating a revised theory of Abkhaz stress assignment

In this section I argue for a revised theory of Abkhaz stress assignment. Aside from various accentual allomorphies for affixes, the key innovation is the idea that for some verbs, stress is not assigned by Dybo's Rule at all. Instead these verbs are pre-accenting, with stress falling immediately before the stem. I show that the revised theory accounts for 86% of the verbal stress alternations, rather than the 77% of the original theory. It ties or outperforms the original theory for every verb type in the corpus. In Chapter 7 I implement a version of the revised theory, but where stress is carried by individual segments rather than Spruit's (1986) 'elements'. The revised theory is as follows:

(42) Revised theory of Abkhaz stress

- The causative prefix /r-/ is invisible to stress assignment
- The negative prefix /m-/ is accented in absolutive-oblique verbs without preverbs
- The negative prefix /m-/ and all ergative prefixes are accented in causatives
- Stress falls immediately before the stem in unaccented absolutive-only verbs with one element and no preverbs
- Stress falls immediately before the stem in non-accent-initial absolutive-only verbs with a causative and no preverbs
- In all other cases, stress is assigned by Dybo's Rule with stem-final stress

The revisions are discussed in Section 6.3.1, followed by the evaluation of the theory against the verbal corpus in Section 6.3.2. Since the theory only makes revisions to verbal accentuation, its performance on the nominal corpus is unchanged.

6.3.1 A revised theory of Abkhaz stress assignment

In this section I attempt to use the patterns of correct and incorrect predictions from Section 6.2.3 above to improve on the theory of stress assignment evaluated in that section, which I will refer to as the original theory here, to distinguish it from the revised theory I propose. The original theory has several moving parts, including the algorithm for stress assignment (Dybo's Rule with default stem-final stress) and representational assumptions about which affixes are accented or unaccented from Chapter 2, Section 2.2.3. In what follows I propose revisions to both. In Section 6.3.2 I implement the revised theory and show that it increases empirical coverage considerably.

I discuss the revisions that I propose, which were summarized in (42), and which are repeated as (47) below. I modify the assumptions about accent status by arguing that the unaccented negative prefix has an accented allomorph for certain absolutive-oblique verbs. I modify the stress assignment algorithm by proposing that there is a class of pre-accenting verbs, where stress falls immediately before the stem instead of being assigned by Dybo's Rule. This is a more radical departure from previous literature on Abkhaz stress, but pre-accentuation is familiar from other languages with contrastive but movable stress (Revithiadou 1999 on Greek, Yates 2017 on Cupeño). I also adopt several changes to the accent status of morphemes in causative verb forms which are familiar from earlier work on Abkhaz. In this section I describe in words (and in Python 3 code) the empirical generalizations for these patterns of stress assignment, while in Chapter 7 I provide a theoretical analysis which derives the types of exceptional behavior and the contexts in which they appear. This analysis uses a phonological grammar which does not have direct access to morphosyntactic notions like ‘causative’ or ‘oblique person prefix’.

In order to illustrate the logic of how a theory of Abkhaz stress can be improved using corpus data and the evaluation results from Section 6.2.3 above, I will begin by discussing absolutive-oblique verbs. Recall from (41) in Section 6.2.3 that when there is no preverb, almost none of the verbs with absolutive and oblique person prefixes have stress correctly predicted on all seven forms. In the table below, I investigate these preverbless absolutive-oblique verbs more closely. I mark a form with a check mark ✔ if the original theory correctly predicts the location of stress for a given form, and with an X ✘ if it makes an incorrect stress prediction. Aff. is short for affirmative, and Neg. for negative. Even though the verbs in (43) have different stem lengths and accent patterns in the infinitive, it is clear that there is a pattern, with the same forms (the negative imperative and negative past absolute) being the only two forms incorrectly predicted for all verbs.

(43) Figure 6.8

		Infinitive	Present tense		Imperative		Past absolute	
Verb	Translation		Aff.	Neg.	Aff.	Neg.	Aff.	Neg.
[á-s-ra]	‘hit’	✔	✔	✔	✔	✘	✔	✘
[a-fəɥ-rá]	‘smell’	✔	✔	✔	✔	✘	✔	✘
[a-nə́r-ra]	‘influence’	✔	✔	✔	✔	✘	✔	✘
[á-pʰχʲa-ra]	‘read’	✔	✔	✔	✔	✘	✔	✘

Detailed evaluation results for absolutive-oblique verbs without preverbs (algorithm from Chapter 5)

What separates the cells with incorrect predictions from those with correct predictions? Both forms are negative, but the negative present tense is correctly predicted for all verbs.

However, the negative marker /m/ is a suffix in the present tense, but a prefix elsewhere. A possible generalization, then, is that the original theory fails for these verbs when there is a negative prefix. Below are the three negative forms of ‘to read’, with the negative marker bolded. It is a suffix in (44) a., but a prefix in (44) b. and (44) c.

(44) Negative forms of ‘read’ (Yanagisawa 2010: 342)

a. сапхьом
[s-á-$p^h\chi^j$o-**m**]
1SA-3SNO-read.DYN-**NEG**
‘I don’t read it’

b. Бамыпхьан!
[b-a-**mә́**-$p^h\chi^j$a-n]
2SFA-3SNO-**NEG**-read-NEG.IMP
‘Don’t read it!’

c. дамыпхьакәа
[d-a-**mә́**-$p^h\chi^j$a-k'^wa]
3SHA-3SNO-**NEG**-read-NEG.PST.ABS
‘him/her not having read it’

The forms in (44) also suggest how the theory can be revised to account for these forms. In (44) b. and c., the negative prefix, which is unaccented in the original theory, carries primary stress. Since the morpheme carries stress here, it seems to behave as accented for these verbs. Below I show derivations of the negative imperative of ‘read’ with an unaccented negative prefix, which leads to an ungrammatical surface form (45) a., and with an accented negative prefix, which correctly predicts the location of stress (45) b. Recall that Dybo’s Rule assigns stress to the leftmost accented element not immediately followed by an accented element. As I have done earlier in this chapter, I show accented elements with +, unaccented elements with -, and use ↑ to point to the form assigned stress by Dybo’s Rule.

(45) Derivations of negative imperative forms

a. Бамыцхьан!

*[b-	á-	mə-	p^h	χ^ja	-n]
-	+	-	-	-	-
	↑				
2SFA-	3SNO-	NEG-	read		-NEG.IMP

Intended: ‘Don’t read it!’

b. Бамыцхьан!

[b-	a-	mə́-	p^h	χ^ja	-n]
-	+	+	-	-	-
		↑			
2SFA-	3SNO-	NEG-	read		-NEG.IMP

‘Don’t read it!’

Although I do not show derivations for all forms in (43) here for reasons of space, treating the negative prefix as accented in fact turns all of the incorrect predictions in (43) into correct ones. For this reason, I propose the following pattern of accentual allomorphy.

(46) Negative allomorphy

The negative prefix /m-/ is unaccented
In absolutive-oblique verbs without a preverb, it is accented

This illustrates how to revise a theory in response to the corpus data. I began by noticing an area of the verbal lexicon where the original theory performed poorly. I examined those verbs and found a pattern, isolating the negative prefix as the morpheme causing the problems. Since this prefix can, exceptionally, carry stress in the relevant verbs, this suggests that the prefix has an accented allomorph. By introducing this allomorph all of the incorrect predictions are fixed.

I have attempted to make the reasoning above appear straightforward, but the data are more complicated. Yanagisawa (2010: 209) includes two absolutive-oblique verbs [a-k’-rá], meaning ‘fit into’ and ‘feel’. The verb ‘fit into’ behaves as predicted by (46), but the verb ‘feel’ behaves instead as the original theory predicted. The verb ‘feel’ is the single verb in this category which was marked as correctly predicted in the evaluation in (41) in Section 6.2.3. In cases with multiple stress patterns like these, there is often no principled way to decide which is representative, and which is an exception. I have proposed the revision to the original theory in (46), but other linguists working on Abkhaz stress may make other revisions based on other empirical generalizations. In the rest of this section, I describe the revisions I propose and the generalizations which motivate them. However, given the complexity of the data there may be many alternatives which would be equally empirically successful, and some with greater empirical coverage that I have not discovered.

In (47) below I give a summary of the revised theory I propose for Abkhaz stress assignment. Some of these revisions are complex, making reference to multiple phonological and morphological preconditions. In the remainder of this section I attempt to justify some of this complexity.

(47) Revised theory of Abkhaz stress

- The causative prefix /r-/ is invisible to stress assignment
- The negative prefix /m-/ is accented in absolutive-oblique verbs without preverbs
- The negative prefix /m-/ and all ergative prefixes are accented in causatives
- Stress falls immediately before the stem in unaccented absolutive-only verbs with one element and no preverbs
- Stress falls immediately before the stem in non-accent-initial absolutive-only verbs with a causative and no preverbs

The changes in (47) regarding causative verbs are mostly familiar from earlier work. Dybo’s (1977: 43) original proposal has ergative markers as accented in causatives, while

Spruit (1986: 72) argues that the negative prefix shows the same allomorphy. The invisibility of the causative /r-/ to stress assignment results in causative and non-causative versions of verbs having the same stress patterns in the infinitive, as if the causative marker were not there. These patterns are again familiar from previous literature (Spruit 1986: 70-71, Trigo 1992: 223-224).

(48) Causative /r-/ is invisible in stress assignment

a.

i. адыдра
[á-dəd-ra]
DEF-thunder-INF
'to thunder'
Yanagisawa (2010: 106)

ii. ардыдра
[á-r-dəd-ra]
DEF-CAUS-thunder-INF
'to make (it) thunder'
Yanagisawa (2010: 363)

b.

i. абара
[a-ba-rá]
DEF-see-INF
'to see'
Yanagisawa (2010: 53)

ii. арбара
[a-r-ba-rá]
DEF-CAUS-see-INF
'to show (lit. cause to see)'
Yanagisawa (2010: 359)

The major innovation of the revised theory is a class of pre-accenting verbs. The empirical generalization that some verbs have stress immediately before the stem is occasionally found in earlier literature (Kathman 1992: 220 fn. 10, Yanagisawa 2013: 197), but I am not aware of any theory of Abkhaz stress which implements pre-accentuation.

The conditions for pre-accenting behavior in (47) are complex. Non-causative verb stems must contain at most a single 'element', which must be unaccented, and there must not be a preverb or an ergative. The data in (49) show that these conditions are necessary. Verbs which meet these criteria are pre-accenting, as in (49) a. Polysyllabic verb stems, which have multiple accent specifications because they have more than one 'element', are not (49) b., nor are verbs with preverbs, even if both the verb stem and preverb have one 'element' (49) c. In (49) b. and c. stress is stem-final by default. Stems are shown in bold for clarity.

(49) Conditions for pre-accentuation

a. Быҩ!
[bə́-**ɥ**]
2SFA-**run**
'Run!'
Yanagisawa (2010: 583)

b. Бкәаша!
[b-**k'ʷaʂ̻á**]
2SFA-**dance**
'Dance!'
Yanagisawa (2010: 220)

c. Бнаӡа!
[b-na-**d͡zá**]
2SFA-there-**reach**
'Reach thither!'
Yanagisawa (2010: 305)

That ergative markers block pre-accenting behavior is easiest to see for verb stems which sometimes have an ergative and sometimes do not. Although such verbs still have an agent semantically, ergative markers are not present on imperatives to a singular addressee. If addressing a group, an ergative marker is present even in imperatives. This results in a difference in stress. In the singular imperative in (50) a. there is no ergative marker, so the verb /ʒʷ/ 'drink' is pre-accenting. In the corresponding plural imperative in (50) b., there is an ergative marker, so the verb is instead assigned default stem-final stress.

(50) Ergative markers and pre-accentuation (Yanagisawa 2010: 123)

a. Ижә!
[jí-**ʒʷ**]
3NA-**drink**
'Drink it/them! (singular addressee)'

b. Ижәжәы!
[ji-ʒʷ-**ʒʷə́**]
3NA-2PE-**drink**
'Drink it/them! (plural addressee)'

Causative verbs can also display pre-accenting behavior. The conditions are similar but not identical to those for non-causative verbs. Preverbs and ergatives block pre-accenting behavior in causatives, just as for non-causatives above. However, pre-accentuation in causatives does not depend on the number of 'elements' in the stem. This predicts that polysyllabic verb stems (which have more than one 'element') will be pre-accenting only in causative verb forms. This prediction is correct, as shown in (51). The stem /laʂa/ 'shine' is unaccented, leading to default stem-final stress in the non-causative form in (51) a., but in the causative in (51) b., the same stem is pre-accenting. Recall that the causative prefix itself is invisible to stress, which explains why pre-accentuation in (51) b. does not result in the ungrammatical *[ji-rə́-laʂa]. In other words, pre-accentuation is not a lexical property of individual verb morphemes in Abkhaz; it emerges from the morphological context in which a verb stem is placed.

(51) Causative and non-causative forms of the same stem

a. Блаша!
[b-**laʂá**]
2SFA-**shine**
'Shine!'
Yanagisawa (2010: 272)

b. Ирлаша!
[jí-r-**laʂa**]
3NA-CAUS-**shine**
'Illuminate it/them!'
Yanagisawa (2010: 368)

Unlike for non-causatives, pre-accentuation in causatives also does not require a fully unaccented verb stem. The stem /ʂk'ʷak'ʷa/ 'white' has three 'elements', ʂ.k'ʷa.k'ʷa, the second of which is accented. This causes stress to surface on this element in nominal forms like (52) a. and non-causative verbal forms like (52) b. However, the causative verb 'whiten' is nevertheless pre-accenting (52) c. Unaccented stems like /d͡z/ 'disappear' are also pre-accenting in causatives (52) d., while accented stems like /tʷʰ/ 'full' are assigned stress by Dybo's Rule (52) e. The generalization appears to be that only non-accent-initial stems allow for pre-accentuation.

(52) Pre-accentuation in causatives

a. шкәакәак
[ʂk’ʷák’ʷa-k’]
white-INDF
‘a white one’
Yanagisawa (2010: 556)

b. ишкәакәахеит
[ji-ʂk’ʷák’ʷa-χe-jt’]
3NA-white-become-DYN.FIN
‘it/they became white’
Yanagisawa (2010: 556)

c. Иршкәакәа!
[jí-r-ʂk’ʷak’ʷa]
3NA-CAUS-white
‘Whiten it/them!’
Yanagisawa (2010: 383)

d. Ирӡ!
[jí-r-d͡z]
3NA-CAUS-disappear
‘Lose it/them!’
Yanagisawa (2010: 365)

e. Иртәы!
[ji-r-tʷʰə́]
3NA-CAUS-full
‘Fill it/them!’
Yanagisawa (2010: 374)

There are many more datasets that could be considered to show why particular conditions in (47) were or were not included. I have illustrated the main revisions above, and motivated some of their complex preconditions. I repeat the point that this process is far from deterministic, and that variation in the data as well as analytical preferences may lead other linguists to different theories of Abkhaz stress than that in (47). I have shown one proposal here, and I turn now to the evaluation of the revised theory I have proposed. Without access to a large corpus of inflected Abkhaz verb forms, the only way to evaluate this theory would be to apply it to minimal or near-minimal pairs of hopefully representative verb forms, in much the same way that I have done above. I will instead implement the revised theory in Python 3 and evaluate it empirically against the verbal corpus of Abkhaz. Below I report the results of such an evaluation.

6.3.2 Evaluating the revised theory

I implemented the revised theory from Section 6.3.1 above in Python 3 and evaluated it against the verbal corpus data, with an identical methodology to that of Section 6.2.3. Only one implementational detail deserves comment here. In Section 6.3.1 I described the causative as being invisible in stress assignment, but others instead say that the causative copies the first accent specification of the stem to which it attaches (Spruit 1986: 70-71). These are equivalent formulations, and I have found it easier to implement the latter.[38] In the analysis in Chapter 7 I treat causatives as metrically invisible, following the literal wording of Section 6.3.1.

The results for the revised theory are shown in (53), where I also repeat the results from the original theory in Section 6.2.3 for comparison.

(53) Figure 6.9

Theory	Correct / total (forms)	Correct predictions (forms, %)	Correct / total (verbs)	Correct predictions (verbs, %)
Original theory	2,816 / 3,115	90.40%	343 / 445	77.08%
Revised theory	2,981 / 3,115	95.70%	383 / 445	86.07%

Evaluation results (original and revised theories, verbs)

38 Causatives in Yanagisawa (2010) are not segmented as separate morphemes from the stem (as discussed briefly in Chapter 2, Section 2.2.2.1), so for causative pre-accentuation, placing stress immediately before the stem as identified by Yanagisawa's (2010) segmentations still leads to stress before the causative prefix rather than on it, matching the data from Section 6.3.1.

The difference between the original implementation and the revised theory is that over 40 additional verbs, almost 10% of the verbs in the corpus, now have stress correctly predicted on all seven forms. Over 150 additional verb forms, almost 5% of the total number of forms, are now assigned stress correctly. In (54) I show the results of the revised theory for different subsets of the corpus. For every row in (54), the revised theory either ties or outperforms the original implementation in Section 6.2.3. All verb categories with extremely poor performance are now gone, with no row having less than 87.5% of its forms predicted, and no row having fewer than two-thirds of its verbs fully accounted for. Several classes of verbs are approaching the maximum of 100%.

(54) Figure 6.10

Person prefixes	Causative	Preverb	Correct / total (forms)	Correct predictions (forms, %)	Correct / total (verbs)	Correct predictions (verbs, %)
Absolutive	N/A	N	501 / 504	99.40%	70 / 72	97.22%
		Y	147 / 168	87.50%	18 / 24	75.00%
Absolutive-oblique	N/A	N	79 / 84	94.05%	10 / 12	83.33%
		Y	495 / 504	98.21%	65 / 72	90.28%
Absolutive-ergative	N	N	410 / 413	99.27%	57 / 59	96.61%
	Y		414 / 448	92.41%	50 / 64	78.13%
	N	Y	340 / 378	89.95%	36 / 54	66.67%
	Y		90 / 98	91.84%	12 / 14	85.71%
Absolutive-oblique-ergative	N	N	N/A	N/A	N/A	N/A
	Y		47 / 49	95.92%	6 / 7	85.71%
	N	Y	392 / 399	98.25%	50 / 57	87.72%
	Y		66 / 70	94.23%	9 / 10	90.00%

Breakdown of evaluation results by verb category (revised theory)

There are 46 verbs which are fully accounted for in the revised theory but not in the original theory, and six verbs which were fully accounted for in the original theory but are not in the revised theory. This results in the net difference of 40 verbs in column 4 of (53). One of the six verbs is the absolutive-oblique verb ‘feel’ which I discussed in Section 6.3.1, and the remaining five are all causative verbs. One of these five is the verb meaning ‘forget intentionally’, whose unusual stress pattern I mentioned in Chapter 2, Section 2.2.1.1. It is likely that there are nuances in causative stress behavior not captured by the revised theory. However, the revised theory outperforms the original on causatives overall, suggesting that despite the existence of occasional exceptions, it still represents a step in the right direction.

Despite the fact that the revised theory markedly improves on its predecessor, it is not perfect. There are 62 verbs in the corpus whose stress patterns it fails to fully account for. It is possible that some include typos, or judgement errors because Yanagisawa’s (2010) consultant was distracted, or confused a verb with a similar-sounding one. Some verbs may have two possible patterns of stress alternation, with the dictionary reporting a mix of the two. It is also doubtless the case that Abkhaz has lexical exceptions, forms which, for whatever diachronic reason, do not follow the general synchronic rules.

Given the complexity of the data, it is also surely the case that there are generalizations which I have overlooked, because I never thought to put the right two subsets of the verbal lexicon next to each other to see that they in fact behave the same. I have presented one possible theory of Abkhaz verb stress, which appears to be relatively empirically successful. However, I do not doubt that there are many patterns in the data which remain to be discovered. Since I have only modified the assumptions about verbal stress assignment, the performance on nominals will remain at 97%, just as in Section 6.2.2. In Chapter 7 below I will implement the revised theory in Idsardi's (1992) framework for stress assignment using metrical grids. Before then I will summarize the data and argumentation from this chapter.

6.4 Conclusions

In this chapter I have given a quantitative overview of patterns of Abkhaz stress alternation. Abkhaz exhibits many patterns of stress alternation, for many stem sizes and shapes. A key finding from the quantitative investigation above is that the number of stress patterns varies by stem size, such that longer stems have more patterns. However, the number of vowels in the stem is apparently irrelevant for determining its 'length', with stem shapes such as /CC, CCV, CVC, CVCV/ all having the same number and type of stress alternations in both nominals and verbs. For each stem length, there are both patterns with fixed stress (within the nominal and verbal paradigms considered here) and patterns where the location of stress varies across the paradigm. However, some types of stress alternation are never found, or are only found in a handful of exceptional stems. None of the regular patterns in this chapter show alternations between stem-initial and prefix stress, or stress shifts within parts of the stem.

I have argued that the theory of stress assignment from Chapter 5, Dybo's Rule with default stem-final stress, predicts all and only the regularly attested patterns of stress alternation on nominal stems. By dividing up stems into smaller units called 'elements' (Spruit 1986), which often have the shape CV or C, it is possible to predict correctly which stem shapes will have the same numbers of stress alternations. All stems with the same number of 'elements' will also have the same number of stress patterns. I have used Python 3 to automatically evaluate this theory against the nominal corpus data, and shown that it correctly predicts 97% of nominal stress alternations. The twelve exceptional stems which cannot be accounted for are the same as the twelve which I have independently identified as exhibiting unusually rare patterns of stress alternation.

Evaluating the same theory on verbal stress alternations yields an empirical coverage of 77%. This is impressive, since each stem in the verbal corpus has seven inflected forms, each of which must be correctly predicted. The verbal data are also much more complex than the nominals in terms of their morphophonology, including a much wider range of combinations of prefixes and suffixes. However, there are some verbal categories where the theory performs very poorly. I have used the patterns in where the theory fails to guide the creation of a revised theory of Abkhaz stress assignment which is more suitable for verbal stress alternations. The revised theory has an empirical coverage of 86%, and either ties or outperforms the original theory for every verb category.

Largely following previous literature, the revised theory includes a number of allomorphic changes to the accentual status of particular morphemes. For example, ergative person prefixes are accented in causatives, but unaccented elsewhere. However, the major revision is the inclusion of a class of pre-accenting verbs, in which stress falls immediately before the stem instead of being assigned by Dybo's Rule. Pre-accentuation in Abkhaz is unusual in being determined by morphosyntactic context rather than lexical specification: the same stem can be pre-accenting or not depending on which affixes are attached.

The generalizations about Abkhaz stress assignment in this chapter have so far only been implemented in Python 3 code. In the next chapter I attempt to formalize these generalizations in a theoretical phonological framework. This raises several theoretically interesting questions: can the language-specific 'elements' postulated by Spruit (1986) be understood in terms of more familiar, crosslinguistically motivated units? And can a single phonological grammar correctly assign stress by Dybo's Rule, default stem-final stress, or pre-accentuation in the right morphological and phonological contexts? In Chapter 7 I argue that the grammar I have described in Python code in this chapter can be implemented in Idsardi's (1992) metrical grid theory of stress. I discuss in detail the role of 'elements' in Chapters 7 and 8, and argue that neither syllables nor moras are appropriate replacements for this language-specific unit. The analysis I propose instead replaces 'elements' by segments, with individual consonants and vowels bearing underlying accents.

Chapter 7: A Segmental Analysis of Abkhaz Stress

The goal of this chapter is to provide an explicit analysis of the data and generalizations on Abkhaz stress assignment found primarily in Chapters 5 and 6. In those chapters stress assignment was described either in terms of morphemes or Spruit's (1986) language-specific 'elements', which are often CV or C units. I argue instead for an analysis where stress is assigned with direct reference to individual consonants and vowels, unmediated by a prosodic unit such as the mora or syllable. Alternative analyses based on prosodic units are discussed in detail in Chapter 8.

I use the bracketed grid theory of Idsardi (1992) as the theoretical framework for this segmental analysis. The segmental grammar I develop uses seven rules to assign primary and secondary stress, including default stem-final stress, and also captures pre-accentuation and stress-conditioned schwa epenthesis. It accounts for several exceptions to regular stress assignment, and even exceptions to those exceptions. All rules are sensitive only to phonological information, and do not make direct reference to morphosyntactic entities like 'stem' or 'causative', even when the empirical generalizations in Chapter 6 do.

In this analysis, all segments have a Line 0 gridmark in the lexicon, while accented segments additionally project a gridmark to Line 1. This gives underlying representations like the following for the minimal pair between unaccented 'flea' and accented 'water'.

(1) Representation of accented and unaccented stems

a.	Unaccented ‘flea’	b.	Accented ‘water’
Line 1		Line 1	*
Line 0	*	Line 0	*
Segments	d͡z	Segments	d͡z

I rely on foot boundaries to account for several departures from Dybo’s Rule, including default stem-final stress and pre-accentuation. I make several proposals about Abkhaz morphology and morphophonology to account for less common patterns of stress assignment, including morphological exceptions to do with person markers and causative verbs. All such exceptions are accounted for using phonologically conditioned allomorphy, and the phonological rules refer only to phonological units.

Representationally I show ways in which the segmental analysis departs from Spruit’s (1986) intuition that Abkhaz stress is based on ‘elements’ which formed the basis of the theoretical evaluations in Chapter 6. The analysis I propose has no notion of a CV sequence forming any kind of prosodic unit at any stage in the derivation. This proves to be challenging for the segmental analysis in several respects, since so many aspects of Abkhaz stress assignment appear to be sensitive to just such a unit. However, I argue that independently motivated readjustment rules apply in cases where a consonant and following vowel have different stress specifications, and that these are able to account for all of the data. Below are the seven rules I rely on and the order in which they apply:

Readjustment	ĆV, CV́ → ĆV́
Accented Parenthesis Deletion	Delete) if there is a preceding Line 1 gridmark
Double Parenthesis Deletion	Delete) if there is a preceding)
Line 0 Head:R	Project the rightmost footed gridmark on Line 0 to Line 1
Line 1 Clash Resolution	Iteratively delete accents which immediately precede accents
Epenthesis	Insert schwa after accented consonants and shift stress to them
Line 1 Edge:LLL, Head:L	Project the leftmost Line 1 gridmark to Line 2

In this chapter I will build up to this grammar gradually by introducing one or a few rules at a time, as and when they are relevant to the data being discussed. However, I never introduce a rule in one section only to revise it later. All rules are given in their final version the first time they appear in the text, and the order of the rules will stay constant throughout the section.

A separate chapter, Chapter 8, is devoted to alternative analyses of Abkhaz stress which rely on prosodic units such as syllables and moras. I argue that approaches based on prosodic units suffer from empirical and theoretical drawbacks. In this chapter I present the segmental analysis and show that it works well. A detailed discussion of prosodic alternatives is left for Chapter 8.

This chapter is structured as follows. In Section 7.1 I introduce the basic assumptions of the segmental analysis, and discuss regular primary and secondary stress assignment as well as schwa epenthesis. Section 7.2 introduces the mechanisms for assigning default stem-final stress. In Section 7.3 I discuss CV sequences, and why they appear to form a unit for the purposes of stress assignment. Section 7.4 analyzes several classes of exceptions to regular stress assignment in terms of phonologically conditioned allomorphy. Section 7.5 discusses the derivation of pre-accentuation, which also relies on allomorphy in the analysis I propose. Section 7.6 offers some concluding remarks.

7.1 The basics of Abkhaz stress

I will begin by outlining the basic assumptions of the segmental analysis of Abkhaz stress assignment, which are similar in many ways to those of previous analyses in Kathman (1992), Trigo (1992), Vaux (2015), and Vaux & Samuels (2018). I assume that all segments in Abkhaz, consonants and vowels, come with a Line 0 asterisk in the lexicon. This is an extension of the metrical grid representations in Halle & Vergnaud (1987), where it is parameterized for each language whether the units on Line 0 are syllables, moras, or something else. The only change I make is adding segments as an option.

A segment with only a Line 0 gridmark is unaccented. Lexically accented segments additionally project a Line 1 gridmark. This follows Kathman (1992), who attributes the idea to Prince (1983). Vaux (2015) and Vaux & Samuels (2018) instead project a right) parenthesis to the right of each accented mora on Line 0, while Trigo (1992) projects an gridmark on Line 0 only for accented syllables, leaving unaccented syllables unmarked. The assumptions I adopt lead to underlying forms like the following for unaccented ‘flea’ and accented ‘water’.

(2) Representation of accented and unaccented stems

a.	Unaccented ‘flea’	b.	Accented ‘water’
Line 1		Line 1	*
Line 0	*	Line 0	*
Segments	d͡z	Segments	d͡z

Throughout this section I will follow closely Idsardi’s (1992) theory of grid-based metrical structure (see also Halle & Idsardi 1995 and Idsardi 2009 for similar theories).

The bulk of stress assignment in this theory is accomplished by language specific parameters for edge marking and headedness, which apply to individual lines in the grid. In Abkhaz there is no need for the third type of rule, Iterative constituent construction (Idsardi 1992: 18-19), which I therefore do not discuss. The Edge Marking Parameter takes three arguments, each of which can have the value 'left' or 'right'. This is in addition to a positive integer argument specifying the line to which the parameter applies. The Headedness Parameter takes only a single left/right argument.

(3) Parameters from Idsardi (1992: 12-13)

Edge Marking Parameter
Place a {left, right} parenthesis to the {left, right} of the {left-, right-}most gridmark on Line {0, 1, 2, ...}

Headedness Parameter
Project the {left-, right-}most gridmark in each foot on Line {0, 1, 2, ...} to the next higher line of the grid

Like Idsardi, I abbreviate Edge Marking Parameter: left, right, right as Edge:LRR, and Headedness Parameter: left, as Head:L. The Headedness Parameter makes reference to feet, which are introduced by left and right ( ) parentheses. One parenthesis is enough to define an unbounded foot. In both (4) a. and b. the first two gridmarks are footed, and the initial gridmark is leftmost in each foot.

(4) Footing in Idsardi's (1992) framework

a.	b.
* *) *	(* *) *

Stress assignment according to Dybo's Rule will proceed as follows: an iterative rule of clash resolution on Line 1 ensures that the only gridmarks left on this line are those which are not immediately followed by gridmarks. This works because Dybo's Rule assigns stress to accents *not* immediately followed by other accents, and clash resolution *removes* all accents which *are* immediately followed by other accents. After clash resolution, schwa epenthesis applies to all consonants which project to Line 1. The leftmost Line 1 gridmark then projects to Line 2. In the resulting metrical grids, Line 2 encodes the location of primary stress, and Line 1 the location of secondary stresses.

The projection of the leftmost Line 1 gridmark to Line 2 is easily stated with the following parameters, which apply to Line 1:

(5) Projection parameters for Line 1

Edge:LLL	Place (to the left of the leftmost Line 1 gridmark
Head:L	Project the leftmost footed gridmark from Line 1 to Line 2

Before this I apply clash resolution on Line 1. A rule of clash resolution on Line 1 is present in all previous generative analyses of Abkhaz stress, applying either to gridmarks or parentheses depending on other representational assumptions (Kathman 1992, Trigo 1992, Vaux 2015, Vaux & Samuels 2018). Kathman (1992: 222-223) motivates it by noting that when coupled with the projection rules discussed above, clash resolution decomposes the rather idiosyncratic Dybo's Rule into typologically familiar metrical operations.

Abkhaz clash resolution (6) a. is typically applied iteratively from left to right (Kathman 1992, Vaux 2015), but Kathman (1992: 228 endnote 7) notes that another alternative would be to apply it simultaneously to all parts of the underlying representation which meet the structural description. Since they are predictively identical (see Andersson et al. 2021 on distinguishing iterative and simultaneous process application), I do not commit to a particular mode of application. What is essential is that in a sequence of three adjacent accents as in (6) b., both the first and second are deleted so that projecting the leftmost Line 1 gridmark to Line 2 yields rightmost stress according to Dybo’s Rule, as shown in (6) c. A globally optimizing *Clash constraint (or iterative right-to-left application) would only remove the middle accent, incorrectly predicting leftmost stress, shown in (6) d. (Vaux 2015).

The word in (6) is [a-$\widehat{ts}^h$a-rá] DEF-go-INF ‘go’. I show underlying accents on all segments of this word here. Later, in Section 7.3, I introduce readjustment rules which allow words like ‘go’ to be derived from underlying representations where only the three vowels are accented.

(6) Derivations illustrating clash resolution

a. Clash resolution (iterative left-to-right or simultaneous)

Line 1	*	→	Ø	/	_	*

b. Underlying representation

Line 1	*	*	*	*	*
Line 0	*	*	*	*	*
Segments	a	$\widehat{ts}^h$	a	r	a

c. Correct application of clash resolution

Line 2					*
Line 1					(*
Line 0	*	*	*	*	*
Segments	a	$\widehat{ts}^h$	a	r	a

d. Incorrect application of clash resolution

Line 2	*				
Line 1	(*				*
Line 0	*	*	*	*	*
Segments	a	t͡sʰ	a	r	a

Once clash resolution has been applied, the remaining Line 1 gridmarks will be the ones which receive some level of prominence (primary or secondary stress), and which serve as possible sites for schwa epenthesis. I formalize schwa epenthesis as the insertion of a metrically significant schwa, i.e. one with a Line 0 gridmark,[39] in any location where a consonant projects to Line 1. This schwa then acquires the Line 1 gridmark of its preceding consonant by a rule of stress shift. The rules are shown below. Recall that /d͡z/ 'water' is accented, having a Line 1 gridmark, while the indefinite suffix /-k'/ is unaccented, having only a Line 0 gridmark. Schwa epenthesis as formulated in (7) a. applies to the underlying representation in (7) b. i., because there is an accented consonant. Stress shift then ensures that the epenthetic schwa takes over the Line 1 gridmark from the consonant, allowing for eventual surface representations with stress on the vowel rather than the consonant.

(7) Derivations illustrating schwa epenthesis

a. Rules

i. Schwa epenthesis

Line 1					*	
Line 0			*		*	
Segments	Ø	→	ə	/	C	_

39 This ensures that the inserted schwa is available to carry stress, unlike the epenthetic vowels familiar from many languages which are ignored in stress assignment (see Broselow 2008 and Hall 2011 among others).

ii. Stress shift

Line 1	*				*
Line 0	*	*	→	*	*
	C	V		C	V

b. Sample derivation

i. Underlying representation

Line 1	*	
Line 0	*	*
Segments	d͡z	k’

ii. Schwa epenthesis

Line 1	*		
Line 0	*	*	*
Segments	d͡z	ə	k’

iii. Stress shift

Line 1		*	
Line 0	*	*	*
Segments	d͡z	ə	k’

The stress shift rule here is very similar to those discussed in Halle & Vergnaud (1987: 28-30),[40] and it is identical to their Sanskrit rule which shifts stress to the right from a consonant onto a vowel. In their analysis, vowels which becomes glides cease to be metrically relevant, since consonants are not stress-bearing in Sanskrit. Their Line 0 gridmarks are removed, leaving Line 1 gridmarks which in Sanskrit shift to the right (but which shift to the left in their analysis of Russian). The rule I have written above retains Line 0 asterisks for consonants, but I do not know of any arguments against the analysis in Halle & Vergnaud (1987): after schwa epenthesis has applied, consonants cease to be

40 There is also some resemblance with Move x (Prince 1983: 33, Hayes 1995: 370-371), which has been used to account for the so-called Rhythm Rule in English stress clashes: *fourtèen wómen → fòurteen wómen*. However, the rule in Abkhaz, like those of Russian and Sanskrit, move a stress only to the adjacent stress-bearing unit, while the landing site for Move x is the stress-bearing unit which projects the highest: *Sunset Pàrk Zóo → Sùnset Park Zóo, *Sunsèt Park Zóo* (Hayes 1995: 370).

metrically relevant in Abkhaz, so they could be removed from Line 0 with no empirical consequences.

Another alternative analysis would insert a schwa with a Line 1 gridmark directly. This looks somewhat unusual, since epenthetic vowels are often distinguished by their lack of participation in stress assignment (see footnote 39 above). However, such a rule very directly encodes what is unusual about stress-conditioned epenthesis in Abkhaz: the language has epenthetic vowels which are inserted just when they will be stressed. (As discussed in Chapter 4, Abkhaz also has epenthetic unstressed schwas, but these arise in different environments and are not inserted by the rule considered here.) It would be a rule which is unusual precisely because it describes a crosslinguistically unusual process. I retain the rules formulated in (7) above, but in derivations I will often collapse epenthesis and stress shift into a single derivational step labeled 'Epenthesis' to save space.

7.2 Default stem-final stress

The grammar above only assigns stress according to Dybo's Rule when there is at least one underlying accent. If no accents exist, I assume that the default is stem-final stress (see Chapter 5, Section 5.7). There are several ways of targeting the stem rather than the word. Some allow constraints to make direct reference to the stem, as in Kim & Pulleyblank's (2009: 576) constraint Dep[root]Stem, which says that any output root node in the stem must have an input correspondent. I pursue instead an indirect reference account, where the phonology has no direct access to morphological information such as where the stem begins and ends (for the terms direct and indirect reference, see Bennett

& Elfner 2019 for an overview). In order to understand how stem-final stress is assigned, it is necessary to investigate the behavior of grammatical categories in Abkhaz.

Many stems in Abkhaz can be productively used as several different parts of speech. Nouns and adjectives are productively used as stative verbs meaning 'to be NOUN/ADJECTIVE', and adjectives can be used as nouns meaning 'an ADJECTIVE one' (see examples in Andersson et al. 2023). In (8) a. the prototypically nominal stem 'village' is used predicatively as a verb simply by adding verbal morphology. In (8) b. the same is done for the prototypically adjectival stem 'good'. (8) c. shows the adjectival stem 'white' being used as a noun with the addition of a noun suffix.

(8) Grammatical category shifts without overt suffixes

a. Џьгьарда қыҭоуп
[d͡ʒgʲárda kʰə́tʰo-wp']
Dzhgyarda village-STAT.PRES
'Dzhgyarda is a village'
Yanagisawa (2010: 589)

b. амш аныбзиоу
[á-mʂ anə-bzío-w]
DEF-day when-good-STAT
'When the weather is good, ...'
Yanagisawa (2010: 61)

c. шкәакәак
[ʂk'ʷák'ʷa-k']
white-INDF
'a white one'
Yanagisawa (2010: 556)

In the examples above no special morphology is needed to convey that a change in part of speech has taken place. However, there are also many overt derivational suffixes (Chirikba 2003, Jakovlev 2006). The examples below show conversions to nouns (‘beautiful’ to ‘beauty’ with the nominalizer /-ra/ in (9) a.), adjectives (‘copper’ to ‘of copper’ with the adjectivizer /-t’^{w}/ in (9) b.), and adverbs (‘silent’ to ‘silently’ with the adverbalizer /-k’^{w}a/ in (9) c.).

(9) Grammatical category shifts with overt suffixes

a. аԥшӡара
[á-p^{h}ʂd͡za-ra]
DEF-beautiful-NMLZ
‘beauty’
Chirikba (2003: 28)

b. абҩатә
[a-bɥá-t’^{w}]
DEF-copper-ADJZ
‘of copper’
Chirikba (2003: 31)

c. ҿымҭкәа
[ʈ͡ʂ’ə́mt^h-k’^{w}a]
silent-ADVZ
‘silently’
Chirikba (2003: 56)

It seems necessary to assume that there are at least some non-overt categorizers in the language to explain selectional restrictions. For example the adjectivizer /-t’^{w}/ above only attaches to nouns and adverbs (Yanagisawa 2013: 71-72), suggesting that it attaches to categorized stems, e.g. [√-n]-t’^{w}, even though there is often no overt categorizer corresponding to *n* in such structures. This is exemplified by (9) b. above, which lacks any overt nominalizer after the stem. I assume that in the syntax *all* Abkhaz stems are categorized by an appropriate head: *n*, *a*, *v*, ... (for a recent overview of roots and categorization in Distributed Morphology, see Embick 2021). All overt derivational affixes in Abkhaz appear to be suffixal, so I assume that these heads all follow the stems to which they attach. Although such categorizers have no segmental content (for silent heads in syntax, see discussion in Sigurðsson & Maling 2012), I assume that they are spelled out as a right) parenthesis on Line 0. I will show that this allows us to assign default stem-final stress when coupled with a rule of parenthesis deletion, and that it also captures several otherwise unexplained facts about the stress patterns of unaccented stems.

Default stem-final stress on unaccented stems is assigned as follows. Words enter the phonology with a stem ending in), the underlying representation of segmentally null stem-final categorizers in Abkhaz. Recall that this defines a foot in Idsardi's (1992) theory, where a right) parenthesis creates an unbounded foot to its left. The Line 0 Headedness Parameter Head:R(ight) projects the stem-final segment onto Line 1. This is the only Line 1 gridmark in unaccented words, and the stress assignment mechanisms for Dybo's Rule discussed above correctly assign stem-final primary stress. A derivation for [mad͡zá-k'] 'one secret' is shown in (10).

(10) Stem-final stress

a. Underlying representation

Line 1					
Line 0	*	*	*	*)	*
Segments	m	a	d͡z	a	k'

b. Line 0 Head:R

Line 1				*	
Line 0	*	*	*	*)	*
Segments	m	a	d͡z	a	k'

c. Epenthesis

No change

d. Line 1 Edge:LLL, Head:L and surface representation

Line 2				*	
Line 1				(*	
Line 0	*	*	*	*)	*
Segments	m	a	d͡z	a	k’

The grammar formulated above is only partially correct. It incorrectly predicts that all stem-final segments will be treated as accented due to the projection rules on Line 0. In fact the accentedness of a stem-final segment in Abkhaz is contrastive: a stem-final accent leads to word-final schwa epenthesis in [a-pʰsə́] ‘soul’ from /ṕʰś/, while the lack of a stem-final accent leads to schwa epenthesis immediately after the first consonant in [a-pʰə́ʃʷ] ‘lip’ from /ṕʰʃʷ/, *[a-pʰʃʷə́]. The accentual contrast between these stems will be discussed in relation to syllable integrity violations in Chapter 8, Section 8.2.5. By Dybo’s Rule, stem-final accentuation should only apply to fully unaccented stems.

This problem resembles the difficulties in modeling default-to-same stress systems like “stress the leftmost heavy syllable, otherwise the leftmost syllable” discussed by Idsardi (1992: 27-28). To handle a default-leftmost condition it seems that the initial syllable must project to Line 1 (or be footed or otherwise treated as metrically strong). But this predicts initial stress in all words. The initial syllable should be stressed only if there are no heavy syllables elsewhere in the word. Similarly in Abkhaz, the stem-final syllable should be accented only if there are no other accents.

I propose to solve this problem by first deleting a right) parenthesis which is preceded by a Line 1 gridmark, i.e. an accent. This is a close relative of the parenthesis deletion rule in Diyari (Idsardi 1992: 71). In the rule below, which I refer to as Accented Parenthesis Deletion,[41] I follow Idsardi in using x* to stand in for zero or more metrical constituents (i.e. gridmarks or parentheses).

(11) Accented Parenthesis Deletion

Line 1					*		
Line 0	)	→	Ø	/	*	x*	_

This rule correctly accounts for the behavior of words like [a-p^{h}ə́ʃ^w] 'lip', where the stem-final) is deleted because there are accents to its left, thereby keeping stress on a non-final segment.

(12) Derivations illustrating Accented Parenthesis Deletion

a. Underlying representation

Line 1	*	*	
Line 0	*	*	*)
Segments	a	p^h	ʃ^w

b. Accented Parenthesis Deletion

Line 1	*	*	
Line 0	*	*	*
Segments	a	p^h	ʃ^w

c. Line 0 Head:R

No change

41 The name is used purely descriptively. Note that there is no reference to the stem in the formulation of the rule, which applies equally to any parenthesis in the word which matches the structural description. Additional sources of) parentheses in Abkhaz stress assignment are covered in the discussion of pre-accentuation later in this chapter.

d. Line 1 Clash Resolution

Line 1		*	
Line 0	*	*	*
Segments	a	p^{h}	ʃ^{w}

e. Epenthesis

Line 1			*	
Line 0	*	*	*	*
Segments	a	p^{h}	ə	ʃ^{w}

f. Line 1 Edge:LLL, Head:L and surface representation

Line 2			*	
Line 1			(*	
Line 0	*	*	*	*
Segments	a	p^{h}	ə	ʃ^{w}

Accented Parenthesis Deletion makes a number of unusual predictions. Since parentheses are deleted only if there is an accent to their *left*, we predict that they will be retained and project a Line 1 gridmark if the only accents in the word are to the *right* of the stem. In other words, if the only underlying accent in a word is on a suffix, this analysis predicts that Dybo's Rule is ignored, and that stress will be stem-final instead of falling on the only accented segment in the word. However, this does not apply if the accent of the suffix is immediately adjacent to the stem. In this case the stem-final accent and the suffix accent will be next to each other, which means that clash resolution on Line 1 will remove the stem-final accent, giving stress on the suffix regardless.

The derivations below illustrate these rule interactions, and show that both the exception to Dybo's Rule and the exception to the exception correctly describe the stress behavior of Abkhaz words. These data were also mentioned in Chapter 5, Section 5.7. I show the accented non-human plural suffix /-k^{wh}a/ as having an underlying accent on each of its two segments here. In the discussion of apparent CV units in Abkhaz accentuation below I motivate rules which allow it to be represented with an accent on the vowel only.

(13) Derivations of exceptions to Dybo's Rule

a. Underlying representation

Line 1					*
Line 0	*	*	*)	*	*
Segments	p^h	t^h	a	k'	g^j

b. Accented Parenthesis Deletion

No change

c. Line 0 Head:R

Line 1			*		*
Line 0	*	*	*)	*	*
Segments	p^h	t^h	a	k'	g^j

d. Line 1 Clash Resolution

No change

e. Epenthesis

Line 1			*			*
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k'	g^j	ə

f. Line 1 Edge:LLL, Head:L and surface representation

Line 2			*			
Line 1			(*			*
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k'	g^j	ə

(14)

a. Underlying representation

Line 1				*	*	
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k^{wh}	a	k’

b. Accented Parenthesis Deletion

No change

c. Line 0 Head:R

Line 1			*	*	*	
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k^{wh}	a	k’

d. Line 1 Clash Resolution

Line 1					*	
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k^{wh}	a	k’

e. Epenthesis

No change

f. Line 1 Edge:LLL, Head:L and surface representation

Line 2					*	
Line 1					(*	
Line 0	*	*	*)	*	*	*
Segments	p^h	t^h	a	k^{wh}	a	k’

Exceptions to Dybo’s Rule in cases like (13) were noted by Spruit (1986: 43), who claims that these unaccented stems exceptionally have a final accent in these environments, and Trigo (1992: 214) makes a similar assumption. There cannot be an underlying stem-final accent in all two-element words with a stress pattern like [á-p^ht^ha] ‘cloud’. For similarly stressed [á-sas] ‘guest’, the optionality seen in [sasə́-k’]~[sas-k’ə́] ‘one guest’ (Trigo

1992: 204) and other such words (Spruit 1986: 42) is only available for fully unaccented stems (see Chapter 5, Section 5.4).

Unlike previous analyses, the grammar I have given above correctly predicts the exact environments in which these apparent stem-final accents appear, and these predictions fall out from the system used to assign default stem-final stress. Having illustrated the ability of this analysis to predict previously mysterious generalizations, I now turn to the elephant in the room for a segmental analysis of stress: why does a CV sequence seemingly behave as a unit in Abkhaz? The stem-final parentheses discussed above will be useful in predicting some exceptional CV behavior, and they will also be used in the analysis of pre-accentuation later in this chapter.

7.3 CV units in a segmental analysis

Before delving further into the analysis of other aspects of Abkhaz stress assignment it is worth discussing in some detail the consequences of adopting a segmental theory of stress. The metrical rules manipulating gridmarks and parentheses discussed above are similar to those in typological work on stress assignment, but allowing each segment to carry underlying accents is novel. In particular, all analyses following Spruit (1986) have a privileged role for the CV unit, whether it is called an element, a syllable, or a mora. A segmental analysis challenges this idea, and treats both the CV sequence in (15) a. and the CC sequence in (15) b. as having two accentual specifications.

(15) Representation of CV and CC sequences

a.	*	*	b.	*	*
	C	V		C	C

Without modifications such representations lead to multiple incorrect predictions, illustrated here with data repeated from Chapter 6. Each CV stem has one of two possible stress patterns (16) a., while each CC stem has one of three possible patterns (16) b., suggesting that they differ in their number of accent specifications.

(16) Absence of parallelism between CV and CC stems (corpus data)

a.

i. /la/
[a-lá]~[lá-k’]
‘dog’

ii. /la/
[á-la]~[lá-k’]
‘eye’

b.

i. /ʃʷʃ/
[a-ʃʷʃə́]~[ʃʷʃə́-k’]
‘storm cloud’

ii. /q’z/
[a-q’ə́z]~[q’ə́z-k’]
‘goose’

iii. /χʲʃ/
[á-χʲʃ]~[χʲʃə́-k’]
‘hawk’

Allowing a CV sequence to contain two accent specifications also predicts the existence of an additional type of stress alternation on stems which begin CVC. If only the vowel in such a stem is accented, it is possible to generate a definite-indefinite alternation [á-CVC]~[CV́C-k’], as shown in (17). Such alternations between prefix and stem-initial stress are very poorly attested, and it seems preferable to analyze the few cases that do occur using suppletive allomorphy rather than regular stress assignment (see Chapter 6, Sections 6.1.7-6.1.9 for discussion). In (17) the surface representations are those which arise when applying the rules defined above.

(17) Generating poorly attested stress patterns

a. Definite

i. Underlying representation

Line 1	*		*	
Line 0	*	*	*	*
Segments	a	C	V	C

ii. Surface representation

Line 2	*			
Line 1	(*		*	
Line 0	*	*	*	*
Segments	a	C	V	C

b. Indefinite

i. Underlying representation

Line 1		*		
Line 0	*	*	*	*
Segments	C	V	C	k’

ii. Surface representation

Line 2		*		
Line 1		(*		
Line 0	*	*	*	*
Segments	C	V	C	k’

I propose to resolve both of these problems by introducing readjustment rules which apply to representations where a C and an immediately following V differ in accent specifications. The rules are given in (18) below. After these rules have applied, all CV sequences will project to the same height in the grid. By ordering the readjustment rules before stress assignment, derivations like those in (17) will never occur, because their inputs will already have been readjusted. This gives the impression that they behave metrically as a unit, giving rise to the alternations which have led people to postulate a single element, mora, or syllable in these cases. Underlying representations /CV́/, /ĆV/, and /ĆV́/ will all be treated as if they were a single accentual unit. In Chapter 8, Sections 8.2.2-8.2.3 I will show a moraic analysis of Abkhaz stress which has the same property.

(18) Readjustment rules

a.

Line 1	Ø → * /	*	_
Line 0		*	*
Segments		C	V

b.

Line 1	Ø → * /	_	*
Line 0		*	*
Segments		C	V

It would be suspiciously convenient if these rules only served to create apparent CV units in stems, just before any metrical rules would have allowed us to see their (incorrectly predicted) effects on Abkhaz stress. However, both of the rules in (18), and their application before metrically sensitive rules like schwa epenthesis and stress assignment, are independently motivated. By virtue of containing many single-segment morphemes, polymorphemic words in Abkhaz regularly contain /C-V/ sequences where the C and V have different accent specifications.[42] Such sequences are readjusted by the rules in (18),

42 This fact was used to design stimuli for the phonetic experiment on stress alignment in /CV/ sequences in Chapter 3, Section 3.3.

and it can be shown that not applying the readjustment rules would lead to incorrect surface representations.

In (19) and (20) I show derivations which illustrate both types of readjustment. In each case the correct surface forms are obtained only if readjustment rules precede the metrical rules discussed earlier in this section. In /ś-an/ [sán], readjustment and subsequent hiatus resolution must remove the accent from the consonant so that schwa epenthesis does not apply. Note that the stress shift rule, which shifts a gridmark from a consonant to a vowel, cannot be invoked to bleed schwa epenthesis, since it crucially follows the epenthesis rule. Columns in which a change has been made are bolded.

(19) Independent evidence for readjustment rules

сан
[sán], *[sə́an]
/ś-an/
1S.POSS-mother
'my mother'
Yanagisawa (2010: 302)

a. Underlying representation

Line 1	*		
Line 0	*	*	*
Segments	s	a	n

b.i Without readjustment

No change

b.ii With readjustment

Line 1	*	*****	
Line 0	*	*****	*
Segments	s	**a**	n

c.i Clash Resolution

No change

c.ii Clash Resolution

Line 1		*	
Line 0	*****	*	*
Segments	**s**	a	n

d.i	Epenthesis				d.ii	Epenthesis		
Line 1		*				No change		
Line 0	*	*	*	*				
Segments	**s**	**ə**	a	n				

e.i	Projection to Line 2				e.ii	Projection to Line 2		
Line 2		*			Line 2		*	
Line 1		(*			Line 1		(*	
Line 0	*	*	*	*	Line 0	*	*	*
Segments	s	**ə**	a	n	Segments	s	**a**	n

In (20) I show that readjustment is also necessary when it is the vowel which bears the underlying accent, here in the /m-á/ sequence. The effect is seen clearly in the differing locations of primary stress predicted with and without readjustment rules. I do not show the application of later phonological rules, such as unstressed schwa epenthesis in what would otherwise be an initial triconsonantal cluster *[dlm] (see Chapter 4, Section 4.1), nor the change of /a/ to [e] before [j] (see Chapter 1, Section 1.3.2).

(20) Independent evidence for readjustment rules

[dəlmák^{wh}p^{h}ejt’], *[dlə́mak^{wh}p^{h}ejt’]
/d-l-m-a-k^{wh}-p^{h}a-jt’/
3SHA-2SFO-NEG-DAT-PREV(on)-jump-DYN.FIN[43]
‘(S)he fought against her’
Yanagisawa (2010: 234)

43 The affix order in this form is unexpected, since the negative prefix usually appears between the preverb and the stem. Yanagisawa (2010: 234) also gives this as an option: [d-l-á-k^{wh}ə-m-p^{h}e-jt’]. The affix order I cite would be expected if this preverb-stem combination has been lexicalized as a new stem /k^{wh}p^{h}a/ ‘fight (against)’. This does not affect the argument, and the same point about readjustment holds for preverbless stems that also use the dative morpheme, such as /χ^{w}t^{h}-χ^{w}t^{h}/ ‘whisper to’, /t͡s^{h}lab/ ‘compete with’, /t͡ʃ^{wh}aʒ^{w}a/ ‘talk to’, or /t͡ʃ^{wh}ħa/ ‘scold’ (Yanagisawa 2010: 482, 495, 502-503, 508-509 respectively).

a. Underlying representation

Line 1		*		*					
Line 0	*	*	*	*	*	*	*	*	*
Segments	d	l	m	a	k^{wh}	p^h	a	j	t’

b.i Without readjustment

No change

c.i Line 1 Clash Resolution

No change

d.i Epenthesis

Line 1			*		*					
Line 0	*	*	*	*	*	*	*	*	*	*
Segments	d	**l**	**ə**	m	a	k^{wh}	p^h	a	j	t’

e.i Line 1 Edge:LLL, Head:L and surface representation

Line 2			*							
Line 1			**(***		*					
Line 0	*	*	*	*	*	*	*	*	*	*
Segments	d	l	**ə**	m	a	k^{wh}	p^h	a	j	t’

b.ii With readjustment

Line 1		*	*	*					
Line 0	*	*	*	*	*	*	*	*	*
Segments	d	l	**m**	a	k^{wh}	p^h	a	j	t’

c.ii Line 1 Clash Resolution

Line 1				*					
Line 0	*	*	*	*	*	*	*	*	*
Segments	d	**l**	**m**	a	k^{wh}	p^h	a	j	t’

d.ii Epenthesis

No change

e.ii Line 1 Edge:LLL, Head:L and surface representation

Line 2				*					
Line 1				(*					
Line 0	*	*	*	*	*	*	*	*	*
Segments	d	l	m	**a**	k^{wh}	p^{h}	a	j	t’

The fact that polymorphemic forms require readjustment has the distinct advantage of allowing a child to learn that the readjustment rules are a part of their language. They do not have to infer that stems are readjusted from the absence of certain patterns of stress alternation. Instead, assuming that they have learned the accentual status of common grammatical prefixes, they can deduce that readjustment rules must have applied to yield the forms that they hear in relatively common Abkhaz words like ‘my mother’ or ‘you didn’t talk to me’ (see footnote 43 above for this verb stem).

There is one class of apparent counterexamples to the second readjustment rule in (18) b. (i.e. CV́ → ĆV́), where it seems not to apply to a /C-V́/ sequence. It is very important to examine these more closely. If the readjustment rules turn out not to be motivated by the behavior of polymorphemic forms, we would either have to accept the faulty predictions of a segmental theory without readjustment rules, or else relegate readjustment rules to an ad hoc stem-only status which the child would have no positive independent evidence for. These counterexamples arise when combining a noun with a postpositional phrase. In such cases it is clear that the noun, the agreement prefix on the postposition, and the postposition itself all form a single domain for stress assignment and schwa epenthesis (Cvinaria 1987: 62, Arstaa et al. 2014: 375). This is shown below, with a word where all segments are underlyingly accented.

(21) Nouns and postpositional phrases form a domain (Yanagisawa 2010: 582)

a. Noun + postposition as single domain (correct)

аҩнаҿы
[aɥnat͡ʂ’ə́]
/a-ɥn-a-t͡ʂ’/
DEF-house-3SNO-in
‘in the house, at home’

b. Noun + postposition as separate domains (incorrect)

*[aɥnə́ at͡ʂ’ə́]
/a-ɥn a-t͡ʂ’/
DEF-house 3SNO-in
Intended: ‘in the house, at home’

Now consider words like [a-d^{w}k^{jh}án] ‘store, shop’. The final /n/ of the stem must be unaccented, since treating as accented would yield *[ad^{w}k^{jh}anə́]. If an accented /á/ followed this word, the sequence /...n-á.../ should be readjusted by (18) b., placing an accent on the /n/. This would create a long string of successive accents, and Dybo’s Rule should propagate stress through such a string, leading to stress at the right edge of the word, as for ‘in the house’ above. In other words, we expect ‘at the store’, with the same postposition as in (21), to be pronounced *[a-d^{w}k^{jh}an-a-t͡ʂ’ə́] rather than the correct [a-d^{w}k^{jh}án-a-t͡ʂ’ə̀] (Yanagisawa 2010: 110).[44] The correct pronunciation follows only if readjustment does not apply.

However, there is an important difference between [a-d^{w}k^{jh}án-a-t͡ʂ’ə̀] ‘at the store’ without readjustment and [dəlmák^{wh}p^{h}ejt’] ‘(s)he fought against her’ with readjustment in (20). In ‘she fought against her’ the readjustment is between two prefixes, /m-/ ‘NEG’ and /a-/ ‘DAT’, but in ‘at the store’ it would have to apply between a stem /d^{w}k^{jh}an/ and a

44 In Abkhaz the noun and postposition are written as separate words in cases like this, unlike in (21) where they are written as one word. I assume the morphosyntax and phonology-syntax mapping does not differ depending on whether the noun ends in a stressed vowel, and treat this merely as an orthographic effect.

following prefix (sic!) /a-/ ‘3SNO’. Above I showed that several problems in Abkhaz stress assignment are solved by assuming a stem-final categorizer), and the absence of readjustment in ‘at the store’ can be explained in the same way. If we show the stem-final parentheses in the two words under discussion, we have [dəlmák^{wh}p^{h}e)jt’] but [ad^{w}k^{jh}án)at͡ʂ’ə̀]. In fact the absence of a) in the environment for the readjustment rule in (18) b. already predicts that readjustment will be blocked across a stem boundary, which is exactly what we see. Partial derivations with and without a stem-final) are shown in (22).

(22) Derivations illustrating readjustment across stem boundaries

a. Incorrect UR without stem-final)

Line 1	*	*	*	*		*	*
Line 0	*	*	*	*	*	*	*
Segments	a	d^{w}	k^{jh}	a	n	a	t͡ʂ’

i. Readjustment allowed to apply

Line 1	*	*	*	*	*	*	*
Line 0	*	*	*	*	*	*	*
Segments	a	d^{w}	k^{jh}	a	n	a	t͡ʂ’

ii. Incorrect predicted SR

Line 2								*
Line 1								(*
Line 0	*	*	*	*	*	*	*	*
Segments	a	d^{w}	k^{jh}	a	n	a	t͡ʂ’	ə

b. Correct UR with stem-final)

Line 1	*	*	*	*		*	*
Line 0	*	*	*	*	*)	*	*
Segments	a	d^{w}	k^{jh}	a	n	a	t͡ʂ’

i. Readjustment blocked by)

No change

ii. Correct predicted SR

Line 2				*				
Line 1				(*				*
Line 0	*	*	*	*	*	*	*	*
Segments	a	d^w	k^{jh}	a	n	a	t͡ʂ’	ə

Since the rule of Accented Parenthesis Deletion will apply to ‘store’, it is crucial that this rule follow and counterfeed readjustment. The order of the rules proposed thus far is as follows:

Readjustment	ĆV, CV́ → ĆV́
Accented Parenthesis Deletion	Delete) if there is a preceding Line 1 gridmark
Line 0 Head:R	Project the rightmost footed gridmark on Line 0 to Line 1
Line 1 Clash Resolution	Iteratively delete accents which immediately precede accents
Epenthesis	Insert schwa after accented consonants and shift stress to them
Line 1 Edge:LLL, Head:L	Project the leftmost Line 1 gridmark to Line 2

7.4 Deriving exceptional stress assignment

Having seen how apparent CV units can be derived in a segmental theory of stress, we will now turn to the data from Chapter 6, Section 6.3 on pre-accentuation and accentual allomorphy. Based on the grammar with readjustment rules created above, in what follows I treat Spruit’s (1986) accented CV elements as two stress-bearing segments with an accent only on the vowel, e.g. /lá/ ‘dog’, although the Abkhaz-speaking child is equally free to set up underlying /ĺa/ or /ĺá/.

In Chapter 6, Section 6.3 I discussed the following three properties of stress assignment in Abkhaz verbs. I will discuss these largely using the language of Distributed

Morphology (Halle & Marantz 1993), although I hope that what I have to say is not specific to that framework, but can readily be translated into other theories of morphology.

(23) Accentual allomorphy

a. The causative prefix /r-/ is invisible to stress assignment
b. The negative prefix /m-/ is accented in absolutive-oblique verbs without preverbs
c. The negative prefix /m-/ and all ergative prefixes are accented in causatives

As discussed in Kathman (1992: 225-226), (23) a. can easily be modeled by assuming that this morpheme does not associate to a Line 0 gridmark in the lexicon, rendering it extrametrical in the most literal sense of being absent from the metrical representation. All derivations therefore proceed as if the causative were not present, which is the desired result.

(23) b. is a relatively simple type of allomorphy to model, where one needs only to assume that allomorphy can be sensitive to linearly adjacent morphemes. Recall that the Abkhaz verbal template has ...O-PREV-NEG-STEM... if there is no ergative morpheme. This means that oblique prefixes are immediately adjacent to the negative prefix in the relevant verb types, while preverbs intervene between them, blocking the allomorphy. This could be expressed as:

(24) Spellout of negative marker in obliques

Line 1			*				
Line 0			*				
Segments	NEG	↔	m	/	O-[45]	_	-STEM[46]

For (23) c. a similar allomorphy can be written for the negative prefix, since again the allomorphy is between the negative and causative morphemes, which are linearly adjacent in the verbal template: ...A-O-PREV-E-NEG-CAUS-STEM...

(25) Spellout of negative marker in causatives

Line 1			*			
Line 0			*			
Segments	NEG	↔	m	/	_	-CAUS

If none of these conditions are met, default spellout of the negative as unaccented is given by:

(26) Elsewhere spellout of negative marker

Line 0			*
Segments	NEG	↔	m

However, a problem arises for the ergative prefixes in (23) c. There are nine such prefixes for different combinations of person, number, gender, and animacy. It would be surprising if all nine of these independently had two allomorphs which differed in the same way — one being accented and one unaccented — and which only happened to have the same

45 See discussion below for the oblique case morpheme I propose for Abkhaz.

46 I have tried to make the environment as specific as possible, but even including the stem to the right here is not quite sufficient. This allomorphy must not be allowed to create an accented negative /m-/ in [ji-rә́-m-t^ha-k’^{w}a] ‘not having given it to them’, *[ji-r-mә́-t^ha-k’^{w}a] (Yanagisawa 2010: 405). Presumably this is due to the presence in the trivalent verb ‘give’ of an ergative morpheme between negative /m-/ and the stem /t^ha/. Ergatives are regularly absent in the past absolute construction. However, in the same construction the non-overt ergative sometimes has no impact on stress assignment whatsoever. For example, in [ji-mә́-$ʒ^w$-k’^{w}a] ‘not having drunk it’ (Yanagisawa 2010: 123), the non-overt ergative does not block pre-accentuation (see Chapter 6, Section 6.3 on ergatives blocking pre-accentuation). I have no explanation for why non-overt ergatives are sometimes treated as completely absent, while at other times they affect stress assignment.

morphological conditioning. This is a recurring theme in Abkhaz: all ergatives are accented in causatives, all ergatives become voiced before a stem beginning with a voiced consonant (Aristava et al. 1968: 24, Arstaa & Č̦ʹḳadua 2002: 32-33, Yanagisawa 2013: 163), and in general all prefixes of a given case have the same accentual specification.[47]

This type of behavior, where a natural class of morphemes patterns together, is well-known from work on grammatical tone. Rolle (2018: 1) defines the behavior as a tonal pattern which is "restricted to the context of a specific morpheme or construction, *or a natural class of morphemes or constructions*" (emphasis mine). Tonal or accentual idiosyncrasies can and do arise due to the underlying representations of individual morphemes, and individual morphemes can be spelled out with different allomorphs based on their surrounding morphophonological environment. But it is far from obvious how to represent class behavior which affects multiple morphemes. Consider what Downing & Mtenje (2017: 208) have to say about such patterns based on their study of Chichewa:

(27) Grammatical tone in Chichewa

> Where in the grammar are the grammatical tone patterns represented?
>
> This issue has, surprisingly, received no attention in the literature on Bantu morphosyntax, as far as we know, and relatively little attention in the phonology literature analyzing grammatical tone patterns. (Botne 1990/1 and Hyman 2016 are among the rare exceptions.) As far as we can see, the answer to this question is not obvious since a combination of factors can determine the choice of tone

47 The one exception is that the third-person singular inanimate ergative /a-/ is accented, while other ergative prefixes are unaccented (Spruit 1986: 57).

> pattern. We hope that the data presented in Chapters 7 and 8 and the attention we draw to the issue of grammatical representation in this section will stimulate future research on this topic.

I can only agree that this question is deserving of more theoretical research. Below I will attempt to analyze the Abkhaz situation, although it seems unlikely that the solution I propose for Abkhaz will generalize to other languages. Below I give the 25 person prefixes found in Abkhaz, organized by case.[48] Apart from the fact that they seem to behave in parallel metrically, it is striking how segmentally similar almost all of the affixes are across case categories.

(28) Figure 7.1

Features	Absolutive	Oblique	Ergative
1S	/s-/	/s-/	/s-/
2SM	/w-/	/w-/	/w-/
2SF	/b-/	/b-/	/b-/
3SM	/d-/	/j-/	/j-/
3SF		/l-/	/l-/
3SN	/j-/	/a-/	/a-/
3P		/r-/	/r-/
1P	/ħ-/	/ħ-/	/ħ-/
2P	/ʃʷ-/	/ʃʷ-/	/ʃʷ-/

Person prefixes by case

I propose that both of these unusual similarities can be explained if the morphemes in the table above are decomposed as sequences of two adjacent morphemes. There is only a

48 I do not include here the possessive prefixes which attach to nouns. However, there is some reason to treat these as a fourth category of prefixes, as reflected by the glosses in this dissertation. Even when they appear in verbal complexes, for example when attached to an incorporated noun, they do not undergo the same morphophonological changes as corresponding oblique person prefixes (see Yanagisawa 2013: 302-303 fn. 148), with which they are otherwise homophonous.

single series of nine person markers in Abkhaz, whose underlying forms are those of the oblique and ergative columns. These nine morphemes combine with a segmentally null absolutive, oblique, or ergative case morpheme, which carries only metrical information.[49] The absolutive and ergative case morphemes are unaccented, while the oblique case morpheme is accented. I assume that floating accents dock to the left, as shown in (29) below.

The third-person prefixes have different allomorphs before the absolutive morpheme. One or two additional allomorphies must be proposed. For example, the person prefix /a-/ '3SN' surfaces as /na-/ in some conditions in the environment of an ergative case morpheme, but never in the environment of an oblique case morpheme. And as discussed above, the ergative case morpheme is accented in the environment of this /a-/ '3SN' prefix, while it is unaccented with other prefixes.

(29) Underlying representations of person prefixes

a. Underlying representation of /s-/ '1S' (case-invariant)

Line 0	*
Segments	s

b. Underlying representation of /Ǿ-/ 'O' (person-invariant)

Line 1	*
Line 0	
Segments	

49 Since ergatives surface as voiced before stems which begin with voiced consonants (see main text), it is possible that the ergative morpheme in these situations has an allomorph which also carries a voice feature. I do not pursue this here.

c. Underlying sequence /s-Ǿ-/ ‘1SO’

Line 1		*		*
Line 0	*		→	*
Segments	s	Ø		s

This decomposition predicts that if one of the person prefixes should disappear, its stress will remain. This prediction is borne out by the segmentally null allomorph of /a-/ ‘3SN’, which appears in obliques with a lexically specified class of preverbs which includes /k^{wh}-/ ‘on’.

(30) Accents on segmentally null morphemes

a. With overt prefix

i. Аҵәцақәа аишәақәа ирықәгылоуп
[á-t͡ʃ’^{w}t͡s^{h}a-k^{wh}a áj∫^{w}a-k^{wh}a ji-rə́-k^{wh}-gəlo-wp’]
DEF-glass-N.PL DEF.table-N.PL 3PA-3PO-PREV(on)-stand-STAT.PRES
‘The glasses are standing on the tables’
Yanagisawa (2010: 228)

ii.

Line 1			*					*		
Line 0	...	*		*	...	→	...	*	*	...
Segments		r	Ø	k^{wh}				r	k^{wh}	
		3P	O	PREV(on)						

b. Without overt prefix

i. Аҵәца аишәа иқәгылоуп
[á-t͡ʃ’^{w}t͡s^{h}a áj∫^{w}a jí-Ø-k^{wh}-gəlo-wp’], *...[ji-Ø-k^{wh}-gə́lo-wp’]
DEF-glass DEF.table 3PA-3SNO-PREV(on)-stand-STAT.PRES
‘The glass is standing on the table’
Yanagisawa (2010: 228)

ii.

Line 1				*				*		
Line 0	*				*	...	→	*	*	...
Segments	j	Ø	Ø	Ø	k^{wh}			j	k^{wh}	
	3P	A	3SN	O	PREV(on)					

This decomposition also allows us to explain the final condition of (23) c., that all ergative prefixes become accented in causatives. The single ergative case morpheme in the language becomes accented in this environment, but is unaccented elsewhere. The negative morpheme may intervene between the ergative and the causative, but it does not affect the allomorphy, so it is enclosed in parentheses denoting optionality here.

(31) Spellout of ergative

Line 1			*			
Line 0						
Segments	E	↔	Ø	/	_	(-NEG)-CAUS

Line 1			
Line 0			
Segments	E	↔	Ø

7.5 Pre-accentuation

I turn now to pre-accentuation, where I will also rely on the decomposition of person prefixes. Recall from Chapter 6, Section 6.3 that pre-accentuation applies in the following two contexts:

(32) Generalizations for pre-accentuation

a. In unaccented absolutive-only verbs with one element and no preverbs
b. In non-accent-initial absolutive-only verbs with a causative and no preverbs

Although these contexts are extremely similar to each other, I know of no way of unifying them. I will have to restate (32) a. in terms of segments since I do not use

Spruit's (1986) elements, but I begin with the more straightforward (32) b.

It would be simple to write a spellout rule giving the causative some particular accentual allomorph in the right morphological environment, which is / A-_. Nothing other than the absolutive person prefixes needs to be specified here. The other morphemes which can appear between an absolutive and the causative prefix are obliques, ergatives, the negative prefix, and preverbs. The stipulations "absolutive-only verbs" and "with no preverbs" in (32) b., justified in Chapter 6, Section 6.3, mean that we are right to exclude obliques, ergatives, and any preverbs from the environment of the spellout rule. The negative prefix does give rise to descriptively pre-accenting behavior in causatives, but this follows from the fact that it is independently known to be accented in causatives (see allomorphies already discussed and justification in Chapter 6, Section 6.3). The environment / A-_ therefore seems to be the one in which the causative morpheme triggers pre-accenting behavior. The question is which underlying representation a causative morpheme in this environment could be given to generate pre-accenting behavior.

I argue that the answer once again lies in a) parenthesis on Line 0, in addition to its segmental content /r-/ which does not change. Recall from the discussion above that the default accentual behavior of the causative is being metrically inert, having no representation in the metrical grid. By spelling it out as), pre-accentuation can be generated. The spellout rules for the causative are given below.

(33) Spellout of causative

a. Causative allomorphy

Line 1						
Line 0			)			
Segments	CAUS	↔	r	/	A-	_

b. Default causative spellout

Line 1			
Line 0			
Segments	CAUS	↔	r

The allomorphy for the causative says nothing about the accent status of the stem. Recall the following patterns from Chapter 6, Section 6.3. Unaccented stems are pre-accenting (34) a., as are stems which do not begin with an accent even if they contain one later in the stem (34) b. Stems which do begin with an accent are not pre-accenting (34) c. This is very reminiscent of the patterns for unaccented stems discussed earlier in this section, where only suffixes attached immediately at the end of the stem affect the location of primary stress. Here only accents immediately at the beginning of the stem affect the location of primary stress.

(34) Pre-accentuation in causatives

a. Unaccented /d͡z/ 'disappear' (pre-accenting)

Ирӡ!
[jí-r-d͡z]
/j-r-d͡z/
3NA-CAUS-disappear
'Lose it/them!'
Yanagisawa (2010: 365)

b. Non-initial accent /ʂk’ʷák’ʷa/ ‘white’ (pre-accenting)

Иршкәакәа!
[jí-r-ʂk’ʷak’ʷa]
/j-r-ʂk’ʷák’ʷa/
3NA-CAUS-white
‘Whiten it/them!’
Yanagisawa (2010: 383)

c. Initial accent /t́ʷʰ/ ‘full’ (not pre-accenting, stress assigned by Dybo’s Rule)

Иртәы!
[ji-r-tʷʰə́]
/j-r-t́ʷʰ/
3NA-CAUS-full
‘Fill it/them!’
Yanagisawa (2010: 374)

Below I will show that only one rule needs to be added to account for these patterns. In words like [jí-r-d͡z] ‘Lose it/them!’, the causative will introduce a) parenthesis, as will the stem-final categorizer. The Line 0 Headedness Parameter Head:R will project a Line 1 gridmark for both. These gridmarks will then be adjacent on Line 1, since the intervening causative is metrically invisible because it lacks a Line 0 gridmark, leading to clash resolution and incorrectly predicted final stress: *[ji-r-d͡zə́]. A derivation illustrating all of these points will be shown below for [ji-r-tʷʰə́] ‘Fill it/them!’, where final stress is *correctly* predicted since the stem is accented rather than having an accent introduced by the stem-final categorizing).

In order to account for words like ‘Lose it/them!’, we could modify the Headedness Parameter to project the rightmost head of the leftmost foot only. However, this is not allowed by Idsardi’s (1992) restrictive theory of how gridmarks are projected from one line to the next. When this outcome is desired in other languages, the solution is first to project the rightmost gridmark from all feet (i.e. Head:R), followed by projecting the leftmost footed gridmark on the next line (Head:L). This solution is unavailable in Abkhaz, since Line 1 Clash Resolution removes the leftmost Line 1 gridmark in cases of clash, preventing it from projecting. This is normally desired since it derives Dybo's Rule, but to generate [jí-r-d͡z] 'Lose it/them!' another solution must be found. I introduce the rule Double Parenthesis Deletion for this purpose. It deletes a Line 0 parenthesis preceded on Line 0 by a parenthesis, allowing us to keep Line 1 Head:R in unmodified form.

(35) Double Parenthesis Deletion

Line 0) → Ø /) x* _

The rule must apply before Line 0 Head:R, but is not crucially ordered with respect to Readjustment or Accented Parenthesis Deletion. With the addition of Double Parenthesis Deletion, the segmental grammar of Abkhaz stress assignment is complete. The following is the final inventory of rules, given in the order in which they apply:

Readjustment	ĆV, CV́ → ĆV́
Accented Parenthesis Deletion	Delete) if there is a preceding Line 1 gridmark
Double Parenthesis Deletion	Delete) if there is a preceding)
Line 0 Head:R	Project the rightmost footed gridmark on Line 0 to Line 1
Line 1 Clash Resolution	Iteratively delete accents which immediately precede accents
Epenthesis	Insert schwa after accented consonants and shift stress to them
Line 1 Edge:LLL, Head:L	Project the leftmost Line 1 gridmark to Line 2

Derivations for the three types of causative in (34) are given below. In all cases the causative allomorphy introduces a) parenthesis which projects a Line 1 gridmark. In (36) c. clash resolution on Line 1 deletes this gridmark and allows stress to fall on the stem.

Note that a clash configuration does occur despite the intervening causative, since the parenthesis on Line 0 does not affect adjacency of grid marks on Line1, where clash resolution applies. In (36) a. and b. there is no clash on Line 1 and the accent introduced by the causative) parenthesis is the site of primary stress. Note that these derivations do not show vowel coloring of *[jə] to [ji] (see Chapter 1, Section 1.3.2).

(36) Derivations of causative pre-accentuation

a. Underlying representation

Line 0	*		)	*	)
Segments	j	Ø	r	d͡z	Ø
Gloss	3N	A	CAUS	disappear	VBLZ

i. Readjustment

No change

ii. Accented Parenthesis Deletion

No change

iii. Double Parenthesis Deletion

Line 0	*		)	*
Segments	j	Ø	r	d͡z

iv. Line 0 Head:R

Line 1	*		
Line 0	*	)	*
Segments	j	r	d͡z

v. Line 1 Clash Resolution

No change

vi. Epenthesis

Line 1		*		
Line 0	*	*	)	*
Segments	j	ə	r	d͡z

vii. Line 1 Edge:LLL, Head:L and surface representation

Line 2		*		
Line 1		(*		
Line 0	*	*	)	*
Segments	j	ə	r	d͡z

b. Underlying representation

Line 1						*			
Line 0	*		)	*	*	*	*	*	)
Segments	j	Ø	r	ʂ	k’ʷ	a	k’ʷ	a	Ø
Gloss	3N	A	CAUS	white					VBLZ

i. Readjustment

Line 1				*	*		
Line 0	*	)	*	*	*	*	*)
Segments	j	r	ʂ	k’ʷ	a	k’ʷ	a

ii. Accented Parenthesis Deletion

Line 1				*	*		
Line 0	*	)	*	*	*	*	*
Segments	j	r	ʂ	k’ʷ	a	k’ʷ	a

iii. Double Parenthesis Deletion

No change

iv. Line 0 projection

Line 1	*			*	*		
Line 0	*	)	*	*	*	*	*
Segments	j	r	ʂ	k’ʷ	a	k’ʷ	a

v. Line 1 clash resolution

Line 1	*				*		
Line 0	*	)	*	*	*	*	*
Segments	j	r	ʂ	k’^{w}	a	k’^{w}	a

vi. Epenthesis

Line 1		*				*		
Line 0	*	*	)	*	*	*	*	*
Segments	j	ə	r	ʂ	k’^{w}	a	k’^{w}	a

vii. Line 1 projection and surface representation

Line 2		*						
Line 1		(*				*		
Line 0	*	*	)	*	*	*	*	*
Segments	j	ə	r	ʂ	k’^{w}	a	k’^{w}	a

c. Underlying representation

Line 1				*	
Line 0	*		)	*	)
Segments	j	Ø	r	t^{wh}	Ø
Gloss	3N	A	CAUS	full	VBLZ

i. Readjustment

No change

ii. Accented Parenthesis Deletion

Line 1			*
Line 0	*	)	*
Segments	j	r	t^{wh}

iii. Double Parenthesis Deletion

No change

iv.	Line 0 projection			
Line 1	*		*	
Line 0	*	)	*	
Segments	j	r	t^{wh}	
v.	Line 1 clash resolution			
Line 1			*	
Line 0	*	)	*	
Segments	j	r	t^{wh}	
vi.	Epenthesis			
Line 1				*
Line 0	*	)	*	*
Segments	j	r	t^{wh}	ə
vii.	Line 1 projection			
Line 2				*
Line 1				(*
Line 0	*	)	*	*
Segments	j	r	t^{wh}	ə

I propose that the other condition for pre-accentuation, in (32) a., is accomplished by similar allomorphies introducing right) parentheses. Pre-accentuation outside of causatives can cause stress to fall on an absolutive prefix or on a negative prefix:

(37) Pre-accentuation on non-causatives (Yanagisawa 2010: 583)

a. дыҩны
[də́-ɥ-nə̀]
3SHA-run-PST.ABS
‘him/her having run’

b. дмыҩкәа
[d-mə́-ɥ-k’ʷa]
3SHA-NEG-run-NEG.PST.ABS
‘him/her not having run’

Although this results in a markedly non-unified analysis of pre-accentuation in Abkhaz, both the negative and the segmentally null absolutive case morpheme are subject to very similar allomorphies in the analysis I propose. Both require the stem that follows them to be of the shape C(V), which is how I rewrite 'with one element' in a segmental grammar. These are examples of phonologically conditioned allomorphy, where I make use of the fact that stems are suffixed with). Note that this requires the stem and the stem-final categorizer to have been spelled out before the absolutive and negative prefix. This is consistent with the observation that suffixes are more closely integrated with stems they attach to than prefixes are (Nespor & Vogel 1986, Peperkamp 1997).[50]

(38) Spellout of absolutive and negative

a. Absolutive allomorphy

Line 1								
Line 0			)			*	*	)
Segments	A	↔	Ø	/	_	C	(V)	

b. Negative allomorphy

Line 1								
Line 0			)			*	*	)
Segments	NEG	↔	Ø	/	_	C	(V)	

(38) a. generates pre-accentuation in (37) a., and (38) b. in (37) b., in much the same way as has already been shown for causative pre-accentuation above. The fact that this analysis uses multiple allomorphies which are nearly identical is a significant drawback. If stress falls immediately before the stem, it would be preferable to encode this as a fact about the stem rather than the prefixes which attach to it. Such an analysis is possible if

50 If stems merge with a categorizer as the first step of the syntactic derivation in Abkhaz, the prefix-suffix asymmetry may fall out if spellout "is cyclic at the phase level" (Chomsky 2001: 9), although I will not speculate on the phasal structure of highly agglutinative Abkhaz verbal complexes here.

some stems are pre-accenting and others are not, but this is not the situation found in Abkhaz. All stems are pre-accenting when they meet the morphophonological requirements discussed in Chapter 6, and the same stems cease to be pre-accenting if any requirement is not met. Pre-accentuation is not a fact about stem morphemes, but a fact about particular constructions and verb types. I repeat the data from Chapter 6, Section 6.3 showing that the stem /laş̧a/ 'shine' is pre-accenting in causatives (39) a., but not outside of causatives (39) b.

(39) Stress alternations depending on causativity

a. Ирлаша!
[jí-r-laşa]
3NA-CAUS-shine
'Illuminate it/them!'
Yanagisawa (2010: 368)

b. Блаша!
[b-laşá]
2SFA-shine
'Shine!'
Yanagisawa (2010: 272)

Above I discussed the difficulties in generating such patterns for grammatical tone, difficulties which I proposed to resolve for person prefixes by decomposing them into multiple morphemes. I am not aware of any reason to favor a similar decomposition of Abkhaz verb stems. Nor is it sensible to propose that all Abkhaz verb stems have two allomorphs, one with a preceding right) parenthesis for pre-accentuation and one without. It would be better if stems in the right morphological context for pre-accentuation could be spelled out twice, first STEM ↔)STEM adding a parenthesis, and then again to fill in the stem's segmental and metrical content.

An analysis with cophonologies (Orgun 1996, Anttila 1997 among others; see Inkelas & Zoll 2007 for an overview and evaluation) could operate with a pre-accenting grammar and a separate grammar for Dybo's Rule, but the problem remains of deciding what triggers which cophonology. No individual morpheme or prosodic boundary appears to be responsible, and it is a cluster of morphophonological properties from different morphemes which combine to yield pre-accentuation. I am the first to admit that the analysis I use is far from elegant, and I am sure many improvements can be made. The argument in favor of the analysis is that it sidesteps the problems outlined above, relies only on phonologically conditioned allomorphy, and that it generates the data.

The allomorphies above make no reference to the accent status of the stem. In particular, since the representation of an unaccented segment is a subset of the representation of an accented segment (missing a Line 1 gridmark), I assume that the allomorphies in (38) target accented and unaccented stems alike. Since pre-accentuation only affects unaccented stems, this seems problematic, but just as for the causatives the allomorphy is sufficient when combined with the regular stress assignment rules already discussed. Below is a derivation for the past absolute of the unaccented stem /ɰ/ 'run', where pre-accentuation overrides the demands of the lexically accented past absolute suffix. Crucially, Double Parenthesis Deletion applies to ensure that this unaccented stem does not project a Line 1 gridmark. After this is a derivation for the same form of the accented stem /t͡sʰa/ 'go', where Dybo's Rule applies as usual, despite the additional parenthesis introduced by allomorphy of the absolutive case morpheme.

(40) Derivation of non-causative pre-accentuation

a. Underlying representation

Line 1					*
Line 0	*	)	*	)	*
Segments	d	Ø	ɥ	Ø	n
Gloss	3SH	A	run	VBLZ	PST.ABS

i. Readjustment

No change

ii. Accented Parenthesis Deletion

No change

iii. Double Parenthesis Deletion

Line 1				*
Line 0	*	)	*	*
Segments	d		ɥ	n

iv. Line 0 projection

Line 1	*			*
Line 0	*	)	*	*
Segments	d		ɥ	n

v. Line 1 clash resolution

No change

vi. Epenthesis

Line 1		*				*
Line 0	*	*	)	*	*	*
Segments	d	ə		ɥ	n	ə

vii. Line 1 projection and surface representation

Line 2		*				
Line 1		(*				*
Line 0	*	*	)	*	*	*
Segments	d	ə		ɥ	n	ə

b. Underlying representation

Line 1				*		*
Line 0	*	)	*	*	)	*
Segments	d	Ø	t͡sʰ	a	Ø	n
Gloss	3SH	A	go		VBLZ	PST.ABS

i. Readjustment

Line 1			*	*		*
Line 0	*	)	*	*	)	*
Segments	d		t͡sʰ	a		n

ii. Accented Parenthesis Deletion

Line 1			*	*	*
Line 0	*	)	*	*	*
Segments	d		t͡sʰ	a	n

iii. Double Parenthesis Deletion

No change

iv. Line 0 projection

Line 1	*		*	*	*
Line 0	*	)	*	*	*
Segments	d		t͡sʰ	a	n

v. Line 1 clash resolution

Line 1					*
Line 0	*	)	*	*	*
Segments	d		t͡sʰ	a	n

vi. Epenthesis

Line 1						*
Line 0	*	)	*	*	*	*
Segments	d		t͡sʰ	a	n	ə

vii. Line 1 projection and surface representation

Line 2						*
Line 1						(*
Line 0	*	)	*	*	*	*
Segments	d		t͡s^{h}	a	n	ə

I have now shown how the segmental grammar assigns stress in Abkhaz in a wide variety of morphological and phonological contexts, and it is time to summarize the lessons learned about Abkhaz in this chapter.

7.6 Conclusions

The segmental grammar that I have developed in this chapter uses seven rules to assign primary and secondary stress, including default stem-final stress, and also captures pre-accentuation and stress-conditioned schwa epenthesis. It accomplishes this by readjustment rules for CV sequences, clash resolution to ensure that not all accented segments are stressed on the surface, and rules for which feet project gridmarks to the next line of the grid. Underlying parentheses are responsible for pre-accentuation and default stem-final stress, with some rules deleting parentheses to ensure that these methods of stress assignment do not overapply.

The analysis accounts for several exceptions to Dybo’s Rule, and even exceptions to those exceptions. All rules are sensitive only to phonological information, and do not make direct reference to morphosyntactic entities like ‘stem’ or ‘causative’. The analysis uses only edge marking and headedness parameters from Idsardi (1992) to determine the projection of gridmarks. The analysis begins with unprosodified underlying representations, and there is no need to first go through a multi-step derivation to create prosodic units such as moras.

There are, of course, significant drawbacks to the segmental analysis. Many of the allomorphies I propose are relatively ad hoc, and there is no unity in the analysis of pre-accentuation. I rely crucially on several assumptions about Abkhaz morphology, including the decomposition of person markers and the existence of stem-final categorizers. Such morphemes are often segmentally null and have unusual underlying representations in the analysis I have proposed. These aspects of the analysis are tentative and warrant more research. I have justified the more controversial assumptions with their ability to correctly predict many of the intricacies of Abkhaz stress assignment.

However, the most obvious point of controversy is the fact that underlying accents are on individual consonants and vowels, and that all stress computation is done directly with segments. This undermines the allegedly universal importance of the syllable in stress assignment, and I have not even replaced it with another prosodic unit like the mora. Despite the reliance on segments, there are traces of some prosodic unit in the form of readjustment rules for CV sequences, and I have occasionally used segmental workarounds for cases where it would have been simpler notationally to refer to language-specific 'elements' in the sense of Spruit (1986). The next chapter is devoted entirely to alternative analyses of Abkhaz stress assignment, with discussion of both syllabic and moraic approaches. I develop a moraic analysis based on feet without metrical grids. I argue that both theoretical and empirical drawbacks abound in analyses which rely on prosodic units, so that the evidence favors the segmental analysis presented in this chapter.

Chapter 8: Alternative Analyses with Prosodic Units

In the previous chapter I provided a detailed analysis of Abkhaz stress assignment which makes direct reference to segments. In this chapter I discuss alternative analyses which instead make reference to prosodic units, including syllables and moras. I discuss evidence for syllables from native speaker intuition as well as poetry and music, evidence which converges on syllables much larger than the units relevant in Abkhaz stress assignment. I show that attempting to use these large syllables to assign stress fails to account for more than 40% of stress alternations in the nominal corpus. Most of the chapter is therefore devoted to pursuing a moraic analysis of Abkhaz stress, which relies on metrical feet. This analysis keeps Spruit's (1986) 'elements' from Chapter 6 intact, but argues that these units, which are often CV or C in size, are moras. I argue that like previous moraic analyses of Abkhaz (Kathman 1992, Vaux & Samuels 2018), the moraic analysis is empirically successful, but suffers from several theoretical drawbacks.

A moraic analysis must admit up to six moras in a single syllable, twice as many as the three (and in many languages only two) moras which are typologically recognized as the crosslinguistic maximum. Many of these moras must also dominate only onset consonants, an impossibility in several models of moraic syllabification. Moreover, the distribution of onset moras in Abkhaz is different from that of other languages argued to have moraic onsets. Finally, I show that building moraic feet which capture the core patterns of Abkhaz stress assignment inevitably leads to violations of syllable integrity. Abkhaz has monosyllabic words with different patterns of stress alternation, and this requires foot boundaries which split these monosyllables down the middle. I argue that these theoretical problems remain even if no prosodic constraints are violated in surface representations, and that underlying moras do not improve the analysis.

These arguments strengthen the case for a segmental analysis of Abkhaz stress, such as that provided in the previous chapter. However, as in the analysis of any complex phenomenon, there are analytical choices at every step where I have taken one decision and where other linguists may have preferred other decisions. The moraic analysis I develop is the first to use feet rather than metrical grids, and although I make reference to work which goes beyond Dybo's Rule, a fully worked out moraic theory which includes pre-accentuation and other details has yet to be provided. I argue in this chapter that the moraic analysis faces significant drawbacks even when only Dybo's Rule is considered, but it may be the case that some of these problems are alleviated if additional data on pre-accentuation and morphological exceptions are taken into account.

This chapter is structured as follows. In Section 8.1 I discuss syllabic analyses of Abkhaz, and introduce evidence from speaker intuition and metrics which argues against treating Spruit's (1986) 'elements' as syllables. I also show that the syllables which emerge from such pieces of evidence are unsuitable as stress-bearing units in Abkhaz, failing to explain 40% of nominal stress alternations. I turn to the mora as stress-bearing unit in Section 8.2, developing a foot-based analysis and discussing previous analyses in some detail. I focus on theoretical drawbacks concerning the relationship between moras and syllables in these analyses. Several proposed prosodic universals are violated, either in surface representations or at earlier stages of the derivation in serial theories. Section 8.3 offers concluding thoughts.

8.1 Syllabic stress

8.1.1 Background

There is a strong typological connection between stress and the syllable. Hayes (1995: 49) says that it is universally the case that in a word with two syllables, there can be at most two possibilities for stress: either on the first syllable or on the second. This amounts to saying that the stress-bearing unit is the syllable in all languages which have stress. In this respect Hayes (1995) disagrees with Halle & Vergnaud (1987) who allow stress to fall on different-sized units, including the mora, on a language-specific basis. Hyman (2006) agrees with Hayes (1995), proposing that syllable-dependency is a definitional property of word stress. Other word-level prosodic phenomena like tone may be sensitive to other units like moras (or perhaps even the segment; Andersson 2021). But for Hyman (2006), unless the syllable is the relevant prosody-bearing unit the phenomenon in question definitionally cannot be stress. Based on this typological perspective on the importance of the syllable in stress systems, it is appropriate to begin by considering Trigo's (1992) analysis of Abkhaz where Spruit's (1986) elements are reanalyzed as syllables.

8.1.2 Elements as syllables

Recall from Chapter 6 that in Spruit's (1986) analysis of Abkhaz, an 'element' is a language-specific unit, often with the shape C or CV. Trigo's (1992) analysis of Abkhaz stress accepts the prosodifications that elements entail, but instead of using the language-specific label 'element', Trigo (1992) treats the relevant units as syllables. This means that at least in terms of representations, Trigo's account is identical to Spruit's, albeit with a different label for the prosodically relevant unit. However, Trigo (1992) also advances the understanding of Abkhaz stress assignment considerably by discussing in detail several classes of exceptions to Dybo’s Rule and how they can be analyzed by splitting up the unitary “Dybo’s Rule” into three separate phonological rules.

Note that the commitment to elements-as-syllables entails accepting many vowelless syllables in Abkhaz, since many ‘elements’ consist of only a single consonant: “[O]ne must assume that every consonant in Abkhaz is capable of bearing stress i.e., that every consonant is underlyingly syllabic” (Trigo 1992: 196). The phrase ‘every consonant’ here refers to consonant phonemes (types) rather than consonants in individual words (tokens). The use of elements means that immediately pre-vocalic consonants, for example, are not syllabic in Trigo’s (1992) analysis, but all consonants which occur in other environments are. A word like [ap^{h}ħ^{w}ə́s] ‘woman’ therefore consists of four syllables /a/, /p^{h}/, /ħ^{w}/ (the schwa being epenthesized), and /s/ (Trigo 1992: 198). Such syllabifications are reminiscent of analyses of Imdlawn Tashlhiyt Berber words like [ra.tk̩.ti] ‘she will remember’ (Dell & Elmedlaoui 1985: 113), or indeed [t͡s̩’.k̩.ts̩.k̩^{w}.t͡s̩’] ‘he arrived’ in some analyses of Nuxalk (see discussion of alternative syllabifications in Bagemihl 1991: 593).

Trigo’s (1992) analysis maintains the typologically motivated connection between stress and syllables which is made explicit in work discussed above, such as Hayes (1995) and Hyman (2006). Although this may be desirable, there are several arguments against treating elements as syllables in Abkhaz: it does not agree with syllabifications given by native speakers, and it does not agree with syllabifications inferrable from Abkhaz poetry and music. I also discuss segmental phonological processes which appear to be sensitive to syllable structure, and which may favor larger syllables than those proposed by Trigo (1992). These sources of information suggest that Abkhaz syllables obligatorily have a vocalic nucleus, with consonants always occuping either onset or coda position even when this results in long clusters. The evidence is discussed in the next subsection.

8.1.3 Evidence concerning syllables in Abkhaz

Several works describe Abkhaz syllabification, and there is broad consensus on many of the details. Syllabifications with vowels as the only nuclei are found in Hewitt's work, even when this results in sonorant-obstruent onset clusters as in monosyllabic [mʈ͡ʂ'ə́k'] 'one piece of wood' (Hewitt 1979: 262-263). Arkadiev & Lander (2021: 379) also claim that clusters of this type involve "non-syllabic sonorants" in Abkhaz and closely related Abaza. Spruit (1986: 83) is the only work I am aware of which has syllabic sonorants in this position, where he gives as an example disyllabic [m̩.tʰák'] 'one present'. Some work on varieties of Abkhaz other than Abzhywa have reported the presence of syllabic consonants. Andersson et al. (2023) discuss Cwyzhy Abkhaz forms like [ʒ̩ʲk']~[ʒʲə́k'] 'one piece of meat'. Bruening (1997), also working on Cwyzhy Abkhaz, argues that this variety lacks complex clusters entirely, with a combination of syllabic consonants and epenthetic non-moraic vowels being used to analyze long strings of consonants.

Since none of these claims about syllabification have been made by native speakers of Abkhaz, it may be helpful to examine what native speakers say about syllabification. Aristava et al. (1968: 25) write that "[a]s in other languages, the sounds which make syllables in Abkhaz are vowels"[51]. They therefore have a bisyllabic [am.ʂə́n]

51 Russian original: "Как и в других языках, в роли слогообразующих звуков в абхазском языке

‘sea’ (Aristava et al. 1968: 25) rather than a form with four syllables required by Trigo’s (1992) analysis: [a.m.ʂə́.n]. More recently Arstaa et al. (2014: 94) write that “[i]n the Abkhaz language the vowels **a, ə, e, o** make a syllable”[52] (bolding in original; Arstaa et al. 2014: 92), with separate discussion of the dual nature of [j], [i] and [w], [u]. In their list of possible syllable shapes one finds monosyllabic example words like [ámt͡sʰχʷ]‘surplus, redundant’, [pʰstʰħʷák’] ‘one storm cloud’, [dámsχt’] ‘I took him/her from it’, and [pʰslə́md͡zk’] ‘one grain of sand’. There is not much discussion of long medial clusters in the literature (pace Cvinaria 1987: 70-71), but VCCV is generally syllabified as VC.CV (Aristava et al. 1968: 25, Hewitt 1979: 262, Cvinaria 1987: 70).

This corresponds well with intuitions from non-linguists that I have come across when working on Abkhaz. For example, when I pointed out to an Abkhaz speaker that the word ‘five’ sounds almost disyllabic [χʷu.bá], he insisted that [χʷbá] has only a single beat. This is despite the presence of a range of factors which might lead one to expect a disyllabic parse: i) the cluster violates the sonority sequencing principle, ii) the cluster disagrees in voicing, iii) the cluster disagrees in secondary articulation of the consonants, and iv) there is a transparent morpheme boundary between /χʷ-/ ‘five’ and /-ba/ ‘non-human numeral’. Arstaa et al. (2014: 94) also give this same word as monosyllabic. Cvinaria (1987: 68-69) expresses some doubts about the syllabification of some numerals with consonant clusters, but concludes that when there is an extra syllable there is also an unstressed schwa: [bʒbá]~[bəʒbá] ‘seven’. The intuition of Abkhaz speakers is clear that all Abkhaz syllables, at least in the Abzhywa dialect studied in this dissertation, have vocalic nuclei.

выступают гласные”, my translation.

52 Abkhaz original: “Аԥсуа бызшәаҿы ацыра ҟарцоит абжьыҟақәа **а, ы, е, о**.”, my translation.

The same syllable types that native speakers describe, with obligatory vowels and long consonant clusters, are also the units found in Abkhaz poetry and music. Generative linguistic analyses of metrics have a long history (see Halle & Keyser 1966 for an early influential paper, and Blumenfeld 2016 for a recent overview). Examples from Moroccan Arabic and English will illustrate how poetry can give insight into syllable structure. In English /sk/ clusters are perceived by native speakers to form complex onsets, and this is readily observed in syllable-counting meters, as in the following line of iambic pentameter from William Wordsworth. Below W stands for a metrically weak syllable, S for a metrically strong syllable, and ( ) parentheses enclose metrical feet. Note that if ‘scorn’ were parsed with disyllabic [s.k] the line would no longer form five iambs.

(1) A line from William Wordsworth

Scorn	not	the	Son-	net,	Cri-	tic;	you	have	frowned,
(W	S)	(W	S)	(W	S)	(W	S)	(W	S)

By contrast, the similar cluster /sq/ in Moroccan Arabic behaves metrically in the exact opposite way to English /sk/. Below is a line from ‘the qˤsˤiˤdˤaˤ of Muni’ (Al-Fassi 1997: 5-6), where lines follow the metrical pattern WWWSSWW. Note that [s.q] must be treated as disyllabic for this line to scan.

(2) A line from the qˤsˤiˤdˤaˤ of Muni (Dell & Elmedlaoui 2002: 255)

s-	qa-	ni	kas	men mˤ-	rˤaˤ-	rˤaˤ
W	W	W	S	S	W	W

‘He has handed me a cup of bitterness’

The metrifications found in Abkhaz poetry and music are decidedly English-like, and never show vowelless parses of consonant clusters as in Moroccan Arabic. The verse below, from which I have removed a refrain of nonsense syllables which occurs between each line in the original, illustrates possibilities for complex onsets. There is no regular alternation between stressed and unstressed syllables, but each line has four syllables before a pause (caesura, marked by ‖), and four syllables after it according to Kogonia (2019: 306-307). In the second line, a schwa is elided due to poetic hiatus resolution rules (which I have marked with the symbol ‿), for which see Cvinaria (1987: 66). The meter only guarantees the number of syllables and not the location of syllable boundaries, but it is the number of syllables that is of interest. For purposes of presentation I have applied the syllabification criteria from Hewitt (1979: 262-263) to determine the location of syllable boundaries. I have modernized the orthography, and supplied word stresses based on dictionary sources.

(3) A metrified Abkhaz poem (Kogonia 2019: 306-307)

[ʃəb.	ʒón	də́.	t͡ʃ^{wh}ojt’	‖
Шьыбжьон		дыцәоит,		
noon		she.falls.asleep		
t͡ʃ^{wh}ə́ʃ.	t^{h}ən	dgə́.	lojt’]	
цәышьҭын		дгылоит		
sunset		she.gets.up		
[sák^{wh}.	lej	t͡ʃ’^{w}áp^{h}ʃ.	lej	‖
Сақәлеи		ҵәапшьлеи,		
and.with.powder		and.with.lipstick		
lχə	lt͡ʂ’‿ej.	bə́.	t^{h}owp’]	
лхы-лҿы		еибыҭоуп		
her.head her.mouth		are.assembled		
[lə́χ^{w}.	da	t^{h}ə́χ.	nə	‖
Лыхәда		ҭыхны,		
her.collar		dipping		

lmaʁ. rá χt͡ʃʼʷa. nə́]
лмаґра хцәаны
her.sleeve being.cut

‘She falls asleep at noon, she gets up at sunset.
Her make-up is on, both powder and lipstick,
In a low-cut top with short sleeves.’

This poem illustrates tautosyllabic parses of word-initial clusters with falling sonority, such as [lχ] and [lm], where the poem would not scan if these clusters involved a syllabic lateral. Other complex onsets are [dg] and [χt͡ʃʼʷ]. In [t͡ʃʼʷápʰʃ.lej] ‘and with lipstick’, the medial CCC cluster is divided between onset and coda, instead of a trisyllabic parse like *[t͡ʃʼʷá.pʰʃ̩.lej].

Another example of complex consonant clusters comes from a poem by D. Gulia. In the couplet below each line consists of two iambs (Cvinaria 1987: 160). As above, [pʰʃ] is treated as a complex coda in line 1, and not as a syllable of its own, despite the rising sonority. Line 2 illustrates a CCC coda cluster in the syllable [t͡ʃʷʰə́rt͡sʼtʼ]. Again the syllabification of these forms is guaranteed by the requirements of the meter, and they would not scan with alternative syllabic parses.

(4) From a poem by D. Gulia (Cvinaria 1987: 160)

[a. ʃʷápʰʃ qʼapʰʃ. d͡zá]
Ашәапшь ҟапшьӡа
dawn/glow very.red

[jaa. t͡ʃʷʰə́rt͡sʼtʼ ʃəʒ. d͡zá]
Иаацәырҵт шьыжьӡа
it.rose.up early.morning

‘The blushing morning glow
Came rising up at dawn.’

The same patterns of metrification are found in traditional Abkhaz music. The example below comes from the ‘Song of Nart Sasryq°a’, a hero in the North Caucasian epic, the Nart sagas. The metrification comes from the number of notes on which each word is sung in the accompanying sheet music, and the locations of the syllable boundaries from the typesetting of the lyrics. Note the presence of both complex onsets [bs], [p^{h}χ], [rt], and the complex coda [jt’]. I have removed the meaningless syllables [a.ħa.ħa.ħa] from Line 2.

(5) From the Song of Nart Sasryq̣°a (Aš°ba 1986: 54)

[sán	sán	bsə́r.	p^{h}χa.	ʃar.	ħ^{w}a	bəm.	ʃ^{w}án]
Сан	сан	бсырпхашьарҳəа				бымшəан,	
my.mother	my.mother	that.I.embarrass.you				do.not.fear	

‘Mother, fear not, don’t be ashamed!’

səm.	ɥa.	χ^{w}ás.	t^{h}a.	k^{wh}a	rt^{h}ə́p^{h}	g^{w}ás.	t^{h}ojt’]
Сымҩахəасҭақəа					рҭып	гəасҭоит	
my.paths					their.place	I.pay.attention.to	

‘I know where the road bends and turns.’

As a final consideration in the discussion of elements as syllables, I will mention certain segmental phonological processes which have a straightforward explanation if syllables are large enough to include codas, contra Trigo (1992). In Chapter 1, Section 1.3.2 I described a process of vowel coloring by adjacent glides, whereby /aj, aw/ → [ej, ow] respectively (Arstaa & Č̣’ḳadua 2002: 23-29, Jakovlev 2006: 306, O’Herin 2021: 453-454). This process only applies when the glides stand before a word boundary (i.) or another consonant (ii.). Before a vowel (iii.), vowel coloring does not apply (Hewitt 2010: 13).

(6) Vowel coloring

a. /aw/ → [ow]

i. /j-q’**a-w**/
[jí-q’**o-w**]
A.REL-be-STAT
‘which is, which are’
Yanagisawa (2010: 246)

ii. /j-q’**a-w**p’/
[jí-q’**o-w**p’]
3NA-be-STAT.PRES
‘it is, they are’
Yanagisawa (2010: 246)

iii. аүа
/**a-w**a/
[**á-w**a]
DEF-relative
‘relative, kin’
Yanagisawa (2010: 423)

b. /aj/ → [ej]

i. Иҟалеи?
/j-q’al**a-j**/
[jí-q’al**e-j**]
A.REL-happen-Q
‘What happened?’
Yanagisawa (2010: 248)

ii. иҟалеит
/j-q’al**a-j**t’/
[ji-q’al**é-j**t’]
3NA-happen-DYN.FIN
‘it happened’
Yanagisawa (2010: 248)

iii. аиатцәа
/**a-j**at͡ʃ’ʷa/
[**á-j**at͡ʃ’ʷa]
DEF-star
‘star’
Yanagisawa (2010: 165)

The crosslinguistically recurring conjunction of environments / _ {C, #} was one of the motivations for introducing the syllable into generative phonological analyses. The pattern in Abkhaz can be described as applying only to coda glides, which of course presupposes having syllables large enough to contain codas. For Trigo (1992) the situation is different, since the syllabifications of /aw#/, /awC/, and /awa/ are [a.w], [a.w.C], and [a.wa] respectively. Vowel coloring only applies when the glide is in a different syllable to the vowel, but this is not enough, since that condition also includes [a.wa]. Trigo would have to describe the environment of vowel coloring as "before nucleic glides".

There may certainly be a way of generating the correct surface forms in Trigo's (1992) approach. However, many models of phonology employ separate mechanisms (e.g. feature spreading) for processes like assimilation, and such processes are often limited to applying within some domain such as the syllable. It is interesting that such an analysis of vowel coloring is only possible if syllables in Abkhaz are large enough to accommodate coda consonants. Accepting Trigo's (1992) syllabifications means rejecting this particular type of analysis for Abkhaz vowel coloring, in favor of what is effectively a harmony process, affecting adjacent nuclei.

8.1.4 Syllables as stress-bearing units

Because of the data laid out above, chiefly the speaker intuitions and metrical data, I do not believe it is fruitful to treat Spruit's (1986) elements as small, sometimes vowelless syllables. The available data instead converge on syllables with long clusters in both onset and coda position, which obligatorily contain a vowel. However, one can ask whether the syllables that the evidence points to are equally good as elements at capturing patterns of Abkhaz stress alternation. Perhaps elements are unnecessarily small, and larger syllables have similar empirical coverage. Since all Abkhaz syllables have vowels, accentual contrasts could be hosted by underlying vowels rather than by any underlyingly syllabic consonants. This is commonplace in analyses of lexical stress systems of other languages. The following citations are taken from Köhnlein & Coppola (2023), who also argue that only vocalic elements play a role in lexical stress.

(7) Vowels as the locus of underlying accentual contrasts

> "Accent is encoded as a lexical prominence, i.e., a grid mark over an accented vowel in the underlying representation" (Alderete 1999: 17)
>
> "A lexical accent can be associated to a vocalic peak /.../ or be floating" (Revithiadou 1999: 2)
>
> "[I]t is possible that [stress] depends on the presence of [+vocalic]" (de Lacy 2020: 2)
>
> "Lexical accent is an underlying prominence hosted by a vocalic peak" (Yates 2017: 16)
>
> "[S]tress is positionally marked by linking a π-node to the vowel that bears stress, and I assume that this linking is present underlyingly on roots." (Spahr 2016: 88)

I will argue that while theoretically motivated by previous work and empirically motivated by data on Abkhaz syllables, an analysis where only underlying vocalic segments bear accents does not come close to the empirical coverage of a theory based on elements. The reason for this is primarily that the vowel schwa is not present in underlying forms (see Chapter 4). Although it contributes to the syllable count on the surface (see metrical data earlier in this section with many schwas being metrically relevant), its absence underlyingly means that it cannot host any accent specifications. Stems without underlying vowels are therefore predicted not to participate in stress alternations, contrary to fact.

I ran a Python 3 script to evaluate the empirical coverage of a syllabic analysis on the corpus of 545 definite-indefinite alternations described in Chapter 2, Section 2.2. The methodology is nearly identical to that described in Chapter 5: the script attempts to find an underlying representation for each stem such that, when Dybo's Rule with stem-final stress is applied, the surface stress placements attested in the corpus are obtained. However, the following changes were made to evaluate accent on syllables (underlying vowels) rather than 'elements' as in Chapter 6. Note that schwa is ignored since schwa is not a phoneme (see Chapter 4), and therefore cannot carry underlying accent specifications.

(8) Modifications for evaluation of a syllabic theory of Abkhaz stress

a. Stems are syllabified as if schwa were not present: the script sees surface forms such as [a-t'ə́ʂ̺a] 'hole' but treats the stem as monosyllabic /t'ʂ̺a/

b. Stems are allowed as many accent specifications as there are vowels: underlyingly vowelless stems such as /d͡z/ 'water' are always treated as unaccented, since there is no vowel to carry an accent

c. Default stem-final stress only results in epenthetic schwa if the stem is vowelless (i.e. as a last resort if there is no underlying vowel to carry stress): stem-final stress on /ʃʷtʰ/ 'flower' is predicted to yield [ʃʷtʰə́], but stem-final stress on /sas/ 'guest' is predicted to yield [sás] rather than [sasə́]

Five definite-indefinite pairs were not evaluated by the script due to having segmentally different allomorphs in the definite and indefinite (see Chapter 6, Section 6.1.9 for details). The results for the 540 pairs which were evaluated are shown below.

(9) Figure 8.1

Correct / total (forms)	Correct predictions (forms, %)	Correct / total (pairs)	Correct predictions (pairs, %)
712 / 1,080	65.93%	307 / 540	56.85%

Evaluation results (syllabic theory, nouns and adjectives)

As in Chapter 6, the percentage of forms predicted is higher than the percentage of pairs since for some words, there is an underlying accent specification which works for only one of the two forms in the definite-indefinite pair. For example, for an alternation on an underlying vowelless stem, e.g. [a-pʰsə́] ~ [pʰsə́-k'] 'soul', the stress on the indefinite is correctly predicted: the stem is unaccented because it is vowelless, and unaccented roots receive default stem-final stress. However, if the stem is unaccented, the definite form is incorrectly predicted to be *[á-pʰs]. The fact that a vowelless stem is receiving non-default stress cannot be explained under this theory. Hence only the indefinite is counted as correctly predicted, adding one to the count of total correct forms, but zero to the count of total correct pairs.

It was clear that this analysis would perform worse than allowing each element to bear an accent, since there are demonstrably vowelless stems which show stress alternations in Abkhaz. The evaluation above allows us to quantify exactly how much empirical coverage is sacrificed. By comparing the 56.85% percentage above to the 97.78% for elements from Chapter 6, we can see that approximately 40% of the Abkhaz nominal lexicon requires underlying accents on vowelless units. Accordingly, Abkhaz is not a language whose stress system is based on syllables.

8.1.5 Conclusions on syllables

Analyses where lexical accents are the property of underlying vocalic peaks, which have worked so well for so many other languages, cannot account for four-tenths of the stress alternations in Abkhaz nominals. Nor is it the case that the small vowelless units which Abkhaz seems to require so often are themselves syllables. As I have argued in this section, converging evidence from native speaker judgements and metrics suggest that Abkhaz syllables obligatorily have a vocalic nucleus, and that they contain long consonant clusters. For these reasons I will not pursue a syllabic analysis of Abkhaz in the remainder of this chapter. Although much has been written about the connections, sometimes claimed to be universal, between syllables and stress, I have argued that Abkhaz is not a language with a syllabic stress system. What is needed appears to be a unit smaller than the syllable, which may include a vowel or which may just include a consonant. In the next section I turn to a moraic analysis of Abkhaz stress, since the mora appears to fit this description perfectly.

8.2 Moraic stress

8.2.1 Introduction

Several linguists have noted that Spruit's elements in Abkhaz resemble moras in many of the world's languages (Kathman 1992, Vaux & Samuels 2018). In a CVC word, the CV unit is grouped together as an element, while the final C constitutes an element of its own. This is identical to the moraification of a CVC word in a language where coda consonants are moraic. In this section I construct a moraic analysis of Abkhaz stress assignment in Harmonic Serialism (McCarthy 2000, 2010). Spruit's elements are retained as is, but are interpreted as moras and not as language-specific ‘elements’. This grammar includes moraification and syllabification, and assigns stress according to Dybo’s Rule by virtue of constructing trochaic feet over moras rather than syllables. I adopt here the syllabifications favored by metrical evidence and native speaker intuition discussed in the previous section. The grammar does not include pre-accentuation or any of the other departures from the core of stress assignment discussed in Chapter 6, and is therefore incomplete. For a grammar of Abkhaz stress which does include these additional complications, see the segmental analysis in Chapter 7.

What I call the core of Abkhaz stress assignment above is sufficient to illustrate a number of important properties of the moraic analysis which call into question the usefulness of treating elements as moras. Most of these properties are shared by existing moraic analyses in the literature (Kathman 1992, Vaux & Samuels 2018), and do not only arise in the grammar I construct here. In particular, treating elements as moras 1) requires syllables with up to six moras, and 2) requires up to three moras dominating only onset consonants. I argue that what is known about the mora typologically, even if moraic onsets are granted, should lead us to reject this analysis. Vaux & Samuels (2018) are aware of both 1) and 2) as problems with Kathman’s (1992) moraic analysis of Abkhaz, and revise certain assumptions about moraification in order to remedy these problems. Their analysis crucially relies on underlying schwa, which I have argued against in Chapter 4. I show that even if schwa were a phoneme, both problems 1) and 2) persist in Vaux & Samuels’ (2018) analysis once certain polymorphemic forms are taken into account.

Previous analyses of Abkhaz stress are grid-based, although Vaux (2015) and

Vaux & Samuels (2018) use feet in the sense of bracketed grid theories (see Idsardi 1992, Kager 1995, Hayes 1995 among others), as in the segmental analysis in Chapter 7. The grammar I construct here is the first attempt to assign stress in Abkhaz using feet and no metrical grids. I show that even if the previously mentioned problems for moraic analyses are set aside, constructing moraic feet in Abkhaz leads to violations of syllable integrity (Prince 1976), the constraint which requires that foot boundaries also fall at syllable boundaries. Abkhaz has monosyllabic words which display different patterns of stress alternation, and which must be footed differently to account for their behavior. It is impossible to foot a monosyllabic word in two ways without having at least one foot split a syllable in two. This violates syllable integrity, which has been argued to be a universal property of human language. I argue that syllable integrity violations must occur even if surface representations in Abkhaz always respect this constraint, and that this is incompatible with Optimality Theoretic models of absolute universals.

Below I first construct a moraic grammar of Abkhaz stress assignment, with syllabification in Section 8.2.2 and footing in Section 8.2.3. This is followed by a discussion of the drawbacks of this approach in Sections 8.2.4-8.2.7. I discuss several ways in which 'elements' fail to resemble the moras familiar from other languages. As a consequence, Abkhaz violates prosodic constraints typically imposed on surface representations. Sections 8.2.6-8.2.7 discuss analyses of Abkhaz where surface representations respect prosodic constraints, while either underlying or intermediate forms of the derivation do not. I conclude that moraic analyses are theoretically undesirable independently of the stage at which prosodic constraints apply. Additional discussion of languages which have been analyzed as violating syllable integrity can be found in Chapter 9, Section 9.2.

8.2.2 A grammar of syllabification

The grammar below is based closely on Elfner's (2009) theory of syllabification in Harmonic Serialism (HS).[53] In HS the input-output mapping happens as a result of iteratively passing the output of one step of the derivation as the input to the next. This process is repeated until the output is the same as the input, at which point the derivation is said to have converged. HS has a so-called gradualness requirement, meaning that GEN outputs only candidates which differ from the input in one operation. The following are counted as single operations by Elfner (2009):

(10) Operations in Elfner (2009)

a. Project Syllable: create a syllable with a moraic nucleus

b. Core Syllabification: create a syllable with a moraic nucleus and non-moraic onset

c. Adjunction: Adjoin a segment on the left (onset) or right (coda) of an existing syllable. The adjoined segment may, but need not, become moraic in a single step

Although Core Syllabification could be accomplished by Project Syllable followed by Adjunction (on the left, without adding a mora), Elfner (2009) shows that this leads to pathological predictions. It allows /CVCV/ strings to be parsed CVC.V and therefore treated as heavy for the purposes of stress assignment. A separate operation of Core Syllabification (as in Steriade 1982 among other work) is therefore justified. In the grammar I develop, the constraint ParseSeg(ment), which favors the parsing of segments into moras and syllables, is a high-ranking constraint. The importance of this constraint is

53 In later work, Elfner (2016) proposes an entirely different theory of similar empirical phenomena, where syllabification is 'free', not counting as an operation at all for the purposes of GEN.

what drives the syllabification/moraification operations in (10) in derivations of Abkhaz words.

Abkhaz words like [p^hşák’] ‘one wind’ are divided into three elements [p^h.şá.k’], and therefore three moras under the analysis pursued here. Note that this includes a moraic onset [p^h], while the immediately prevocalic consonant [ş] is not assigned a mora, and is instead grouped with the vowel. In order to achieve this, I use Topintzi’s (2006: 45) MoraicOnset, the onset counterpart of Weight-by-Position (see also Topintzi 2010, 2011). I assume, contra Elfner (2009) and Hayes (1989: 254) but following Hyman (1985: 89) and Hayes (1995: 53) among others, that onsets created from Core Syllabification share the nucleic mora with the vowel. MoraicOnset will not assign such consonants another mora, which is desirable since immediately prevocalic consonants in Abkhaz do not have their own moras/accent specifications.

(11) Figure 8.2

a. Elfner (2009) b. Current proposal

Possible moraic representations of onsets

The following constraints, which I rank in the order in which they are given below, will now accomplish much of Abkhaz syllabification and moraification. Note that I do not show certain common constraints like Onset and NoCoda, which are routinely violated in Abkhaz. I assume that they are dominated by constraints that would repair their violations, such as Dep-IO and Max-IO. I use the constraint name *Nucleus/C (Prince & Smolensky 1993/2004) below for what Elfner (2009) calls *σ/C.

(12) Syllabification constraints

ParseSegment (ParseSeg)	Assign a violation for every segment not dominated by a syllable
V-mora	Assign a violation for every vowel not dominated by a mora
MoraicOnset	Assign a violation for every onset consonant not dominated by a mora
Weight-by-Position	Assign a violation for every coda consonant not dominated by a mora
*Nucleus/C (*Nuc/C)	Assign a violation for every consonantal nucleus
*Complex	Assign a violation for every syllable with a complex onset or coda

Like Topintzi (2006), I use the cover constraint Moraic to stand in for all constraints requiring moras. Since I follow Elfner (2009) in assuming that vowels must be assigned a mora during the course of the derivation (contra Hayes 1989 among others, for whom vowels are underlyingly moraic), I include in the Moraic cover constraint also Rosenthall's (1994) V-mora, requiring that vowels be moraic.

Let's consider how this grammar syllabifies /a-t͡sʰħa/, the definite form of /t͡sʰħa/ 'bridge' (Yanagisawa 2010: 498). I enclose syllables in ( ) parentheses and use subscript μ to denote moraic segments. Note that in $(C_1C_2V_\mu)$, C_2 shares a mora with the vowel while C_1 does not. If C_1 is moraic, I will write $(C_\mu CV_\mu)$.

(13) /a-t͡sʰħa/ 'bridge', step 1

	/at͡sʰħa/	ParseSeg	Moraic	*Nuc/C	*Complex
	at͡sʰħa	***!*	****		
☞	at͡sʰ(ħa$_\mu$)	**	**		
	a(t͡sʰħ$_\mu$)a	**	**	*!	
	(a$_\mu$)t͡sʰħa	***!	***		

Core Syllabification (second candidate) is the only operation which can parse two segments into a single syllable, and it will therefore be chosen over no change (first candidate) and Project Syllable (final candidate). The choice between at͡sʰ(ħa$_\mu$) and the implausible-looking a(t͡sʰħ$_\mu$)a is made by *Nuc/C, as in Elfner (2009: 22, fn. 21).

In the next step of the derivation, the initial vowel will be syllabified.

(14) /a-t͡sʰħa/ 'bridge', step 2

	/at͡sʰ(ħa$_\mu$)/	ParseSeg	Moraic	*Nuc/C	*Complex
	at͡sʰ(ħa$_\mu$)	**!	**		
☞	(a$_\mu$)t͡sʰ(ħa$_\mu$)	*	*		
	a(t͡sʰħa$_\mu$)	*	**!		*
	a(t͡sʰ$_\mu$ħa$_\mu$)	*	*		*!

Syllabifying the vowel is preferable to syllabifying the consonant (with or without a mora) since it avoids violations of *Complex. In the final derivational step, the affricate is syllabified, eliminating the final ParseSeg and Moraic violations. Due to high-ranking *Complex, it is syllabified as the coda of a preceding syllable, in line with literature on Abkhaz syllabification (see Section 8.1.3). Because of Moraic, candidates with non-moraic onsets or codas are harmonically bounded by their moraic counterparts with this subset of constraints.[54]

54 Of course in a fuller constraint set we would also find a constraint banning moraic onsets, *μ/Ons

(15) /a-t͡sʰħa/ ‘bridge’, step 3

	/(a$_\mu$)t͡sʰ(ħa$_\mu$)/	ParseSeg	Moraic	*Nuc/C	*Complex
	(a$_\mu$)t͡sʰ(ħa$_\mu$)	*!			
	(a$_\mu$t͡sʰ)(ħa$_\mu$)		*!		
☞	(a$_\mu$t͡sʰ$_\mu$)(ħa$_\mu$)				
	(a$_\mu$)(t͡sʰħa$_\mu$)		*!		*
	(a$_\mu$)(t͡sʰ$_\mu$ħa$_\mu$)				*!

At this point the derivation converges since there are no changes that result in a better syllable structure, and the output is VC.CV [(a$_\mu$t͡sʰ$_\mu$)(ħa$_\mu$)]. The same grammar is capable of prosodifying words without underlying vowels, as shown below for /b-ɥ/ 2SFA-write ‘Write!’ [bɥə́] (Yanagisawa 2010: 584).

(16) /b-ɥ/ ‘Write!’, step 1

	/b-ɥ/	ParseSeg	Moraic	*Nuc/C	*Complex
	bɥ	*!*	*		
☞	(bɥ$_\mu$)			*	
	b(ɥ$_\mu$)	*!	*	*	
	(b$_\mu$)ɥ	*!	*	*	

In this short word, the derivation converges after only a single step. In longer vowelless words, additional syllables would be created, just as shown above for the polysyllabic /at͡sʰħa/ ‘bridge’.

8.2.3 A grammar of foot structure

Now that both moras and syllables are in place, the grammar must be expanded to use these prosodic units to assign stress by Dybo’s Rule (see Chapter 5 for arguments for this

(Topintzi 2006: 45). By ranking such a constraint highly it is possible to generate outputs without moraic onsets, as is the case in most of the world’s languages.

rule of stress assignment). I assume that accents are autosegments linked to segments in the underlying representation (Revithiadou 1999, Yates 2017). Recall that stress falls on an accent not immediately followed by an accent. In other words, stress assignment depends on a binary grouping accented-unaccented. Such a binary strong-weak group can be straightforwardly modeled as a moraic trochee, with an accented head mora and an unaccented dependent. I use conventional constraints such as Trochee and (the moraic version of) FootBinarity to ensure the creation of such feet. Accented moras are preferentially placed in head position by a constraint Accent=Head. Parts of the word which cannot be parsed according to these requirements are left unfooted. A Leftmost constraint is included to mark the leftmost foot as the head foot, receiving primary stress, while other feet receive secondary stress. All feet are also subject to schwa epenthesis if no vowel is available (see Chapter 4), discussed further below.

There is one exception to the conditions above. Dybo's Rule also assigns stress to word-final accents, since these are not immediately followed by an accent. A word-final mora cannot head a moraic trochee, since there is by definition no following mora to act as dependent. Only in word-final position, therefore, do we want to allow monomoraic feet. I model this with a positional version of Accent=Head, relativized to word-final position. This constraint dominates Rhyme-Contour (Kager 1999: 174), which penalizes feet that do not have a strong-weak pattern. Once feet are in place, schwas can be epenthesized using *Head/C, which dominates Dep-IO and disprefers foot heads without vowels. Above I used *Nuc/C, banning consonantal nuclei, which might seem to obviate the need for a special foot-level constraint *Head/C. However, as I will show below, the accented consonants which trigger schwa epenthesis are not always syllabified as nuclei, but instead as onsets or codas in at least some words. In order to derive the correct epenthesis patterns *Head/C is needed. For the discussions of epenthesis, again following Elfner (2009), I allow epenthetic vowels to be prosodified in a single derivational step.

Below is a list of all of the constraints, in the order in which they are ranked. This includes all constraints from (12) as well as the new ones discussed in preceding paragraphs.

(17) Syllabification and footing constraints

ParseSeg	Assign a violation for every segment not dominated by a syllable
V-mora	Assign a violation for every vowel not dominated by a mora
MoraicOnset	Assign a violation for every onset consonant not dominated by a mora
Weight-by-Position	Assign a violation for every coda consonant not dominated by a mora
Accent=Head$_{Final}$	Assign a violation for every word-final mora associated with an accent which is not parsed as the head of a foot
Rh(yme)-Contour	Assign a violation for every foot which does not end in a strong-weak contour
Trochee	Assign a violation for every foot whose head is not leftmost in the foot
FtBin$_{\mu}$	Assign a violation for every foot which is not bimoraic
Accent=Head	Assign a violation for every mora associated with an accent which is not parsed as the head of a foot
Leftmost	Assign a violation for every head foot which is not the leftmost foot in the word
*Head/C	Assign a violation for every foot head which does not dominate a vowel
Dep-IO	Assign a violation for every output segment without an input correspondent
*Nuc/C	Assign a violation for every consonantal nucleus
*Complex	Assign a violation for every syllable with a complex onset or coda

Below I provide a representative derivation from the completely unprosodified underlying representation to the surface representation with moras, syllables, and feet. I show derivations for the following word, where acute accents in inputs mark underlying accents. The underlying representation contains accented vocalic and consonantal morphemes, and the surface representation has both primary and secondary stress, as well as schwa epenthesis. Since the word contains both non-final and final stresses, both a non-final moraic trochee and a final monomoraic foot must be created.

(18) A past absolute verb form (Yanagisawa 2010: 342)

дапхьаны
[d-á-p^{h}χ^{j}a-nə̀]
/d-á-p^{h}χ^{j}a-ń/
3SHA-3SNO-read-PST.ABS
'him/her having read it'

The first four steps of the derivation in (19)-(22) create moras and syllables. It is optimal to begin with Core Syllabification, syllabifying two segments at once. The consonant-only core syllable in the losing candidate dá(p^{h}χ$^{j}_{\mu}$)ań is ruled out by *Nuc/C. After Core Syllabification the consonants /p^{h}/ and /n/ are adjoined as moraic codas of the preceding syllable, giving the fully syllabified winner (dá$_{\mu}$p$^{h}{}_{\mu}$)(χ^{j}a$_{\mu}$ń$_{\mu}$) in the fourth tableau in (22).

At this point foot assignment begins. I mark feet with enclosing [ ] square brackets, and mark the head mora of a foot by <u>underlining</u>. In forms with multiple feet, [ ]$_{H}$ denotes the head foot of the word. In order to reduce visual clutter, I remove the subscript μ's at this stage, but the moraification derived earlier is still assumed to be present. Due to Accent=Head$_{Final}$ >> FtBin$_{\mu}$ the accented /ń/ is given its own monomoraic foot, while the ranking FtBin$_{\mu}$ >> Accent=Head ensures that in non-final position, the underlying accent on the /á/ results in a bimoraic trochee [<u>dá</u>p^{h}]. The word-final foot violates syllable integrity, since the syllable (χ^{j}a[<u>ń</u>]) is split up by a foot boundary. High-ranking Trochee prevents the parse ([χ^{j}a<u>ń</u>]) with an iamb.

In the seventh and final tableau in (25), applying schwa epenthesis is optimal due to *Head/C, preventing the accented consonant /ń/ from serving as a foot head without a vowel. In this particular word, the ensuing resyllabification repairs the syllable integrity violation since (χ^ja[$\underline{\acute{n}}$]) is resyllabified to (χ^ja)([$\underline{\acute{n}\text{ə}}$]). In the discussion below I will show that this is a coincidence of this word, and that it is not generally the case that schwa epenthesis repairs syllable integrity violations in Abkhaz.

(19)

dáp^{h}χ^{j}ań	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
dáp^{h}χ^{j}ań	*****!*	******	*			**					
(dá$_{\mu}$)p^{h}χ^{j}ań	****	****	*			**					
☞ dáp^{h}(χ^{j}a$_{\mu}$)ń	****	****	*			**					
dá(p^{h}χ$^{j}_{\mu}$)ań	****	****	*			**				*!	
d(á$_{\mu}$)p^{h}χ^{j}ań	*****!	*****	*			**					

(20)

(dá$_{\mu}$)p^{h}χ^{j}ań	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
(dá$_{\mu}$)p^{h}χ^{j}ań	***!*	****	*			**					
(dá$_{\mu}$)p^{h}(χ^{j}a$_{\mu}$)ń	**	**	*			**					
(dá$_{\mu}$)(p^{h}χ$^{j}_{\mu}$)ań	**	**	*			**				*!	
(dá$_{\mu}$)p^{h}χ^{j}(a$_{\mu}$)ń	***!*	***	*			**					

(21)

(dá$_{\mu}$)p^{h}(χ^{j}a$_{\mu}$)ń	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
(dá$_{\mu}$)p^{h}(χ^{j}a$_{\mu}$)ń	**!	**	*			**					
(dá$_{\mu}$p^{h})(χ^{j}a$_{\mu}$)ń	*	**!	*			**					
(dá$_{\mu}$p$^{h}_{\mu}$)(χ^{j}a$_{\mu}$)ń	*	*	*			**					
(dá$_{\mu}$)(p$^{h}\chi^{j}$a$_{\mu}$)ń	*	**!	*			**					*
(dá$_{\mu}$)(p$^{h}_{\mu}\chi^{j}$a$_{\mu}$)ń	*	*	*			**					*!
(dá$_{\mu}$)(p$^{h}_{\mu}$)(χ^{j}a$_{\mu}$)ń	*	*	*			**				*!	

(22)

$(\text{dá}_\mu \text{p}^\text{h}{}_\mu)(\chi^\text{j}\text{a}_\mu)\acute{\text{n}}$	ParseSeg	Moraic	$\text{A=H}_{\text{Final}}$	Trochee	FtBin_μ	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
$(\text{dá}_\mu \text{p}^\text{h}{}_\mu)(\chi^\text{j}\text{a}_\mu)\acute{\text{n}}$	*!	*	*			**					
$(\text{dá}_\mu \text{p}^\text{h}{}_\mu)(\chi^\text{j}\text{a}_\mu\acute{\text{n}})$		*!	*			**					
$(\text{dá}_\mu \text{p}^\text{h}{}_\mu)(\chi^\text{j}\text{a}_\mu\acute{\text{n}}_\mu)$			*			**					

(23)

(dáp^h)(χ^jań)	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
(dáp^h)(χ^jań)			*!			**					
(dáp^h)([$\underline{\chi^j a}$ń])			*!			**					
(dáp^h)([χ^ja$\underline{\acute{n}}$])				*!		*					
(dáp^h)(χ^ja[$\underline{\acute{n}}$])					*	*					

(24)

(dáp^{h})(χ^{j}a[$\underline{\acute{n}}$])	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
(dáp^{h})(χ^{j}a[$\underline{\acute{n}}$])					*	*!					
([$\underline{\text{dá}}$]$_{H}$p^{h})(χ^{j}a[$\underline{\acute{n}}$])				*!	**						
☞([$\underline{\text{dáp}}$^{h}]$_{H}$)(χ^{j}a[$\underline{\acute{n}}$])					*						
([dá$\underline{\text{p}^{h}}$]$_{H}$)(χ^{j}a[$\underline{\acute{n}}$])				*!	*	*					
([$\underline{\text{dáp}}$^{h}]$_{H}$)(χ^{j}a[$\underline{\acute{n}}$]$_{H}$)					*		*!				

(25)

([dáp^{h}]$_{H}$)(χ^{j}a[ń])	ParseSeg	Moraic	A=H$_{Final}$	Trochee	FtBin$_{\mu}$	A=H	Leftmost	*Head/C	Dep-IO	*Nuc/C	*Complex
([dáp^{h}]$_{H}$)(χ^{j}a[ń])					*			*!			
([dáp^{h}]$_{H}$)(χ^{j}a)([ńə])					*				*		

Because of Core Syllabification, the grammar above also correctly assigns stress in words like /ś-an/ 1S.POSS-mother [sán] 'my mother', where a morpheme consisting of an accented consonant precedes an unaccented vowel in another morpheme. This is because /śa/ is grouped together under the same mora by Core Syllabification. When moraic feet are constructed, the mora dominating śa will be made a foot head since it contains an accent, and this mora will therefore ultimately bear primary stress in the word. By virtue of assigning stress to moras as a unit, the analysis is indifferent to whether the accent comes from the consonant or the vowel underlyingly.

This property of the analysis is attractive because of Richness of the Base. There is no need to specify underlyingly which segments are or are not capable of bearing an accent. An accented stem like /ɥá/ 'dry' could equally well have an input /ɥ́a/ or /ɥ́á/. The grammar ensures that all of these inputs are simply treated as accented moras. In Chapter 7, Section 7.3 I introduced readjustment rules which mean that the segmental analysis of Abkhaz stress that I propose behaves similarly.

As demonstrated above the moraic grammar handles many important aspects of stress assignment in Abkhaz, but it also leaves much out. Default stem-final stress in unaccented words is not implemented, and in words with long strings of underlying consonants, it does not determine which should be made the nucleus, and which become onsets or codas, something which may impact the amount of resyllabification needed once schwa epenthesis is applied. I have also not attempted to implement pre-accentuation, or any of the other morphologically conditioned aspects of stress assignment discussed in Chapter 6, Section 6.3. Despite these shortcomings, the implementation nevertheless illustrates several important properties of analyses which assign stress using moras. These are discussed in Section 8.2.4 immediately below.

8.2.4 Evaluating moraic analyses

In this section and in coming sections I critically evaluate moraic analyses of Abkhaz. I begin by discussing prosodic constraints as if they always apply to surface representations, before turning to constraints at intermediate or underlying levels in Sections 8.2.6 and 8.2.7.

The moraification resulting from the grammar above is the same as that of Kathman (1992), who proposes a grid-based analysis of Abkhaz stress where elements are identified with moras. I highlight two typologically unusual assumptions which must be made by any such theory in the discussion that follows immediately below. The first relates to the number of moras permitted in a syllable. Moras have many uses in phonological theory, but they have been particularly influential as units of both length and weight. Languages with phonemic quantity contrasts almost always have a binary short-long system, although ternary short-long-overlong systems are attested in a handful of languages, including Dinka (Remijsen & Gilley 2008). Quantity-sensitive stress systems are also frequently binary, distinguishing light from heavy, although ternary light-heavy-superheavy systems are also known to exist (Gordon 1999, Davis 2011). Hayes (1989) suggests, based on facts like these, that syllables in many languages are limited to at most two moras, but that a few languages exist which provide evidence for trimoraic syllables.

Kathman's (1992) moraic analysis of Abkhaz stress, however, requires syllables to routinely contain four or more moras in a single syllable. He explicitly gives the four-mora parse [p$^{h}_{\mu}$s$_{\mu}$t^{h}á$_{\mu}$k’$_{\mu}$] ‘one ravine’ despite the word being monosyllabic under his assumptions (Kathman 1992: 220), and under the syllabification assumptions supported by the evidence in Section 8.1.3. Words with long onset or coda clusters can even reach five or six moras. These possibilities are instantiated in words which Abkhaz speakers judge to be monosyllabic, such as [p$^{h}_{\mu}$s$_{\mu}$t$^{h}_{\mu}$ħ^{w}á$_{\mu}$k’$_{\mu}$] ‘one storm cloud’ (five moras) and [p$^{h}_{\mu}$s$_{\mu}$lə́$_{\mu}$m$_{\mu}$d͡z$_{\mu}$k’$_{\mu}$] ‘one grain of sand’ (six moras) (data and syllabification from Arstaa et al. 2014: 94).

A second property of any analysis which treats the element as a mora relates to the onset. The same words quoted above illustrate that there does not appear to be a limit in Kathman’s (1992) analysis on how many moras are allowed in onset position. Three of the five moras in [p$^{h}_{\mu}$s$_{\mu}$t$^{h}_{\mu}$ħ^{w}á$_{\mu}$k’$_{\mu}$] ‘one storm cloud’ only dominate onset consonants. In many versions of moraic theory, “[t]he overriding generalization seems to be that although onset consonants cannot make weight, coda segments can” (Hayes 1989: 293; see also Hyman 1985 and Gordon 1999 among others). Topintzi’s work (2006, 2010, 2011), some of which has been discussed above, challenges this assumption, but the moraic onsets found in Kathman’s (1992) analysis of Abkhaz look strikingly different from claimed moraic onsets in other languages of the world. Below I highlight some of these differences.

Topintzi’s (2006, 2010) analyses of Arabelo, Karo, Nuxalk, Pirahã, and Samothraki Greek rely on moraic onsets. In all of these languages immediately prevocalic consonants are relevant for stress assignment, word minimality, or compensatory lengthening (sometimes subject to sonority effects, much like coda consonants). Whereas non-moraic onsets share a mora with the following vowel, moraic onsets are given a mora of their own: $C_\mu V_\mu$. This is directly parallel to the more typologically common behavior of moraic codas. In languages with coda weight sensitivity, a VC syllable is typically analyzed with a separate mora for the vowel and consonant: $V_\mu C_\mu$. This contrasts with languages where codas do not make weight, where a single mora is shared between the nucleus and coda (Hayes 1989: 257).

By contrast, in Abkhaz all onset consonants matter in stress assignment *except* the immediately prevocalic one. In the HS grammar above I attempted to model this by assuming that Core Syllabification creates a mora which dominates both the nucleus and a single onset consonant, with high-ranking MoraicOnset ensuring that subsequently adjoined onsets are given a mora. However, this analysis is incomplete, since it does not explain why only Core Syllabification can create moras shared with the nucleus. Why is (26) a. chosen over (26) b. for consonants which are adjoined?

(26) Figure 8.3

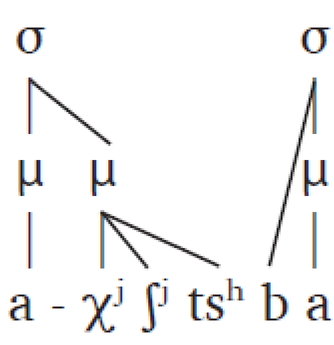
a. b.

Representations of moraic and non-moraic onset consonants

The constraint NoSharedMora (Morén 1999: 362) may be relevant. The problem lies in allowing at most one violation of this constraint, since only a single onset consonant is permitted to share a mora with the nucleus. This may be possible in Harmonic Grammar and similar theories (Legendre et al. 1990, Smolensky & Legendre 2006) where multiple violations of lower-ranked constraints can ‘gang up’ on a higher-ranked constraint. There is also an onset-coda asymmetry, where a single onset consonant is allowed to share a mora with the nucleus, but no coda consonants may do so. I do not attempt to provide an answer to these problems here, but note that until this question is resolved, it is far from clear how to derive the fact that Abkhaz moraic onsets do not behave like in any other language.

If it is difficult to obtain moraifications like those in (26) a., which also result in the proliferation of moras both in the onset specifically and in the syllable more generally, perhaps the moraifications in (26) b. would be preferable. Such an analysis is favored by Vaux & Samuels (2018), who argue that all onsets are non-moraic and that all coda consonants share a single mora. This results in syllabifications like the following for [a-χʲʃt͡sʰbá] ‘sparrowhawk’ (Vaux & Samuels 2018: 158):

(27) Figure 8.4



Representation of ‘sparrowhawk’ in Vaux & Samuels (2018: 158)

Such a reanalysis, they argue, obviates the need for any syllable with more than three moras, and completely removes moraic onsets from the language. However, this is only possible if such strings of consonants do indeed share an accent specification. If individual consonants in clusters have different accent specifications, they cannot be grouped under the same mora in a moraic accentual system like the one used by Vaux & Samuels (2018). They argue that shared accent specifications are indeed the only possibility in Abkhaz, but this is only possible if schwa is a phoneme in the language. Consider words like the following:

(28) Accentual contrasts in clusters

a.
    аԥса
    [á-pʰsa]
    DEF-fir
    'fir'
    Yanagisawa (2010: 334)

b. аԥша
    [a-pʰʂá]
    DEF-wind
    'wind (n.)'
    Yanagisawa (2010: 346)

c. аԥышәа
    [a-pʰə́ʃʷa]
    DEF-attempt
    'attempt, experiment'
    Yanagisawa (2010: 353)

Following Kathman (1992), (28) c. is underlyingly /pʰʃʷa/ without a schwa. The surface form follows from assuming that the mora dominating /pʰ/ is accented while the mora dominating /ʃʷa/ is not. In (28) a. both moras are accented, and in (28) b. neither is. This is because each of the three moras in $a_{\mu}p^{h}{}_{\mu}Sa_{\mu}$ (using S for any sibilant) can bear an accent. But if such words only have two moras [a] and [pʰSa] as in Vaux & Samuels (2018: 156), either the whole mora [pʰSa] is accented, yielding (28) b., or the whole mora is unaccented, leading to (28) a. There is no mechanism by which to generate (28) c. with the underlying forms assumed. Vaux & Samuels (2018: 173 endnote 8) are therefore forced to assume that the underlying forms are different, and that the stem in (28) c. is underlyingly /pʰəʃʷa/. This allows them to maintain that accentedness is a property of whole clusters (moras), not individual consonants.

I have provided arguments against underlying schwa in Abkhaz in Chapter 4.[55] If one accepts schwaless underlying forms for the language, then Vaux & Samuels' (2018) analysis cannot be maintained. However, I argue that both moraic onsets and syllables with up to six moras persist in their model even if their assumptions about the vowel system are granted. This is because their simplified moraic parses are only available in monomorphemic clusters. Individual morphemes must be allowed their own accent specifications, because alternations allow us to observe that even vowelless morphemes can affect where stress falls. Since Vaux & Samuels assume that lexical accents are hosted by moras, a cluster like /C-C-C/ would still require three moras to allow for one accent specification per morpheme. Vaux & Samuels (2018: 153-154 and passim) are explicit that accents in their model are "hosted in the lexicon by moras". This means that their model has the same problems as that of Kathman (1992) in cases like the following:

(29) Long polymorphemic clusters (Ajiba & Habat 2006: 61)

Аҵьма ажә ала ацгәы ҩнатә ҧстәқәоуп

[á-d͡ʒma	á-ʒʷ	a-lá	a-t͡sʰgʷə́
DEF-goat	DEF-cow	DEF-dog	DEF-cat

55 Vaux & Samuels (2018: 173 endnote 8) point to a supposed minimal pair [ak'ə́lχχa] 'full of holes' vs. [ak'ə́ləχχa] 'lattice', but these are variant pronunciations of the same lexical item with and without schwa epenthesis, the optionality of which is discussed in Chapter 4, Section 4.1.

ɥná-t’ʷ   pʰs-t’ʷ-kʷʰó-wp’]
home-ADJZ   soul-ADJZ-N.PL-STAT.PRES

‘The goat, cow, dog, and cat are domestic animals’

Here the word [pʰs-t’ʷ-kʷʰó-wp’] ‘...are animals’ contains at least four morphemes, meaning four accent specifications and four moras, in a single syllable (for syllabification see Section 8.1.3). A fifth morpheme is present if one segments [-wp’] as [-w-p’], as Spruit (1986: 54) does. The fact that this sentence is from a textbook, and that I came across it during an Abkhaz lesson, illustrates the fact that such clusters arise not infrequently in spontaneous Abkhaz. They are not the artificial creations of linguists who attempt to illustrate theoretically maximal syllable shapes. In summary Kathman’s (1992) analysis includes typologically unwarranted moraic onsets and radically exceeds the crosslinguistic maximum of three moras per syllable. Vaux & Samuels (2018) attempt to remedy these problems, but must accept schwa as a phoneme in order to do so. Even then, the same problems remain in their model once polymorphemic clusters are taken into account. This casts doubt on attempts to treat Abkhaz stress assignment as a moraic system.

8.2.5 Syllable integrity

Both Kathman (1992) and Vaux & Samuels (2018) rely on grid-based analyses of Abkhaz stress. How would a foot-based analysis of stress assignment fare by comparison? I will argue that beyond the problems with moraic stress discussed above, foot-based theories face significant problems with syllable integrity. This constraint militates against foot boundaries which are not perfectly aligned with syllable boundaries (Prince 1976). Syllable integrity is argued to be desirable as a strict universal in human language because of the claimed absence of languages where monosyllabic words show contrasting stress behavior. Contrasts like [(báa).la] vs. [ba(á.la)] (where both /baa/ sequences are crucially known or assumed to be monosyllabic) could be generated if syllable integrity were violable. The absence of such languages from the empirical record is argued to favor this constraint (see Hayes 1995: 49 for discussion).

In the HS analysis of Abkhaz given above, we have already seen that violations of syllable integrity can arise. I will argue that violations are inevitable since there are monosyllabic words in Abkhaz which differ in their patterns of stress alternation and locations of schwa epenthesis. I will first introduce the data, and then explain why moraic analyses lead to syllable integrity violations in these words.

(30) Accentual contrasts on CC stems

a. /ps/ 'soul' (Yanagisawa 2010: 338)

i. ҧсык
[p^{h}sə́-k']
soul-INDF
'one soul'

ii. аҧсқәа
[a-p^{h}s-k^{wh}á]
DEF-soul-N.PL
'souls'

b. /pʃ^{w}/ 'lip' (Yanagisawa 2010: 353)

i. ҧышәк
[p^{h}ə́ʃ^{w}-k']
lip-INDF
'one lip'

ii. ацышәқәа
[a-p^{h}əʃ^{w}-k^{wh}a]
DEF-lip-N.PL
‘lips’

In an analysis which treats elements as moras, and which has no underlying schwa, the contrasting behavior of these two stems is simple to understand, but I will show that syllable integrity is violated. /ps/ ‘soul’ has two accented moras: ṕ$^{h}{}_{\mu}$ś$_{\mu}$. Dybo’s Rule assigns stress to the rightmost accent in a sequence, which leads to a stressed ś in the indefinite form in (30) a. i. This explains why a schwa is epenthesized immediately after the /ś/. The stress pattern of this word also explains why stress shifts onto the accented plural suffix in (30) a. ii, again due to Dybo’s Rule placing stress on the rightmost accent in a sequence. A stem like /pʃ^{w}/ ‘lip’ would instead be analyzed with only one of its moras bearing an accent: ṕ$^{h}{}_{\mu}$ʃ$^{w}{}_{\mu}$. This explains why schwa epenthesis is in the middle of the stem in [p^{h}əʃ^{w}-k’] ‘one lip’. The unaccented mora dominating /ʃ^{w}/ also interrupts what would otherwise be a sequence of accents in the plural, so that no stress shift onto the plural suffix occurs.

If moraic trochees are built over accented-unaccented sequences as in the HS grammar developed earlier in this section, all of these facts are explained. The surface representations (p$^{h}{}_{\mu}$[sə́$_{\mu}$k’$_{\mu}$]) and ([p^{h}ə́$_{\mu}$ʃ$^{w}{}_{\mu}$]k’$_{\mu}$) show optimal bimoraic trochees, with schwa epenthesis and primary stress at the foot head. However, both of these feet violate syllable integrity. The /p^{h}/ is not included in the footing of monosyllabic [p^{h}sə́k’], nor is the /k’/ in the footing of monosyllabic [p^{h}ə́ʃ^{w}k’]. Crosslinguistically, moraic systems often include repairs in cases like these so that no misalignment between moras and syllables occurs. An example of this is seen in Tokyo Japanese loanword accentuation, where an accent is placed on the antepenultimate mora (31) a. However, just in the case that the antepenultimate mora occurs in the middle of a syllable, the accent appears instead in pre-antepenultimate position, meaning that the syllable is never split in two (31) b. Moras are marked with subscript $_{\mu}$, while periods separate syllables.

(31) Accentual patterns in Tokyo Japanese loanwords
(Kubozono 2006: 1142, see also Kager & Martínez-Paricio 2018: 150)

a. Accent on antepenultimate mora

i. [su$_{\mu}$.tó$_{\mu}$.re$_{\mu}$.su$_{\mu}$]
'stress'

ii. [dé$_{\mu}$e$_{\mu}$.ta$_{\mu}$]
'data'

iii. [pá$_{\mu}$k$_{\mu}$.ku$_{\mu}$]
'pack'

b. Accent on pre-antepenultimate mora

i. [a$_{\mu}$n$_{\mu}$.dá$_{\mu}$a$_{\mu}$.so$_{\mu}$n$_{\mu}$] *[a$_{\mu}$n$_{\mu}$.da$_{\mu}$á$_{\mu}$.so$_{\mu}$n$_{\mu}$]
'Anderson'

ii. [ba$_{\mu}$.do$_{\mu}$.mí$_{\mu}$n$_{\mu}$.to$_{\mu}$n$_{\mu}$] *[ba$_{\mu}$.do$_{\mu}$.mi$_{\mu}$ń$_{\mu}$.to$_{\mu}$n$_{\mu}$]
'badminton'

iii. [pa$_{\mu}$i$_{\mu}$.ná$_{\mu}$p$_{\mu}$.pu$_{\mu}$.ru$_{\mu}$] *[pa$_{\mu}$i$_{\mu}$.na$_{\mu}$ṕ$_{\mu}$.pu$_{\mu}$.ru$_{\mu}$]
'pineapple'

Is a similar repair strategy available in Abkhaz? Perhaps violations of syllable integrity can be repaired by sliding the foot boundaries over so that they never include only parts of a syllable. But this would result in outputs where both 'one soul' and 'one lip' have feet spanning the entire syllable: ([p$^{h}{}_{\mu}$sə́$_{\mu}$k'$_{\mu}$]) and ([p^{h}ə́$_{\mu}$ʃ$^{w}{}_{\mu}$k'$_{\mu}$]) respectively.[56] This neutralizes the difference between the two words, since they are now footed identically.

56 Since these words have stresses and stress-conditioned schwa epenthesis, I am rejecting analyses where one or both of the words lack a foot altogether.

This cannot be the right representation: how does the grammar know that the medial mora in ‘one soul’ is the foot head, resulting in schwa epenthesis after /s/, while the initial mora is the foot head in ‘one lip’, resulting in schwa epenthesis after the /p^{h}/? The two words demonstrably have different stress patterns, and the differing sites of schwa epenthesis must be explained. As explained above this can easily be done, but only with feet which violate syllable integrity.

8.2.6 Non-surface constraints

At this point I will turn to matters of derivational ordering. In all of the discussion about moraic models I have not specified at which stage in the derivation supposedly universal constraints are intended to apply, and I have acted as if the surface representations always contain a great deal of intricate prosodic structure. It is worth discussing whether being more explicit about derivations can resolve some of the problems which face the moraic approach to Abkhaz stress. For example, I have argued that forms like [p$^{h}{}_{\mu}$s$_{\mu}$t$^{h}{}_{\mu}$ħ^{w}á$_{\mu}$k’$_{\mu}$] ‘one storm cloud’ have five moras in a single syllable, but this is only needed for stress assignment. Perhaps all of these moras are deleted as soon as stress and schwa epenthesis have been applied, so that the surface form is moraified as Vaux & Samuels (2018) assume, with non-moraic onsets. Indeed, since stress assignment makes no reference to syllables in a moraic analysis, perhaps there are no syllables at all at the stage of the derivation at which these five moras are needed. It is impossible to violate constraints against moraic onsets if onsets have yet to be constructed. The same questions can be asked of syllable integrity violations and foot structure: if Abkhaz feet are moraic and do not make any reference to syllables, how do we know that syllables have even been created when foot-based processes like stress assignment apply? This may again make it possible to assume radically simpler surface structures, where [p^{h}sə́k’] ‘one soul’ and [p^{h}ə́ʃ^{w}k’] ‘one lip’ are refooted so as to obey syllable integrity once stress has been assigned and schwas have been epenthesized.

I argue that such compromise solutions, where the prosodic complexity of Abkhaz precedes syllabification, are not viable. Conventional analyses do not allow us to assign moras before syllables have been built. The causality is in the opposite direction, where segments are assigned moras *because* they occupy particular syllabic positions. A constraint like Weight-by-Position encodes this view in its name: it is because a consonant has been syllabified in the coda position that it is given a unit representing weight. Not all consonants in such a language are given moras, and the grammar knows which consonants are which based on syllabification: codas are given moras while onsets are not.

Concerns about moraic onsets are less relevant to Abkhaz, where onsets often are moraic under the analysis developed in this chapter. However, immediately prevocalic consonants still show that moraification in Abkhaz depends on syllabification. In theories like that of Elfner (2009), immediately prevocalic consonants are special because of Core Syllabification, which universally creates CV syllables. I utilized this fact to explain the behavior of Abkhaz onsets in the HS analysis earlier in this chapter. Here the distribution of moras is once again dependent on syllabification. In other words, whether one explains it with Elfner’s (2009) Core Syllabification or some other device, it is not a random fact about Abkhaz that CV sequences behave as a unit rather than CC or VC. It is because of the syllable that this pattern arises. This is not surprising, and occurs entirely by design, since the internal structure of syllables is what moras were created to account for.

These considerations about syllabification argue against analyses where syllables, and constraints on their relationships to other metrical units, only become active at some very late stage of Abkhaz phonology when stress has already been assigned. However, one may wonder if it is possible to maintain that constraints like syllable integrity and the three mora maximum are still strict, inviolable universals when applied to surface representation. Perhaps Abkhaz requires five-mora syllables, or feet which violate syllable integrity, at some stage of the derivation. But if these structures can be universally ruled out from surface representations, that seems like an important universal which theories of prosodic phonology should account for. Note that this is in effect proposing an opaque analysis: words are first prosodified in one way, and this prosodic structure is used to assign stress, but this structure is then removed, so that the initial prosodification cannot be reconstructed from the surface representation.

I will argue that at least with respect to the constraints relevant for Abkhaz stress, an analysis where such universal restrictions apply only to surface representations cannot be formulated. I restrict the discussion to serial theories here, since parallel theories, by design, lack the mechanism of different constraints applying at different stages of the derivation. In constraint-based theories, there are two common ways of ensuring that something is universally impossible in human language. One is to introduce restrictions on GEN, so that violations of the proposed universal are never found in the set of output candidates, and the other is to rely on unrerankable constraints. The first option will not work if the universal can be violated at intermediate stages of the derivation. In Abkhaz, five-mora syllables and syllable integrity-violating feet must win in some tableaux, which means they must be added to the candidate set by GEN.

The second option is more appealing. If a constraint is universally undominated in the final step of a derivation, there would be no way of generating surface representations which violate the constraint in any language. By allowing the same constraint to be reranked in earlier derivational steps, the unusual metrical structures of Abkhaz could be generated and used to assign stress, followed by reprosodification to remove violating structures from surface representations. Such an approach is theoretically viable, albeit only in a few specific versions of Optimality Theory. In HS, for example, different derivations have a different number of steps, and there is no way of knowing a priori whether a given tableau is going to be the final one. This can only be determined once the derivation has converged. However, a theory like Stratal OT (Kiparsky 2015) has the necessary properties. By virtue of connecting the steps in a derivation to morphosyntactic units – stem, word, and phrase – there is a way to know beforehand when a derivation will end. We could postulate that a constraint like syllable integrity is unrerankable only in the postlexical stratum, which would have the desired effect.

I know of no theoretical argument against this kind of solution, but the empirical facts in Abkhaz argue against it. A Stratal OT analysis would require that the universal-violating prosodic structures are built in the stem- or word-level phonology, where they are used to assign stress, only to be repaired postlexically. However, the domain for Abkhaz stress assignment is bigger than the stem or word. Stress must be assigned in the final stratum which means that the surface representations produced by this stratum, contra our assumptions, must allow for the existence of moras, syllables, and feet which violate exactly those prosodic universals which we sought to make inviolable. The highly agglutinative nature of Abkhaz verbs means that whole clauses are often expressed in a single stress assignment and schwa epenthesis domain. Examples with multiple content words in a single domain are given in (32). The ungrammatical forms are those which would result if stress assignment and schwa epenthesis were applied to smaller morphosyntactic units.

(32) Multiple content words in one phonological domain

a. аҩнцара
[a-ɥn-t͡sʰa-rá] *[a-ɥnə́ t͡sʰa-rá]
DEF-house-go-INF
'expel from a house'
Yanagisawa (210: 582)

b. аӡца
[a-d͡z-t͡sʰá] *[a-d͡zə́ t͡sʰá]
DEF-water-hot
Spruit (1986: 41)

c. ахаҵара
[a-χa-t͡s'a-rá] *[aχá t͡s'ará]
DEF-head-put-INF
'put on one's head'
Yanagisawa (2010: 444)

The morphemes 'house' and 'head' in (32) a. and c. respectively are treated here as incorporated nouns. Many nouns are bleached into a preverb when used in this way and do not retain their original semantics. The examples above are ones which are transparently related to existing Abkhaz words and which do retain their semantics. The situation is identical in closely related Abaza, often with cognate morphemes, and Arkadiev (2021) argues that there is a spectrum from noun incorporation (as in (32)) to affixation in the more grammaticalized cases.

8.2.7 Underlying moras

The theoretical problems for a moraic analysis are all related to the relationship between the mora and the syllable. Moras occupy unexpected positions in syllable onsets, and there are more moras per syllable than expected based on crosslinguistic restrictions. Syllable integrity violations arise because feet built over moras are not always aligned with syllable edges. In the preceding section I have argued that these problems necessarily exist at some level of the derivation, even if that level is not the surface representation. There is one possible exception to this: what if moras were underlying?

If moras are present in the lexicon, while syllables are not, it may be possible to assign stress using moraic feet before any syllables are constructed. After stress has been assigned, any theoretically problematic prosodic structure could be deleted so that syllabification can proceed. In the moraic analysis I have proposed, moras are instead assigned during the derivation, due to their syllabic position as usual. However, at least Vaux & Samuels (2018) explicitly argue for underlying moras, against the assumption that predictable prosodic structure is not stored in the lexicon. It is therefore worth considering this possibility briefly here.

If one accepts the possibility of underlying moras, the question becomes which segments are underlying moraic. Since the aim is to assign stress only on the basis of underlying moras, the answer must be that there is one mora for all and only segments which are relevant for stress assignment. A /CVCC/ stem ought to be moraified as /$CV_{\mu}C_{\mu}C_{\mu}$/, with the /CV/ sequence sharing a mora since it behaves as a single unit in stress assignment. It is difficult to ensure that only this type of moraic structure is found in underlying representations.

Optimality Theoretic analyses typically eschew morpheme structure constraints, so there is nothing ruling out an underlying representation /$C_\mu V_\mu$/, where a /CV/ morpheme contains two accent specifications. As I have shown in Chapter 7, Section 7.3, allowing such representations predicts unattested stress alternations. We would like the grammar to repair this structure before stress is assigned. This is relatively straightforward to accomplish, since Abkhaz appears to ban immediately prevocalic syllable onsets from being moraic (see Section 8.2.4 for discussion). However, notice that this makes reference to syllables. It is not possible to have one's cake and eat it too: stress must be assigned based on moras before there are any syllables, but there must be syllables to ensure that the moraic structure corresponds to the number of accent specifications allowed.

One possible solution is to ban $C_\mu V_\mu$ sequences with a purely segmental constraints without reference to syllable structure, e.g. *$C_\mu V_\mu$: assign one violation for every consonantal mora followed by a vocalic mora. However, this undermines the advantage that prosodic approaches to Abkhaz stress have over a segmental analysis like the one in Chapter 7. The motivation for a prosodic approach, whether syllabic or moraic, is precisely the fact that it predicts that /CV/ sequences should behave as units in the stress system. This follows from the universal syllabification of [CV] as onset-nucleus, and does not have to be stipulated using readjustment rules as in Chapter 7, Section 7.3. If one acknowledges that CV units are unrelated to syllabification, and that they are captured by a segmental constraint, it becomes difficult to see what advantage a prosodic analysis has over one which makes direct reference to segments.

If this type of analysis is implemented, it should also be considered whether the prosodic structures it proposes are learnable. The learner would need to postulate underlying representations with moras in the correct places for stress assignment from surface representations which show no evidence for the underlying moras since the surface moraification is, by hypothesis, an entirely different system. This particular combination of hidden structure and opacity must be acquired only by noticing that certain patterns of stress alternation are absent. The segmental analysis in Chapter 7 avoids these problems since stress is not assigned based on an abstract prosodic system, but based directly on segments which are also present in the surface representations. There is no need to learn a prosodic system beyond the surface syllabification.

8.2.8 Conclusions on moras

In this section I have attempted to formulate a moraic analysis of stress assignment and related phenomena, notably schwa epenthesis, in Abkhaz. Such an analysis faces multiple problems, and mapping Spruit's (1986) elements directly onto the mora leads to violations of several prosodic universals. I have discussed solutions from previous literature on moraic stress in Abkhaz (Kathman 1992, Vaux & Samuels 2018), and argued that significant problems remain with respect to moraic onsets and the seemingly limitless number of moras allowed in Abkhaz syllables.

Moreover, even if one accepts typologically unusual prosodifications of Abkhaz, using moraic feet to assign stress leads to still more problems in the form of syllable integrity violations. Syllable integrity will be discussed again with data from languages other than Abkhaz in Chapter 9, Section 9.2. I have attempted to argue that there is no moraic analysis of Abkhaz which does not violate several prosodic universals, and that even restricting the universals to only apply to surface representations or introducing underlying moras is empirically and theoretically unworkable. For these reasons, I have not pursued a moraic analysis in this dissertation, and instead favor the segmental analysis from the previous chapter. I hope that the fragments of a moraic Harmonic Serialism grammar that I have given in this section will nevertheless be useful to anyone who wishes to pursue analyses of Abkhaz stress based on prosodic units such as moras and syllables.

8.3 Conclusions

In this chapter I have discussed alternatives to the segmental analysis of Abkhaz stress assignment in Chapter 7. I have covered both syllabic and moraic analyses, in Sections 8.1 and 8.2 respectively. Replacing Spruit's (1986) 'elements' with syllables contradicts independent evidence on syllables in Abkhaz from the intuitions of native speakers and the units relevant in Abkhaz metrics. On the other hand, using the syllables suggested by these sources of evidence as stress-bearing units fails to capture 40% of the nominal stress alternations in Abkhaz.

The mora is a more promising candidate to replace elements, and I believe this is the most workable non-segmental analysis of Abkhaz stress. Nevertheless I have argued that there are significant theoretical obstacles to a moraic analysis. The units relevant in Abkhaz accentuation do not behave as we would expect moras to behave. Syllables may have four, five, or even six moras under this analysis, many of which dominate only onset consonants. The patterns of moraification do not align with other languages which have been argued to have moraic onsets, and are difficult to generate in a theory of Abkhaz prosodification. I have discussed attempts to address the unusual moras in Abkhaz, and shown that the same problems of mora proliferation remain even if one grants all of the assumptions necessary for the proposed solutions to work.

I have also discussed the difficulties in using feet to assign stress with a partial Harmonic Serialism grammar of moraic stress in Abkhaz. Generating the metrical feet which accomplish primary and secondary stress assignment by Dybo's Rule is not in itself complicated, but it appears to lead inevitably to violations of syllable integrity. The fact that monosyllabic words require different foot structures at some stage in the derivation proves to be problematic. I have tried to circumvent these problems by discussing the ordering of moraification and syllabification, including analyses with underlying moras, and by restricting syllable integrity to surface representations only. However, neither of these solutions appear empirically and theoretically adequate, and I have argued that it is difficult to even state some aspects of the solutions in constraint-based theories of prosodification.

For the reasons summarized above, I have found it more fruitful to examine Abkhaz stress assignment in a theory where individual consonants and vowels are the units relevant for stress assignment, and where stress is assigned using bracketed grids rather than metrical feet. However, the debate initiated by Dybo's (1977) research almost half a century ago about which units are relevant for Abkhaz stress assignment is far from over, and there is no reason to think that it will not continue over the coming half a century too. I close this dissertation with a final chapter discussing some of the questions raised by the existence of a language where stress assignment is segmental.

Chapter 9: Discussion and Conclusions

In this concluding chapter, I not only summarize the arguments from previous chapters, but also discuss some implications of the analysis I have proposed. This includes broad questions about phonological typology, what Abkhaz does or does not provide evidence for, and which other types of rare stress systems one might expect to exist. I provide some discussion of these topics in Section 9.4, after summarizing the dissertation as a whole in Section 9.1, and discussing specific features of Abkhaz stress from a phonological and historical perspective in Sections 9.2 and 9.3.

In this dissertation I have argued for an analysis of Abkhaz with no phonemic schwa, and where underlying accentual contrasts are associated with individual segments. The process(es) of schwa epenthesis in Abkhaz bring about radical differences between the underlying and surface representations as far as prosodic generalizations are concerned. Underlyingly consonants play a vital role in the stress system, but schwa epenthesis ensures that surface stress is always on a vowel. Because of schwa epenthesis all Abkhaz syllables also contain a vocalic nucleus, and there is never more than one stress in a syllable. This raises questions about the potentially universal role vowels and syllables have to play in prosodic systems.

Related to this is the question of syllable integrity, which I have argued must be violated in any moraic analysis of Abkhaz stress. It is possible to maintain that there are no surface violations of syllable integrity in Abkhaz by readjusting foot boundaries after stress has been assigned. Is it an accident of Abkhaz that violations of syllable integrity can be restricted to earlier stages of the derivation, or is it a true universal that surface representations can never violate syllable integrity? As with the discussion of schwa epenthesis, it may seem suspicious that inserted vowels allow for the removal of all of the configurations which violate prosodic universals. The rare properties of Abkhaz stress can therefore not be observed in surface representations, but must be inferred to exist at some earlier level of the phonology.

I also discuss the diachrony of prosodic systems like the one I have argued for in Abkhaz. How did a stress system with consonants being equal in importance to vowels arise diachronically? And does the unusual nature of Abkhaz stress assignment mean that it is diachronically unstable? Perhaps a system like that of Abkhaz is so difficult to learn that within a generation or two of its creation learners will restructure it and reshape it into a more typologically common form. If this is the case, it may call into question whether phonological theories of stress assignment really need to accommodate a type of language which learners struggle to faithfully reproduce.

I do not claim to have definitive answers to any of the questions mentioned above, and can only provide discussion of some possible interpretations based on the data available to me. I argue that comparing Abzhywa Abkhaz with other dialects of Abkhaz and with unrelated languages reveals that schwa epenthesis is indeed a language- and dialect-specific peculiarity. There are languages where consonants play a role in the stress system and where this is reflected directly in surface representations without epenthetic vowels to carry stress. Such cases always involve syllabic consonants, suggesting that perhaps the syllable is more important than the vowel in organizing prosodic systems. However, there are also languages like Banawá, with a typologically more common rhythmic stress pattern, which have been argued to have violations of syllable integrity in their surface representations. It seems difficult, then, to maintain that syllable-based constraints like syllable integrity are true universals at the level of surface representations.

I also argue that the stress patterns found in Abkhaz are stable diachronically. They appear to have been learned faithfully for hundreds of years, and may be as old as the split of the Northwest Caucasian language into the separate languages of Ubykh, Abaza, and Abkhaz. There is no indication that the core principles of stress assignment have undergone any changes since Abkhaz first began to be documented extensively in the middle of the 19th century.

By way of concluding remarks, I discuss the typological implications of recognizing Abkhaz as having a segmental stress system. I suggest that the only change Abkhaz forces us to make in terms of phonological theory is parameterizing on a language-by-language basis the size of the unit (syllable, mora, segment) relevant to stress systems. Once this change is made, at least Idsardi's (1992) framework requires no additional modifications. If one disregards the fact that Abkhaz metrical grids have segments on Line 0, there is nothing prosodically unusual about this language at all. I also exemplify patterns of stress assignment which are, as far as I know, currently unattest*ed*, but which I predict are attest*able* in human language. This includes rhythmic stress assignment defined over segments. I suggest that there may not be universally applicable necessary and sufficient criteria for distinguishing between stress and other word-level prosodic systems (tone, pitch accent), or between suprasegmental and segmental phonology, and that further research will uncover more languages like Abkhaz which straddle these boundaries.

In Section 9.1 I provide a brief general conclusion of the data and arguments in this dissertation. Section 9.2 discusses the issue of differences between underlying and surface representations in Abkhaz prosody, and what this means for prosodic typology. Section 9.3 covers the diachronic situation of how the modern Abkhaz stress system arose, and discusses comparative data from other Northwest Caucasian languages. Section 9.4 discusses typological implications of segmental stress and closes the dissertation.

9.1 A brief summary

In this dissertation I have discussed the lexical accent system of Abkhaz, and its interaction with the segmental phonology. Abkhaz has a rich system of stress alternations even on underlyingly vowelless morphemes. I have argued that it is individual vowels *and consonants* which carry lexical accents in this language, rather than prosodic units such as moras or syllables. I have presented new quantitative and theoretical studies of the phonetics and phonology of Abkhaz, both regarding its vowel system and its prosody, showing that the data lead to a segmental stress system. Methodologically I have relied on a mix of acoustic experiments, poetic scansion data, two new database corpora of Abkhaz stress alternations, computer-guided evaluation of phonological theories, as well as traditional theoretical argumentation.

After the introduction of methodological details and basic empirical facts about Abkhaz stress in Chapters 2 and 3 respectively, I presented a discussion of the vowel system of Abkhaz in Chapter 4, arguing that the vowel [ə] is fully predictable, and need not be entered into underlying representations. I presented novel quantitative data on phonotactic restrictions, as well as acoustic data on secondary stress. These data favor an analysis where [ə] is epenthesized under stress when there is no lexical vowel to carry that stress. The absence of /ə/ from the inventory of underlying vowels leaves many vowelless morphemes, a fact of great significance for the analyses of stress in subsequent chapters.

In Chapter 5 I presented a theory of stress assignment in Abkhaz. I argued for a binary division accented-unaccented, without additional categories such as pre-accenting and post-accenting. By studying affixed forms, I showed how it is possible to determine accent status empirically. By investigating the stress behavior of forms with particular combinations of accents, I derived a theory which places stress on the leftmost accent not immediately followed by an accent, i.e. Dybo's Rule (Dybo 1977). In deriving the theory from the bottom up by comparing empirically motivated categories of stress behavior I hope to have provided stronger empirical evidence that this rule is operative in Abkhaz.

In Chapter 6 I investigated the generalizations about stress alternations found in the nominal and verbal corpora which I have compiled. I showed that in both nominals and verbs, longer stems have more patterns of stress alternation, suggesting that something smaller than the morpheme must carry underlying accents. I implemented the theory of stress assignment from Chapter 5 using computer programming, and showed that it reaches high empirical coverage for nouns and adjectives, but performs more poorly on verbs. I therefore proposed a revised theory of stress assignment, which captures many patterns of exceptional stress placement in verbs. This revised theory improves on the empirical coverage of the original theory. Apart from various patterns of accentual allomorphy, I proposed that verb stems are pre-accenting in certain morphological and phonological contexts, instead of being assigned by Dybo's Rule.

In Chapter 7 I implemented the analysis from Chapter 6 in Idsardi's (1992) grid-based framework. In this analysis individual consonants and vowels can bear underlying accents. I showed that a single phonological grammar, combined with several accentual allomorphies, predicts the regular and exceptional patterns of primary and secondary stress assignment with high accuracy. It also implements the epenthetic analysis of [ə] from Chapter 4, capturing the interactions between segmental and prosodic domains. The segmental analysis of Abkhaz stress gives no special status to CV sequences, which do not show accentual contrasts within morphemes. I analyzed apparent CV units as arising from readjustment rules, independently motivated by the accentual behavior of polymorphemic sequences.

In Chapter 8 I discussed analyses where stress is assigned based on prosodic units, syllables or moras, rather than individual segments. I showed that syllabic analyses either contradict available data on Abkhaz syllabification, or else fail to predict stress placement in over 40% of the nominal lexicon. Moraic analyses fare better, and I provided a Harmonic Serialism grammar of Abkhaz stress assignment based on moraic feet. However, the units relevant for Abkhaz stress assignment look dissimilar from moras in several ways, and many proposed universals about moraic structure are violated by this analysis. Previous moraic analyses of Abkhaz fail to resolve these problems, all of which are absent in a segmental analysis of the stress system. I have discussed several attempts to account for the Abkhaz data while retaining weaker formulations of prosodic constraints, but have not been successful. For these reasons the data in Abkhaz favor an analysis with segmental stress over prosodic alternatives.

Finally, I turn now in this closing chapter to the discussion of some of the broader questions about phonology, typology, and diachrony raised by the Abkhaz data and by the segmental analysis of the data which I have argued for.

9.2 Underlying representations, surface representations, and schwa epenthesis

Many analyses of lexical stress languages treat the vowel as the underlying locus for accentual contrasts (Alderete 1999, Revithiadou 1999, Yates 2017, and other work cited in Chapter 8, Section 8.1.4). In surface representations syllables have been argued to serve universally as the stress-bearing unit (Hayes 1995, Hyman 2006). Abkhaz has the unusual property that its surface representations are unremarkable, while being generated by a typologically unusual segmental stress system which does not depend on vowels. Once stress has been assigned, schwa epenthesis ensures that very little of what is unusual about Abkhaz stress ever reaches the surface representation. Moraic analyses are free to restructure feet to respect syllable integrity after stress assignment, so that no violations of this constraint occur on the surface. Does this reveal something about the nature of phonology in general, perhaps a universal connection between vowels or syllables and prosodic phenomena like stress? I argue that the answer is no.

Beginning with the role of vowels, it is unlikely that Abkhaz schwa epenthesis is a reflection of some universally necessary connection between vowels and stress. This is seen most clearly by comparing Abzhywa Abkhaz, the dialect I have analyzed in this dissertation, with other dialects. Consider the derivation of a word like (Abzhywa Abkhaz) [ʒə́-k’] ‘one (piece of) meat’ (Yanagisawa 2010: 119-120) from the accented stem /ʒ́/ ‘meat’ and the unaccented suffix /-k’/ ‘INDF’. In the analysis I have argued for, stress is assigned to the stem consonant, which is then subject to schwa epenthesis.

(1) Schwa epenthesis for stressed consonants

a. Underlying representation

Line 1	*	
Line 0	*)	*
Segments	ʒ	k’

b. After stress assignment, before epenthesis

Line 1	*	
Line 0	*	*
Segments	ʒ	k’

c. Surface representation after epenthesis

Line 2		*	
Line 1		(*	
Line 0	*	*	*
Segments	ʒ	ə	k’

But it would be equally possible to have a language just like Abzhywa Abkhaz without the schwa epenthesis in (1) c. Evidence for this is the existence of the Cwyzhy dialect of Abkhaz, where schwa epenthesis is optional in many circumstances. The form for ‘one (piece of) meat’ can therefore surface either as [ʒʲə́k’] like in Abzhywa, or as [ʒ̩́ʲk’], with a stressed syllabic fricative on the surface (Andersson et al. 2023). According to Bruening (1997: 301), vowels, nasals, fricatives, and affricates can form nuclei in Cwyzhy.

Stressed syllabic consonants are of course also known from languages unrelated to Abkhaz, for example in Slavic languages like Czech and Slovak (Short 2009). If the lexical set NURSE is analyzed as having a syllabic [ɹ̩] in rhotic varieties of English, pronunciations like [ˈkɹ̩.lɪŋ] ‘curling’ also exemplify syllabic consonants bearing stress. However, the data from Cwyzhy Abkhaz show that this is a possibility even in a variety whose accentual system otherwise appears to be identical to that of Abzhywa Abkhaz

(Vaux 2015, Vaux & Samuels 2018; see Section 9.3 for discussion of the diachronic stability of stress systems in Northwest Caucasian).

The relevant consonants in Cwyzhy Abkhaz are syllabic, and this may be of importance given the close typological connection between syllables and stress. In Chapter 8 I discussed how analyses of Abkhaz based on moraic feet can remove violations of syllable integrity from surface representations entirely by readjusting the foot boundaries once stress has been assigned. Crucially syllable integrity violations are present when stress is assigned, and there is no independent evidence for foot boundaries which always coincide with syllable boundaries in Abkhaz. Nevertheless it is interesting that the constraint can apparently be maintained for surface representations. Once again, however, this appears to be a property which holds only for Abkhaz, and not for human language in general.

In the Arawan language Banawá (ISO 639-3 [jaa], Brazil), it has been argued that syllable integrity is violated in surface representations (Buller et al. 1993, Everett 1996, 1997). Banawá has rhythmic stress, where every other mora is stressed. This can lead to stress contrasts within bimoraic syllables, depending on whether the relevant syllable is an odd or even number of syllables away from the left edge of the word. For example, the single syllable [reu] can be stressed either as [réu] or [reú] (Ladefoged et al. 1997: 108). Stress contrasts within monosyllables is exactly what syllable integrity intends to rule out, and foot-based analyses of Banawá violate this constraint (Buller et al. 1993, Everett 1996, 1997).

(2) Stress contrasts in a monosyllable (Ladefoged et al. 1997: 108)

a. [**réu**.ká.na] to stir

b. [ré.**reú**.ka.ná] crank

The placement of Banawá stress is based not only on transcriptions by fieldworkers but also by data from three native speakers instructed to tap on stressed syllables (Ladefoged et al. 1997). Banawá stress appears to be cued by a combination of pitch, amplitude, and duration (Wiltshire 2004). Independent evidence for Banawá syllabification, confirming that CVV is a single syllable, comes from a truncation process in hypocoristics (Everett 1996, 1997). Apart from analyses of Banawá cited above which violate syllable integrity (for which see also Martínez-Paricio & Kager 2020), it is interesting to note that Hyde's (2007) analysis avoids syllable integrity violations in the same way that I have avoided them in Abkhaz. Hyde (2007) proposes that stress in Banawá is assigned based on metrical grids built over moras, so that feet are not directly used in stress assignment. This is similar to the analysis I have proposed for Abkhaz, with metrical grids built over segments, so that moras, syllables and feet are not used to assign stress. Hyde (2007) does also construct feet for Banawá, but in Abkhaz I am not aware of any independent evidence for feet.

Violations of syllable integrity have also been proposed recently for phonological patterns in several other languages, including tone spread in Copperbelt Bemba (Breteler & Kager 2022) and tone sandhi in Suzhou Wu (Zhu 2023). Earlier analyses which argue for violations of syllable integrity include Blevins & Harrison's (1999) analysis of Gilbertese and Shimoji's (2009) analysis of Irabu Ryukyuan. Although moraic analyses of Abkhaz can be configured so as to only violate syllable integrity in non-surface representations, this is not possible in the languages cited above.[57] In general the data from other languages in this section suggest that schwa epenthesis is a language- or variety-specific process in Abzhywa Abkhaz, and not one which only exists to ensure that surface representations obey inviolable prosodic universals.

9.3 Diachrony

In this section I discuss how the stress system of Abzhywa Abkhaz may have arisen. Although there is a wealth of comparative data for Abkhaz dialects, and to a lesser extent for closely related languages, prosodic reconstruction is exceedingly difficult. The five Northwest Caucasian languages (Abkhaz, Abaza, Ubykh, Kabardian, and Adyghe) either have stress systems which are very similar to that of modern Abzhywa Abkhaz, or else have entirely different systems which are not helpful in reconstructing how the Abkhaz system arose. However, the diachronic stability of Abkhaz stress assignment has some implications for synchronic analyses, since the stress system has been learned faithfully for hundreds of years. It is clearly learnable, and not a transitory or unstable stage in the language with which learners struggle. This makes Abkhaz stress unlike other rare phonological phenomena, which have been argued to disappear from the historical record as soon as they arise.

The earliest written recording of an Abkhaz word may be a 2nd-century BCE coin rendering the present-day Abkhazian capital [áq’ʷa] ‘Sukhum’ as ‘aki’ or ‘aku’ (Chirikba 2003: 9). However, ancient textual references to the ancestors of modern Abkhazians are of little use for prosody. The earliest comprehensive resource which indicates stress is

57 This argument also suggests that perhaps syllable integrity violations are not such a serious problem for moraic analyses of Abkhaz. Recall from Chapter 8, Section 8.2 that moraic analyses also face problems with the numbers of moras per syllable and the types of moraic onset present in Abkhaz, however.

Uslar (1887), which was in fact based on a lithographic edition from 25 years prior (Chirikba 2023: 4: fn. 2). Already in this grammar a stress system identical to that of modern Abkhaz is found. A few examples will illustrate this point. There is no stress shift in the plural for forms which do not end in stressed vowels (3) a. For forms which do end in stressed vowels, stress surfaces on the plural suffix, and if the vowel of the singular is [ə] it is not found in the plural (3) b. This is identical to the generalizations for accented suffixes for modern Abkhaz in Chapter 5.

(3) Stress alternations in 19th-century Abkhaz

a. Uslar (1887: 154)

i. [a-p^{h}sə́d͡z]
DEF-fish
'fish (singular)'

ii. [a-p^{h}sə́d͡z-k^{wh}a]
DEF-fish-N.PL
'fish (plural)'

b. Uslar (1887: 111)

i. [a-t͡ʃ'^{w}ə́]
DEF-skewer
'spit, skewer'

ii. [a-t͡ʃ'^{w}-k^{wh}á]
DEF-skewer-N.PL
'spits, skewers'

In modern Abkhaz definite-indefinite alternations can involve alternations between prefix stress and stem- or word-final stress, and Uslar (1887) records similar alternations. His indefinites most often have word-final stress, which is still an option today.

(4) Stress alternations in Uslar (1887: 111)

a. [á-t͡sʰħa]
DEF-bridge
'bridge'

b. [t͡sʰħa-k'ə́]
bridge-INDF
'one bridge'

Short, i.e. C(V), unaccented verb stems are pre-accenting in particular morphological contexts (see Chapter 6, Section 6.3), but longer (e.g. CCV) unaccented verb stems are not. Thus (5) a. ii. has stress immediately before the (short, unaccented) C(V) stem /t͡ʃʷʰa/ 'sleep', while morphologically identical and phonotactically similar (5) b. ii. has stem-final stress by Dybo's Rule, because the stem is not of shape C or CV.

(5) Pre-accentuation in 19th-century Abkhaz

a. Uslar (1887: 174)

i. [á-t͡ʃʷʰa-ra]
DEF-sleep-NMLZ
'sleep (n.)'

ii. [wú-t͡ʃʷʰa]
2SMA-sleep
'Fall asleep!'

b. Uslar (1887: 176)

i. [á-t͡ʃʰt͡ʃʰa-ra]
DEF-laugh-NMLZ
'laughter'

ii. [wu-t͡ʃʰt͡ʃʰá]
2SMA-laugh
'Laugh!'

Abaza is the Northwest Caucasian language most closely related to Abkhaz, and there is "significant mutual intelligibility between the two" (O'Herin 2021: 448). Its stress system is highly similar to that of Abkhaz (Borise 2021b). Again I give a few examples to illustrate this. Abaza forms come from Allen (1956), and I have retained his transcription system without any attempt to convert it into IPA. These transcriptions do not reflect even obligatory processes of vowel coloring, which are very similar to those of Abkhaz (Allen 1956: 150-151).

The suffix /-χa/ 'become' is accented, and so it takes stress when added to forms ending in a stressed vowel. If the form to which it attaches does not end in a stressed vowel, the suffix is unstressed. This is shown with cognate forms in (6), with Abaza in i. and Abkhaz in ii. Note that stress surfaces on the suffix /-χa/ in (6) b. because the stem 'cold' ends in a stressed vowel, as seen in (6) a. The stem /dw/ 'big' is consonant-final, and therefore the suffix /-χa/ is unstressed in (6) c.

(6) Cognate stress alternations in Abkhaz and Abaza

a.

i. y-x^{y}tá-b
it-cold-STAT.PRES
'it is cold'
Allen (1956: 137)

ii. [ji-χ^{j}t^{h}ó-wp']
3NA-cold-STAT.PRES
'it is cold'
Yanagisawa (2010: 470)

b.

i. y-x^{y}ta-xá-yd
it-cold-become-DYN.FIN
'it is getting cold'
Allen (1956: 137)

ii. [ji-χ^{j}t^{h}a-χó-jt']
3NA-cold-become.DYN-DYN.FIN
'it is getting cold'
Yanagisawa (2010: 471)

c.

i. y-dә́w-xa-d
it-big-become-PST
'it grew big'
Allen (1956: 138)

ii. [ji-dúw-χe-jt']
3NA-big-become-DYN.FIN
'it grew big'
Yanagisawa (2010: 104)

Just as in Abkhaz, Abaza morphemes often show alternations between [Cә́] under stress and [C] when unstressed. This is shown for Abaza c̓^{w}ә́ ~ c̓^{w} 'belong', whose cognate in Abkhaz is /t'^{w}/.

(7) Covariation between stress and schwa in Abaza

a. y-s-c̓^{w}ә́-b
it-me-belong-STAT.PRES
'it belongs to me'
Allen (1956: 137, fn. 1)

b. y-s-c̓^{w}-xá-d
it-me-belong-become-PST
'it came into my possession'
Allen (1956: 137)

Just as in both historical and modern Abkhaz, short unaccented verb stems are pre-accenting, as shown by cognate forms of ‘disappear’:

(8) Pre-accentuation in Abaza and Abkhaz

a. də́-δ-d
he-disappear-PST
‘he has disappeared’
Allen (1956: 149)

b. [də́-d͡zi-jt’]
3SHA-disappear-DYN.FIN
‘(s)he disappeared’
Yanagisawa (2010: 153)

In Dybo (1977) Ubykh was argued to follow Dybo’s Rule for stress assignment just like Abkhaz. As for Abaza I reproduce Dybo’s (1977) transcriptions faithfully. Accented morphemes in Dybo’s (1977) analysis are shown with +, unaccented morphemes with -, and an arrow ↑ points to the morpheme assigned stress. The verb stem /bγ’ən/ ‘open’ is accented, while /bž’ən/ ‘melt’ is unaccented. Stress is final in both accent-final and unaccented words, as shown in (9) a. In (9) b. the leftmost accent generally receives stress, unless it is immediately followed by an accent. This is identical to the principles of stress assignment from Chapter 5, which Dybo (1977) proposes to be valid for Abkhaz.

(9) Dybo’s Rule in Ubykh (Dybo 1977: 44)

a.

i.

a-	bγ’ə́n
-	+
	↑
it-	open

‘it opens’

ii. sə- bž’ə́n
- -
↑
I- melt
‘I am melting’

b.

i. a- sə- bγ’ə́n
- + +
↑
it- I- open
‘I open it’

ii. a- sə́- bž’ən
- + -
↑
it- I- melt
‘I melt it’

However, later work has suggested that the Ubykh facts may be more variable and complex (Fenwick 2011: 30-31, Borise 2021b). It is relevant that much of the documentation of this language is based on the speech of a single person, Tevfik Esenç, whose death in 1992 has left the language without living native speakers (Fenwick 2011: 10-12).

Strikingly different are the stress systems of the other two Northwest Caucasian languages, Kabardian and Adyghe. In Turkish Kabardian, stress is penultimate by default, but final if the final syllable is heavy (Applebaum 2013). Moroz (2012) documents a similar system for Ulyap Kabardian, but where some apparently open syllables nevertheless count as closed for the purposes of stress assignment. Loanwords and certain jussive forms are also exceptions. Some Adyghe varieties may have consistent final stress at least in nouns, but others have described stress as falling on the final or penultimate syllable of the word (Moroz 2021: 125-126). The details of Adyghe stress assignment are variable and relatively understudied (Borise 2021b: 743).

Chirikba (2003: 11) groups Ubykh, Abaza, and Abkhaz as descending from a Proto-Ubykh-Abkhaz ancestor, with Kabardian and Adyghe forming a separate branch of Northwest Caucasian. The accentual system of modern Abkhaz may then date back to this Proto-Ubykh-Abkhaz language. However, others group Ubykh with Kabardian and Adyghe (Chirikba 2003: 11, fn. 21), in which case something like Dybo's Rule for stress assignment may be as old as Proto-Northwest Caucasian itself. Dybo et al. (1978) suggest that the origin of the stress system may be tonal, with modern accents corresponding to historical high tones. They base this on a tonal distinction in Tapanta Abaza, where stressed syllables bear a high tone if and only if they correspond to underlying accents. However, subsequent fieldwork has failed to find any evidence for such tonal distinctions in Tapanta Abaza (Borise 2021a: 761).

The time depth of Northwest Caucasian is not known with any certainty, but even the most closely related languages today appear to have diverged before the first documentation of Northwest Caucasian. There is a 17th-century word and phrase list of Abkhaz from Evliya Çelebi, whose mother spoke Abkhaz. The numerals in this word list are distinctly Abkhaz, with Abkhaz [f] rather than Abaza [t͡sʰ] as the numeral stem for 'six', and without the initial [z] found in Abaza for the number 'one' (for Abaza numerals, see Genko 1955: 177-178; for Abkhaz numerals, see Chirikba 2003: 34-35; for Evliya Çelebi's words and phrases in early Abkhaz, see Gippert 1992). This gives a *terminus ante quem* of the 17th century for the stress system which modern Abkhaz and Abaza share today. This is before factoring in Ubykh, which is more distantly related to Abkhaz and Abaza and which diverged earlier in the family's history.

The diachronic stability of this stress system, having lasted well over 300 years and possibly much longer, suggests that there are no significant problems faced by children learning Abkhaz or Abaza stress. This contrasts with the situation for other typologically rare and complex phonological systems, which have been argued to disappear from the historical record as soon as they arise. For example, rhythmic syncope (deletion of every other vowel) quickly disappeared from Nishnaabemwin, Old Irish, and Old Russian, casting doubt on whether this type of deletion is learnable in human phonological systems (Bowers & Hao 2020). The fact that no restructuring of the Abkhaz-Abaza stress system has happened over the course of hundreds of years suggests that the system is highly learnable, and that synchronic phonological theories must explain how speakers productively use the system to assign stress to novel forms.

As noted above, the data on alternations between schwa and zero are also similar for Abkhaz and Abaza, but little is known about how Abkhaz came diachronically to have a grammar where segments are relevant in stress assignment. Colarusso (1988: 347-372) suggests that Proto-Northwest Caucasian had phonemic /ə/ and that unstressed deletion was later reinterpreted as synchronic epenthesis. Lomtatidze (1976: 300) suggests that at least the great majority of schwas in Abkhaz and Abaza go back to a historical *a which reduced to schwa in some but not all positions. Both of these analyses attribute to the proto-language a phonotactic structure where underlying accents could be seen as properties of underlying vowels or syllables. However, early historical attestations of Abkhaz (Uslar 1887, Gippert 1992) do not show these reconstructed vowels, so the current segmental stress system of Abkhaz appears to be well over 300 years old.

Because of the stability of the Abkhaz-Abaza phonological system over hundreds of years, even in its relatively vowelless form, there is no reason to think that learners struggle with this type of stress system. How does this stability come about in the face of the phonological and morphological complexity of the Abkhaz stress system? I conjecture that the learnability of this system may be helped rather than hindered by the complex morphology of Northwest Caucasian. It is precisely because words regularly contain so many (sometimes consonant-only) morphemes that learners are able to see so many different combinations of accented and unaccented segments, and thereby infer the workings of the accentual system. Complexity is not necessarily a challenge to be overcome, but can help learners acquire the system faithfully.[58]

Because the segmental stress system of Abkhaz is successfully transmitted from one generation to the next, there are no grounds for arguing that phonological theories can ignore Abkhaz as an unstable, transitional state during a restructuring of the language's grammar. Below I discuss what stress-based phenomena we might expect to find in other languages if prosodic theories allow for segmental stress systems.

9.4 Final thoughts and a typological outlook

In this final section, I conclude the dissertation by returning to some of the questions raised in Chapter 1, which highlight the relevance of Abkhaz to phonological theory generally and prosodic typology in particular: which aspects of Abkhaz stress assignment are unique to this language, and which are in line with what is already known about stress systems in other languages? If the segmental analysis I have proposed is on the right track, what other languages or types of languages are predicted to exist? What do the

58 The ideas in this paragraph were developed in part during a conversation with Elan Dresher (p.c.) at the 2024 Annual Meeting of the Linguistic Society of America in New York.

results for Abkhaz suggest about the nature of stress (as opposed to pitch accent or tone) in general?

In the analysis I have developed, there is very little in Abkhaz prosody which is unique to this language. Phonotactically Abkhaz is typologically unusual in allowing long vowelless words underlyingly. But prosodically the only property which sets Abkhaz apart from other languages with similar stress systems is that accents can attach to any segment, not just to vowels. In (10), stress falls immediately after the stem-final consonant /ʂ/ because that is the rightmost accented segment not immediately followed by an accented segment, as indicated by the arrow. The stress assignment algorithm itself proceeds the same for accent specifications associated with consonants and vowels, and it is only later in the derivation that a vowel is epenthesized to carry the stress. The epenthetic vowel is schwa, but due to vowel coloring of əj to [ij] the surface form in (10) has a stressed [i].

(10) A consonant-only word (Yanagisawa 2010: 138)

[sə-b-zə-l-mə-r-pʰʂí-jt’]

/s-	b-	z-	l-	m-	r-	pʰ	ʂ	-j	t’/
-	+	+	+	+	+	+	+	-	-
							↑		
1SA-	2SFO-	BEN-	3SFE-	NEG-	CAUS-	wait		-DYN.FIN	

‘she did not make me wait for you’

Once we take accent specifications on segments into account, however, there is nothing remarkable about Abkhaz prosody whatsoever. I have analyzed the stress assignment rules using Idsardi’s (1992) grid-based framework, and have not made any theoretical modifications. Abkhaz has rules of clash resolution, parenthesis deletion, and gridmark projection, all of which are familiar from typological studies of stress assignment.

The only difference is that the unit represented on line 0 of Abkhaz metrical grids is the segment, and not the syllable, mora or vowel as in analyses of other languages. A parallel can be drawn to other cases where typologically unusual properties are successfully analyzed in an existing framework, simply by modifying the role that different phonological units are allowed to play on a language-by-language basis. In Imdlawn Tashlhiyt Berber, words like [tṛ.kṣt] 'you hid' (Dell & Elmedlaoui 1985: 116) do not require us to redefine sonority or invent new models of syllable structure. Once we allow all Berber segments, even voiceless obstruents, to act as syllable nuclei, the data are explained. The same is true for allowing all Abkhaz segments, even voiceless obstruents, to carry accent specifications. I suggest that the size of the unit relevant to the stress system is parameterized so that languages with stress systems can build prosodic representations over syllables or moras or segments, in the same way that the class of segments allowed as syllable nuclei is parameterized. Other prosodic patterns may make use of different units than these three (syllables, moras, segments), as in whole-word reduplication in Madurese (Steriade 1988), or perhaps the intonational system of Ambonese Malay, where some contours seem to align with words without being anchored to any specific prosodic unit within those words (Maskikit-Essed & Gussenhoven 2016).

I suggest that there are several factors which lead to the rarity of Abkhaz-type stress systems. As mentioned in Section 9.3 above, the complex accentual generalizations in Abkhaz may only be learnable in languages with sufficiently complex morphology. Words must regularly have enough morphemes to allow a learner to deduce how stress is assigned to words with particular sequences of accents. In addition to this, the fact that vowels have no privileged role in stress assignment can only be learned in a language which regularly allows long vowelless strings. Even Abkhaz has not always been analyzed in this way, and this dissertation contributes to our understanding of Northwest Caucasian by providing new arguments against schwa as a phoneme, leading to vowelless words. The combination of these factors means that the typological rarity of the Abkhaz stress system is not especially surprising. This is even more true once we take into account the fact that so much of the literature on prosody focuses on languages without lexical accents. Analyses of more familiar lexical accent languages has already revealed partial dependencies on segmental structure. For example, Chew's (2003: 319-320) analysis of Russian post-accenting stems is that the stem-final consonant is accented: /kolbaś/ gives [kalbás] 'sausage (genitive)' while /kolbaśa/ gives [kalbasá] 'sausage (nominative)'. More detailed studies of lexical accent languages may reveal additional segmental stress patterns.

The fact that Abkhaz can be accounted for within existing frameworks of prosody with a simple parametrical change does not mean that no predictions are made by introducing segmental stress languages into existing typologies. If stress assignment can operate directly on segments, we predict that there are segmental counterparts of stress-based processes which normally apply to larger units. Abkhaz illustrates this with segmental clash resolution, but other segmental stress processes should also be attestable. Segmental rhythmicity, strict alternation between stressed and unstressed segments, may lead to forms like (11).

(11) A hypothetical form with segmental rhythmicity

[sŕtźnáeí]

In Ancient Greek, there was a window restriction whereby an accent could not surface more than three syllables from the right edge of a word (Probert 2003: 33). When an unaccented clitic is added after a word whose accent is already antepenultimate, a rule inserts an additional accent, and the window restriction is not violated in surface representations (Probert 2003: 148). The example below is from Sappho, and reflects Lesbian accentuation patterns (Probert 2003: 160):

(12) Window restrictions in Lesbian Ancient Greek

[enántióstoj], *[enántiostoj]
/enántios=toj/
opposite=you
'opposite you'

We may expect to find a segmental counterpart of Ancient Greek, which would look as follows:

(13) A hypothetical segmental window restriction

[zŕkós], *[zŕkos]
/zŕko=s/

Some of these predictions may be difficult to verify, since the sample of currently attested languages is skewed in various ways: there are not as many languages which allow vowelless syllables or words as ones which ban them, there are not as many languages which have underlying accents as ones which lack them, and so on. However, it would be wise to start a search in areas of the world where complex vowelless syllables and words are found (e.g. Western Canada, Bagemihl 1991; Northwest Africa, Dell & Elmedlaoui

1985) and in language groups with intricate stress systems (e.g. Balto-Slavic, Zaliznjak 1967; Uto-Aztecan, Yates 2017).

The contention that stress systems can be segmental also raises questions about the division between categories like tone, pitch accent and stress. Earlier work (Hayes 1995, Hyman 2006) takes syllable dependency to be an absolute universal of stress systems. If a prosodic system does not depend on syllables, then by definition it cannot be stress. I have argued against this conception. Stresses in Abkhaz are phonetically distinguished by intensity and duration in addition to fundamental frequency, and phonologically, Abkhaz prosody can be analyzed using metrical grid representations and rules developed specifically for stress (for tone, autosegmental representations with association lines between tiers are more typical). If Abkhaz looks phonetically and phonologically like other stress systems, and behaves like other stress systems in all ways except being segmental, I suggest that it is a stress system which happens to be segmental rather than syllabic.

In this respect I agree with a recurring observation in typology, which is that it is difficult to formulate absolute universals which cover every single language without exception. Instead of chasing necessary and sufficient criteria for stress vs. tone, or suprasegmental vs. segmental phonology, it seems more productive to recognize a spectrum. Although the endpoints may be clearly defined prototypes around which most languages cluster, this does not necessarily rule out languages which fall somewhere in the middle. I have argued that Abkhaz is such a language, and I conjecture that as word-level prosodic systems are documented and analyzed in greater detail, the number of Abkhaz-like languages will only increase.

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Appendix A: Acoustics of Primary Stress

In this appendix I present visualizations and statistical analysis of the acoustic cues for primary stress in Abkhaz separately for four speakers. The results for all speakers considered together were presented in Chapter 3, Section 3.2, where I noted that some of the statistical models I fitted have problems due to singular fits. The models presented in this appendix do not have such problems. The appendix contains four sections, one for each participant in the experiment. Each section begins with a visualization of the data for that participant, followed by a statistical analysis using linear mixed effects models.

The statistical models in this appendix are based closely on those in Chapter 3, where each measure (F0, intensity, duration) had four nested models. Two of these differed only in a random slope for the effect of stress by participant. Since the models fitted here only have one participant each, there is no need for such a random slope. I therefore use the following three nested model structures for each measure and for each participant, illustrated with the measure F0 in (1). Vowel has the possible values {[ə], [a]}, while Position may be {Initial, Medial, Final} and Stress {Unstressed, Stressed}.

(1) Figure A.1

Base model:	F0 ~ Vowel + Position + (1|Word)
Intermediate model:	F0 ~ Stress + Vowel + Position + (1|Word)
Full model:	F0 ~ Stress * Vowel + Position + (1|Word)

Model specifications (Experiment 1)

I continue to predict Z-scored values rather than unnormalized values (in Hz, dB, and ms). This is not necessary since there is only one participant in each model, but it makes the numbers reported in this appendix more comparable to the Z-scored values already reported in Chapter 3. The results presented in the sections to come are summarized in (2) below. All participants use F0, intensity, and duration as cues for primary stress, with the exception of speaker C, who does not use F0. Cells marked (int.) denote the additional presence of an interaction effect where the relevant cue is used differently for the two vowels [ə] and [a] for the relevant participant. This table uses a significance threshold of 0.05. There are no trends which hold across the participants for the effect of position, and any participant-specific effects are described in the individual sections of this appendix.

(2) Figure A.2

	F0	Intensity	Duration
Speaker A	✔	✔	✔
Speaker B	✔ (int.)	✔	✔
Speaker C		✔	✔ (int.)
Speaker D	✔	✔ (int.)	✔

Summary of results by participant (Experiment 1)

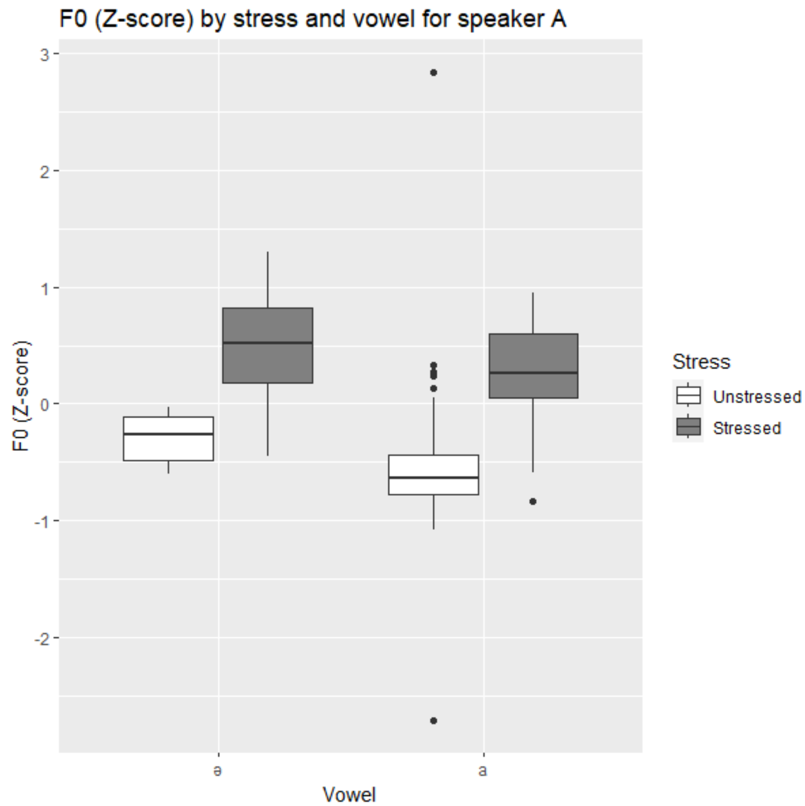
A.1 Speaker A

In this section I show that stressed vowels for speaker A are significantly higher in F0, louder in intensity, and longer in duration than unstressed vowels. There are no statistically significant differences between how stress is realized on the vowels [ə] and [a] for this participant.

A.1.1 Visualization of data

Both vowels for this participant are characterized by a higher F0 when stressed. The vowel [ə] has higher F0 than [a] in both conditions, but the difference between conditions appears to be the same for both vowels.

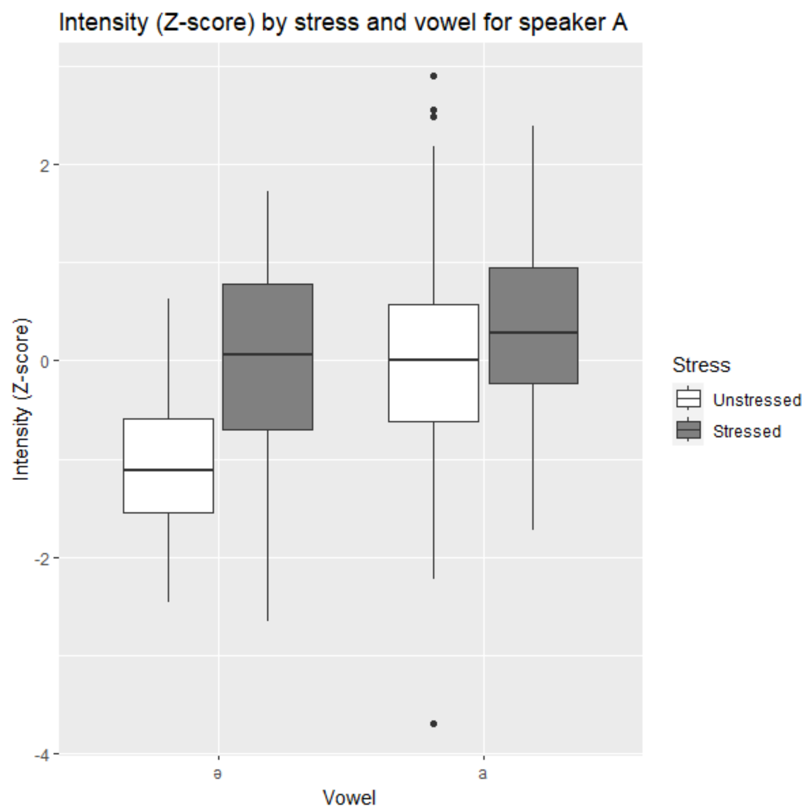
(3) Figure A.3



F0 (Z-score) by stress and vowel (Experiment 1, speaker A)

Stressed vowels are also characterized by higher intensity than unstressed vowels. Intensity is higher overall for the low vowel [a] than for the central vowel [ə], and the difference between stressed and unstressed is greater for [ə].

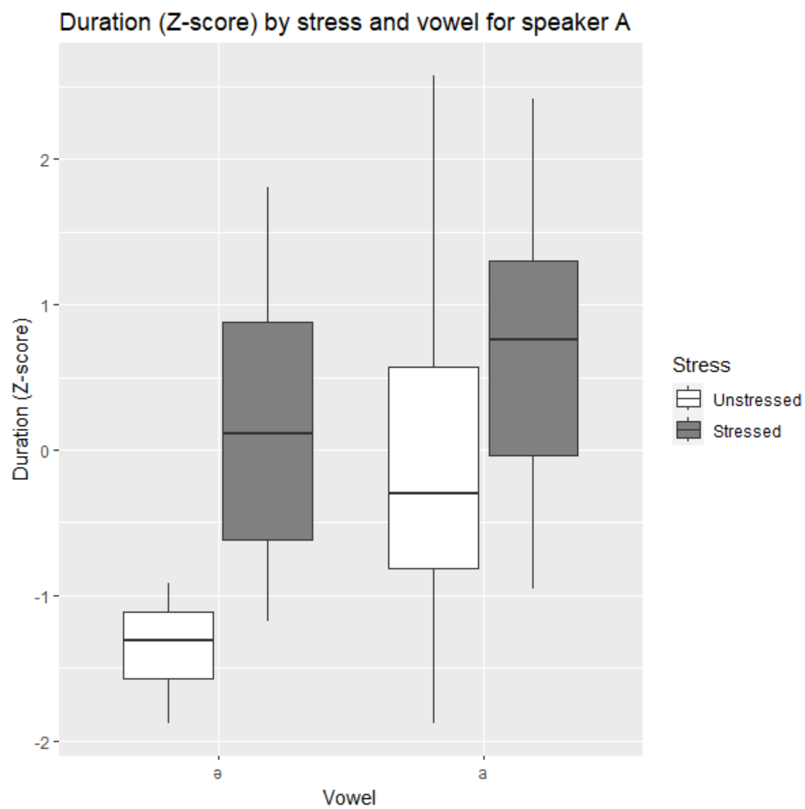
(4) Figure A.4



Intensity (Z-score) by stress and vowel (Experiment 1, speaker A)

For this participant, vowels are also longer in stressed position than in unstressed position. [a] is longer than [ə] overall, and the length difference between stressed and unstressed vowels is slightly smaller for the low vowel.

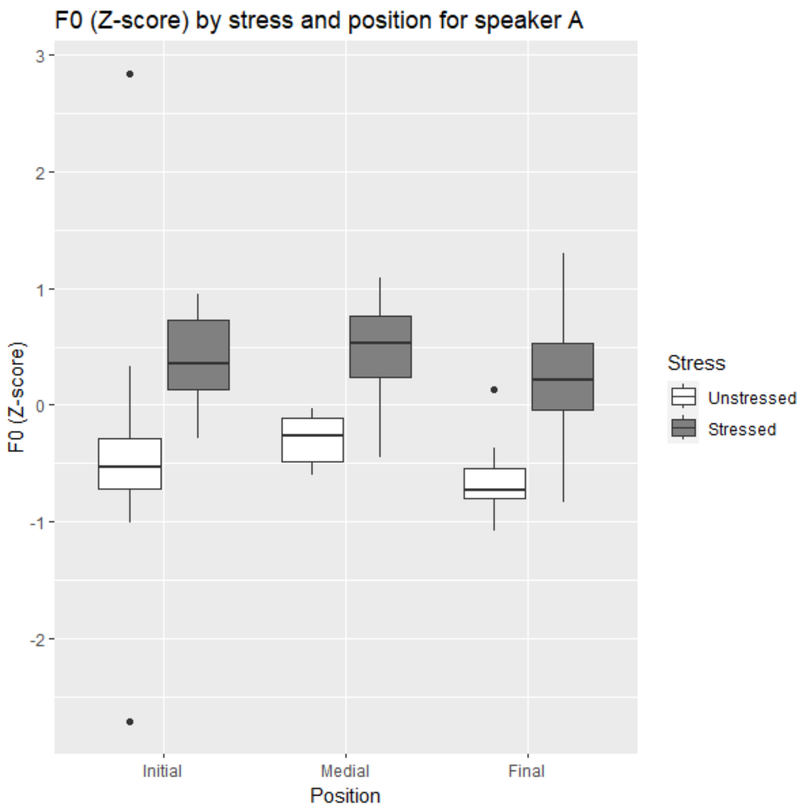
(5) Figure A.5



Duration (Z-score) by stress and vowel (Experiment 1, speaker A)

Medial vowels have a slightly higher F0 than initial vowels, which have a slightly higher F0 than final vowels for this participant. Stress does not obviously affect this in any way.

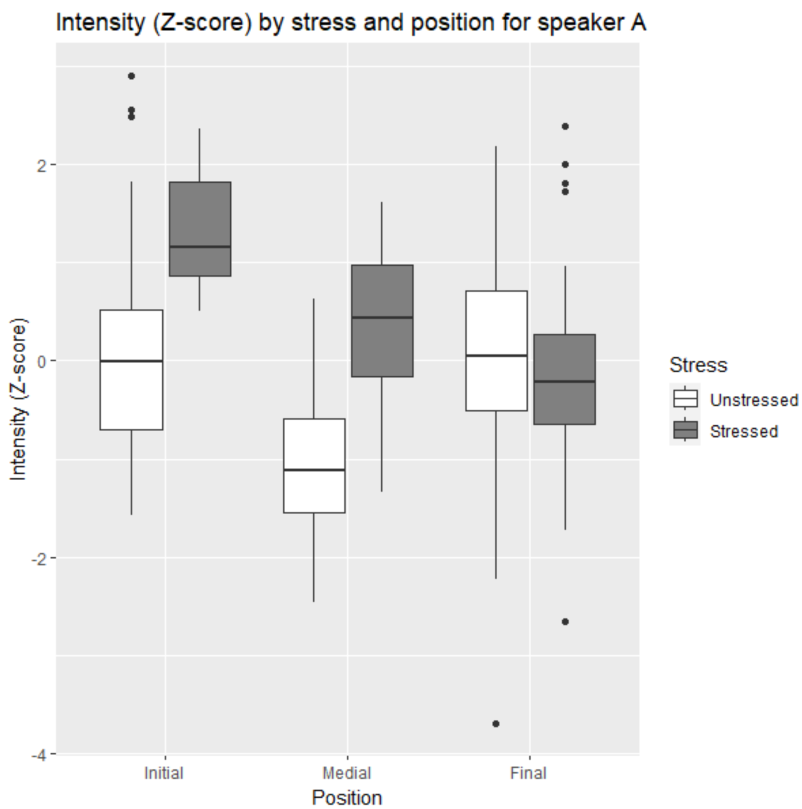
(6) Figure A.6



F0 (Z-score) by stress and position (Experiment 1, speaker A)

Final vowels show no obvious effect of stress on intensity for this participant, while both initial and medial vowels do. Medial unstressed vowels have the lowest overall intensity; initial stressed vowels have the highest intensity.

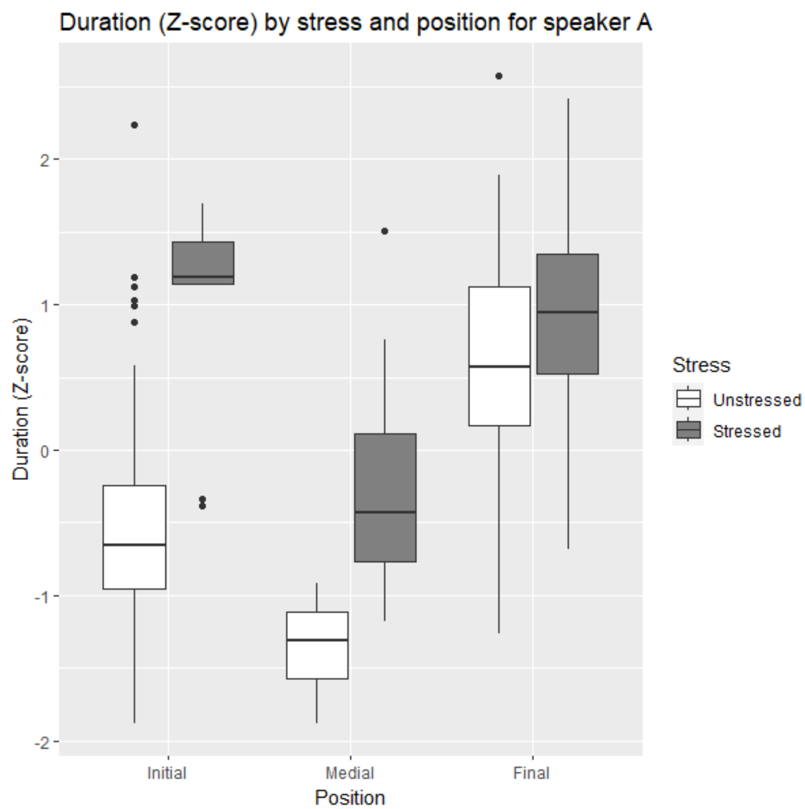
(7) Figure A.7



Intensity (Z-score) by stress and position (Experiment 1, speaker A)

In all three positions of the word stressed vowels are longer than unstressed vowels. However, this effect is much smaller for final vowels, and is the greatest for initial vowels.

(8) Figure A.8



Duration (Z-score) by stress and position (Experiment 1, speaker A)

A.1.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + Position + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, Unstressed for Stress, and Initial for Position. I give the estimates for the fixed effects and the intercept, plus or minus the standard error.. Each model is shown on a separate row.

(9) Figure A.9

Measure	Intercept	Stressed	[a]	Stressed * [a]	Medial	Final
F0	-0.11±0.20	0.68±0.17	-0.33±0.19	0.21±0.22	-0.05±0.14	-0.25±0.08
Intensity	-0.26±0.40	0.59±0.31	0.34±0.36	0.12±0.41	-0.49±0.26	-0.39±0.13
Duration	-0.30±0.30	0.39±0.23	-0.18±0.27	0.49±0.31	-0.72±0.20	0.89±0.10

Fixed effect summaries for the full models (Experiment 1, speaker A)

The positive estimates of the fixed effects for stress in all three models show that stressed vowels are higher in F0, louder in intensity, and longer in duration than their unstressed counterparts. The vowel [a] appears to be lower in F0 than [ə]. The fact that the interaction terms are positive suggests that the measures for [a] tend to be higher than would be expected based on the effect of stress and the effect of [a] alone. Medial vowels are lower in intensity and shorter than initial vowels. Final vowels are lower in F0 and intensity than initial vowels, but longer in duration.

In (10) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(10) Figure A.10

	Baseline	Intermediate	Full
F0	344.17	249.06	250.46
Intensity	602.12	576.26	578.18
Duration	505.18	454.89	454.48

AIC values (Experiment 1, speaker A)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(11) Figure A.11

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	97.11	1	$< 2.2 * 10^{-16}$	0.60	1	0.44
Intensity	27.86	1	$1.3 * 10^{-7}$	0.08	1	0.78
Duration	52.29	1	$4.8 * 10^{-13}$	2.42	1	0.12

The comparison between the base and intermediate models is always significant, and results in a lower AIC. This means that adding information about stress helps significantly in predicting this participant's values for F0, intensity, and duration, suggesting that all three are used to cue primary stress. None of the comparisons with the full (interaction) models are significant, so there is no evidence that this participant realizes stress significantly differently on [ə] and [a]. The interaction for the duration models is the closest to reaching significance, and of the three measures, duration had the highest estimate (0.41) for the interaction term in (9) above.

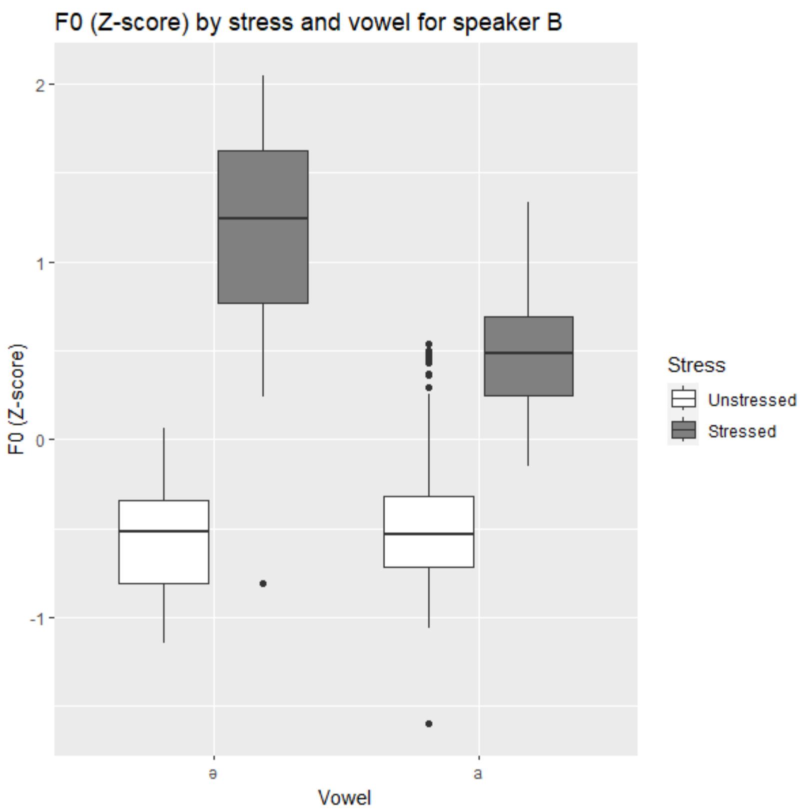
A.2 Speaker B

In this section I show that stressed vowels for speaker B are significantly higher in F0, louder in intensity, and longer in duration than unstressed vowels. There is a statistically significant interaction for F0, so that the difference between stressed and unstressed vowels is greater for [ə] than [a] for this participant.

A.2.1 Visualization of data

Unstressed [ə] and [a] both have approximately the same F0, but while the F0 values are greater in stressed position for both vowels, the difference is much greater for [ə].

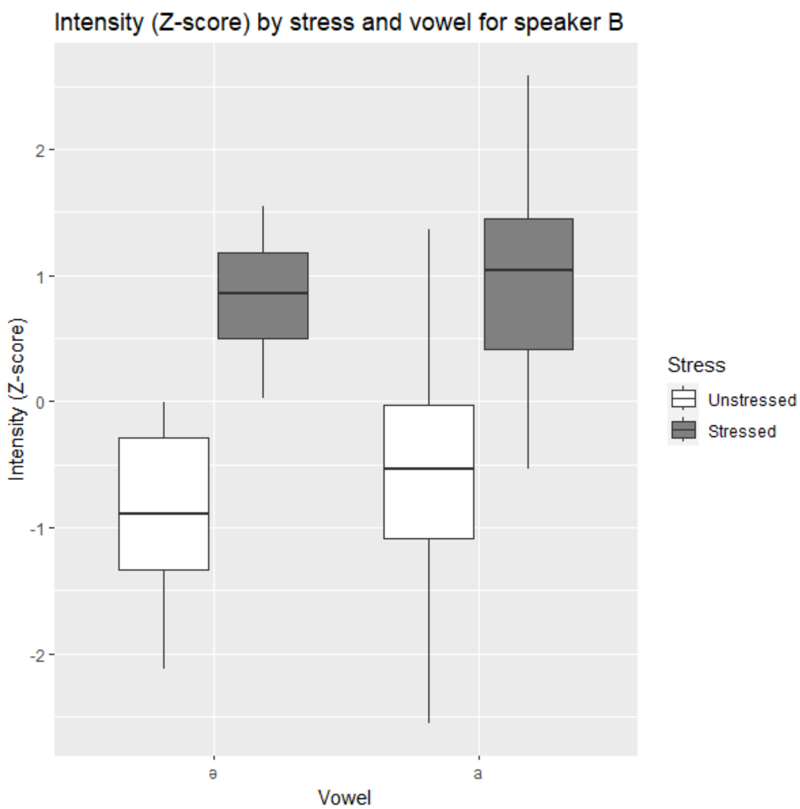
(12) Figure A.12



F0 (Z-score) by stress and vowel (Experiment 1, speaker B)

Both vowels are characterized by higher intensity in stressed position than unstressed position. There are no obvious differences between the effect of stress on the two vowels, but [a] has an overall higher intensity than [ə].

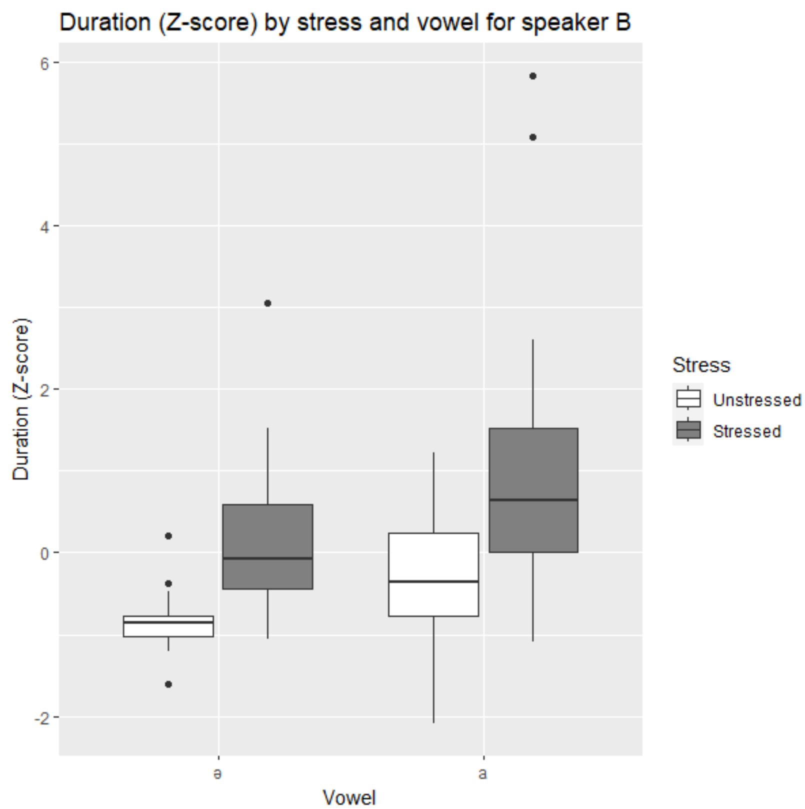
(13) Figure A.13



Intensity (Z-score) by stress and vowel (Experiment 1, speaker B)

The duration data are very similar to the data for intensity. [a] is longer than [ə] generally, and stressed vowels are longer than unstressed vowels, but there is no clear difference between the effect size of stress for the two vowels.

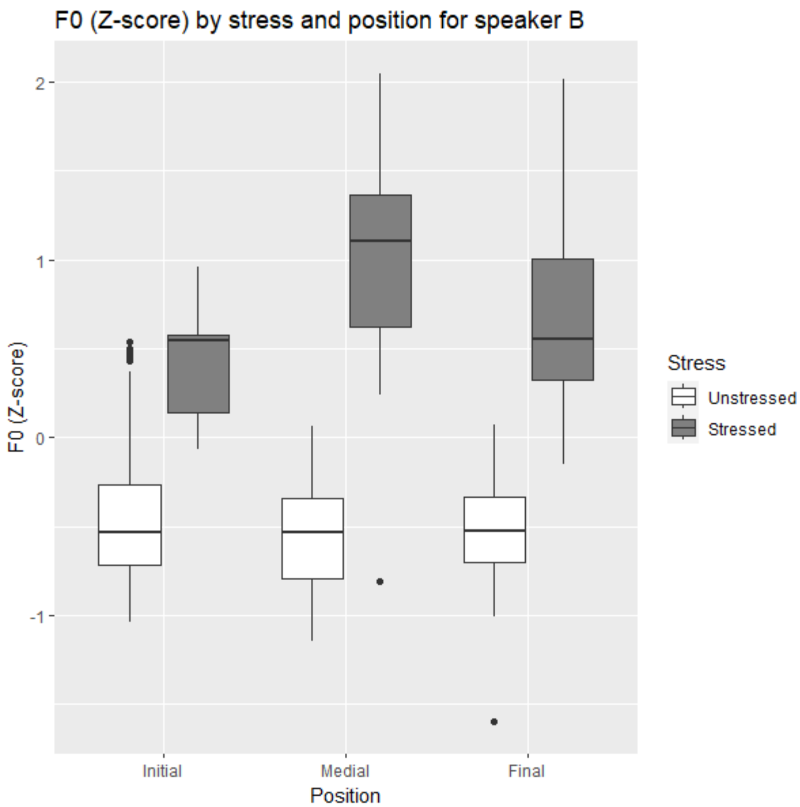
(14) Figure A.14



Duration (Z-score) by stress and vowel (Experiment 1, speaker B)

The F0 difference between unstressed and stressed position is obvious in all word positions, but the effect is greater medially.

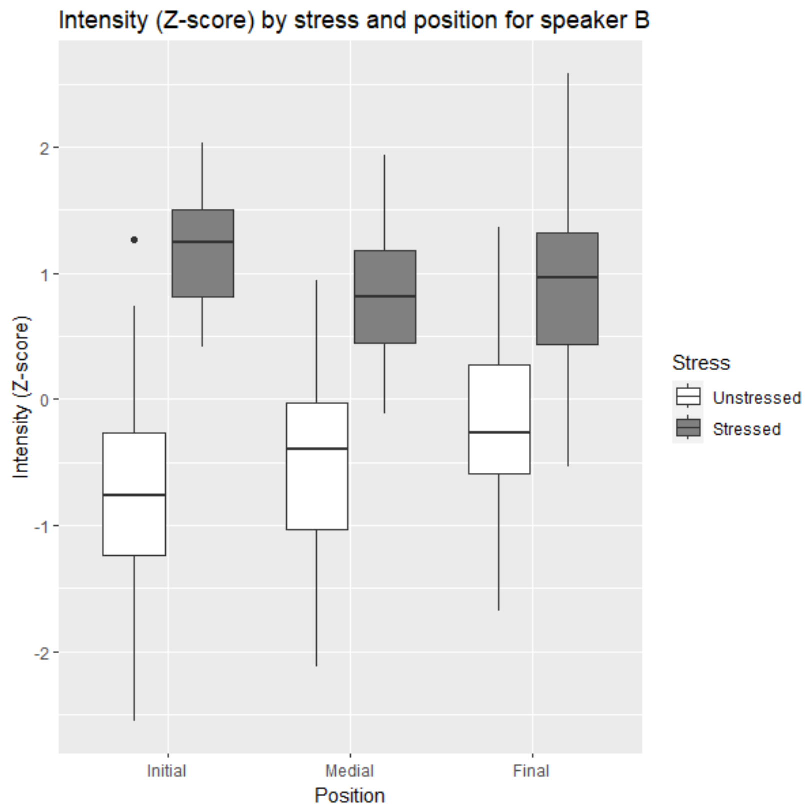
(15) Figure A.15



F0 (Z-score) by stress and position (Experiment 1, speaker B)

All three word positions are also characterized by higher intensity when stressed, but the effect is greatest in initial position.

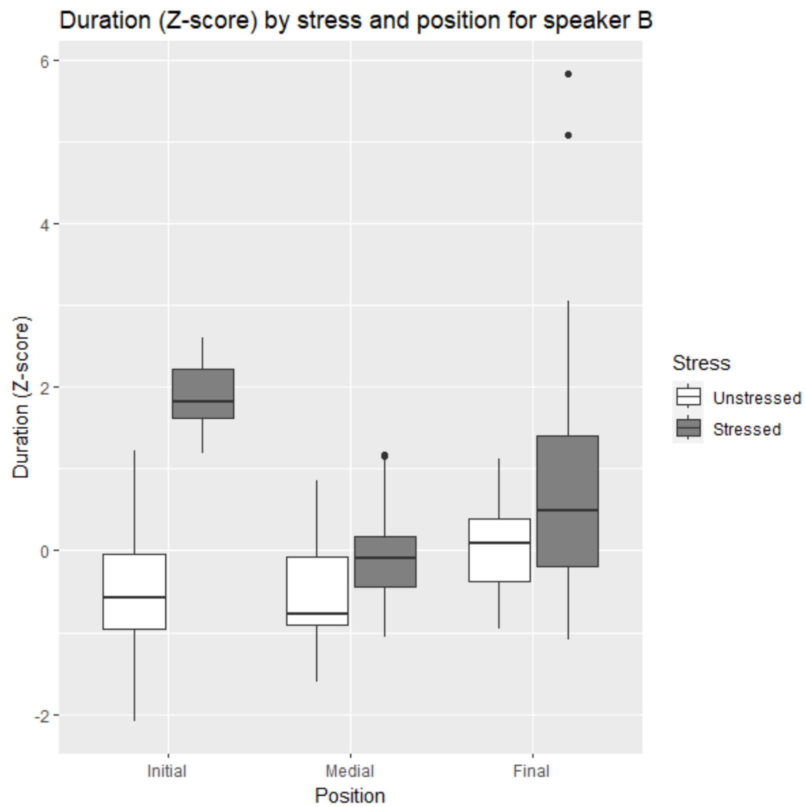
(16) Figure A.16



Intensity (Z-score) by stress and position (Experiment 1, speaker B)

Initial stressed vowels are much longer than initial unstressed vowels. There is a small effect in the same direction for medial and final vowels.

(17) Figure A.17



Duration (Z-score) by stress and position (Experiment 1, speaker B)

A.2.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + Position + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, Unstressed for Stress, and Initial for Position. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(18) Figure A.18

Measure	Intercept	Stressed	[a]	Stressed * [a]	Medial	Final
F0	-0.51±0.15	1.73±0.13	0.06±0.14	-0.73±0.15	-0.06±0.10	-0.06±0.06
Intensity	-1.17±0.24	1.62±0.21	0.47±0.23	-0.33±0.25	0.39±0.16	0.43±0.10
Duration	-0.68±0.31	0.77±0.27	0.32±0.30	0.18±0.32	-0.07±0.21	0.30±0.13

Fixed effect summaries for the full models (Experiment 1, speaker B)

The positive estimates of the fixed effects for stress in all three models show that stressed vowels are higher in F0, louder in intensity, and longer in duration than their unstressed counterparts. The vowel [a] appears to be slightly louder in intensity and longer in duration than [ə]. The fact that the interaction terms for F0 and intensity are negative suggests that the measures for [a] tend to be lower than would be expected based on the effect of stress and the effect of [a] alone. Medial vowels are greater in intensity than initial vowels. Final vowels are greater in intensity than initial vowels, and longer than initial vowels.

In (19) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(19) Figure A.19

	Baseline	Intermediate	Full
F0	541.57	297.33	278.69
Intensity	723.69	572.62	572.97
Duration	761.20	715.35	717.03

AIC values (Experiment 1, speaker B)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(20) Figure A.20

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	246.24	1	$< 2.2 * 10^{-16}$	20.64	1	$5.5 * 10^{-6}$
Intensity	153.07	1	$< 2.2 * 10^{-16}$	1.65	1	0.20
Duration	47.85	1	$4.6 * 10^{-12}$	0.32	1	0.57

ANOVA results (Experiment 1, speaker B)

The comparison between the base and intermediate models is always significant, and results in a lower AIC. This means that adding information about stress helps significantly in predicting this participant's values for F0, intensity, and duration, suggesting that all three are used to cue primary stress. The full (interaction) model only improves on the intermediate model without an interaction term for F0, again lowering AIC. The negative interaction term estimate for this model in (18) tells us that stressed [a] has a lower F0 than would be expected based on the effects of stress and [a] alone. This matches the visualizations in Section A.2.1, where the effect of stress on F0 was much greater for [ə] than for [a].

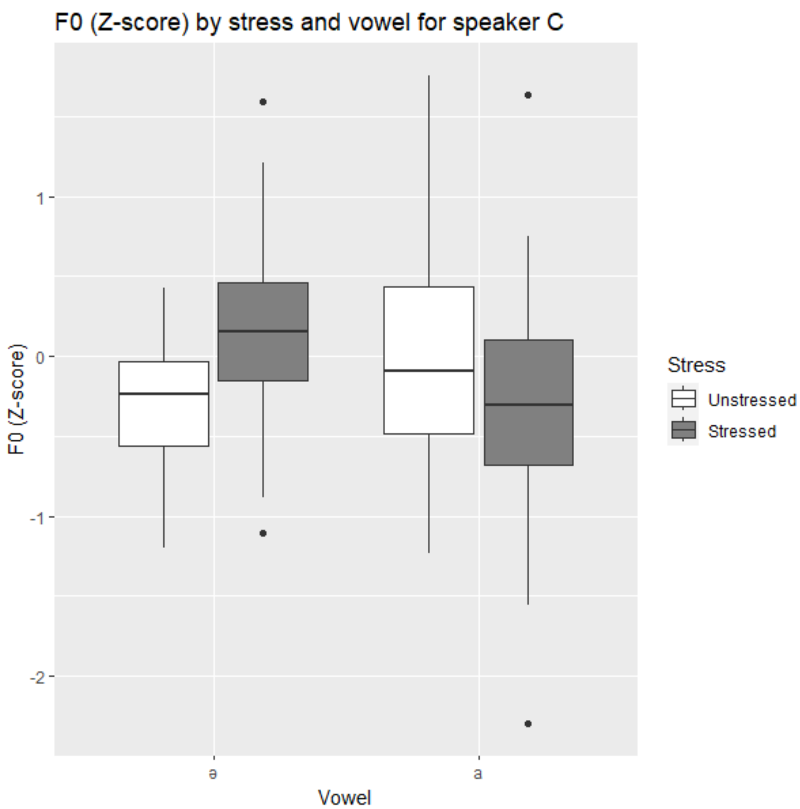
A.3 Speaker C

In this section I show that stressed vowels for speaker C are significantly louder in intensity and longer in duration than unstressed vowels. F0 does not appear to be used to cue stress for this participant. There is a statistically significant interaction for duration, so that the difference between stressed and unstressed vowels is greater for [a] than [ə] for this participant.

A.3.1 Visualization of data

Stressed [ə] is higher in F0 than unstressed [ə], but stressed [a] instead has a lower F0 than unstressed [a].

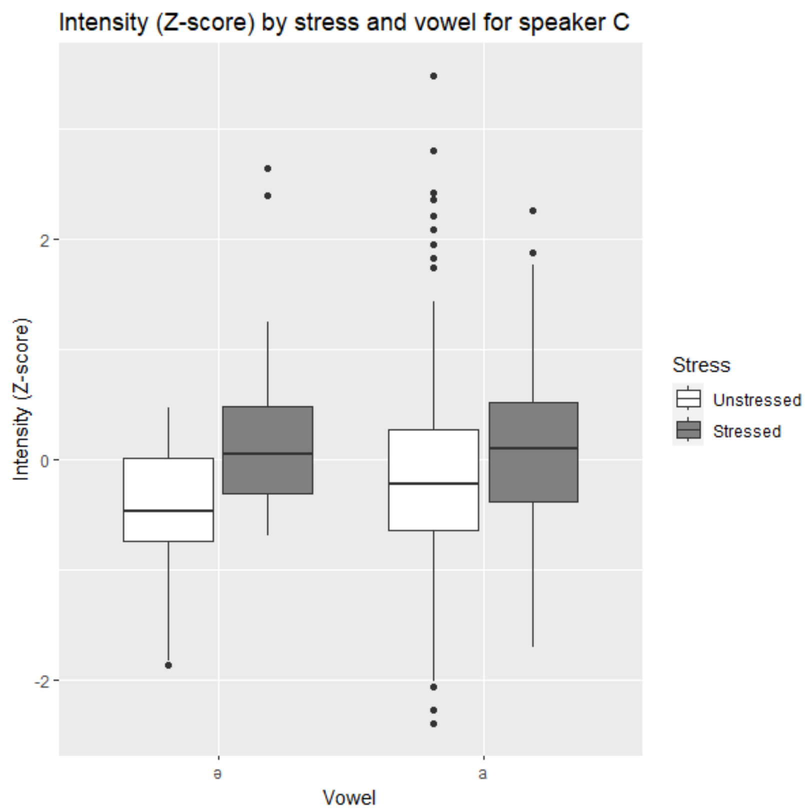
(21) Figure A.21



F0 (Z-score) by stress and vowel (Experiment 1, speaker C)

[a] generally has a slightly higher intensity than [ə]. Stressed vowels are somewhat higher in intensity than unstressed vowels, and the effect size is slightly greater for [ə] than for [a].

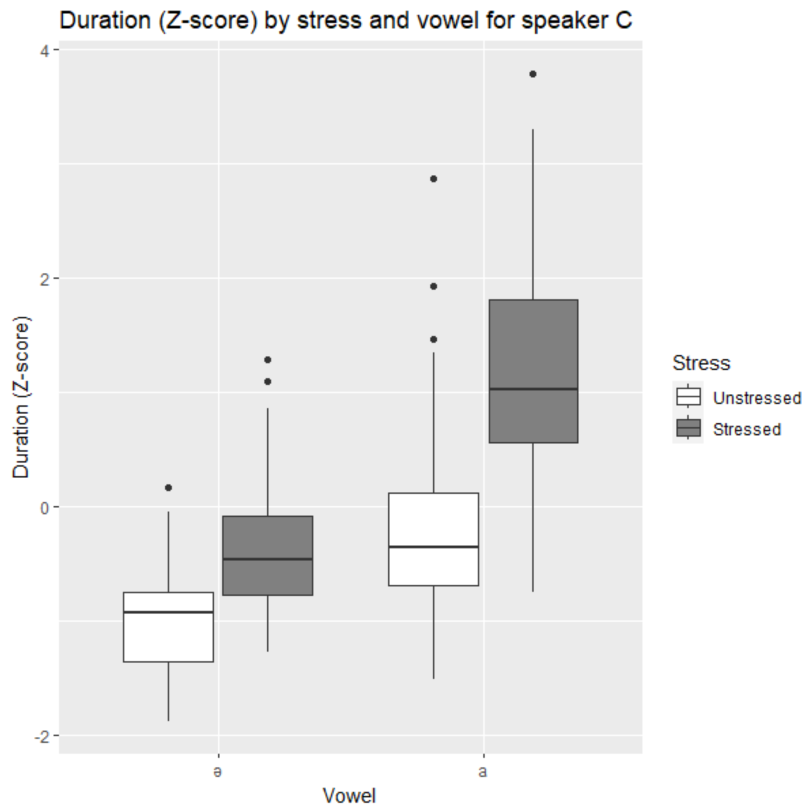
(22) Figure A.22



Intensity (Z-score) by stress and vowel (Experiment 1, speaker C)

[a] is longer than [ə] overall. Stressed vowels are longer than unstressed vowels, with a much greater effect size for [a] than for [ə].

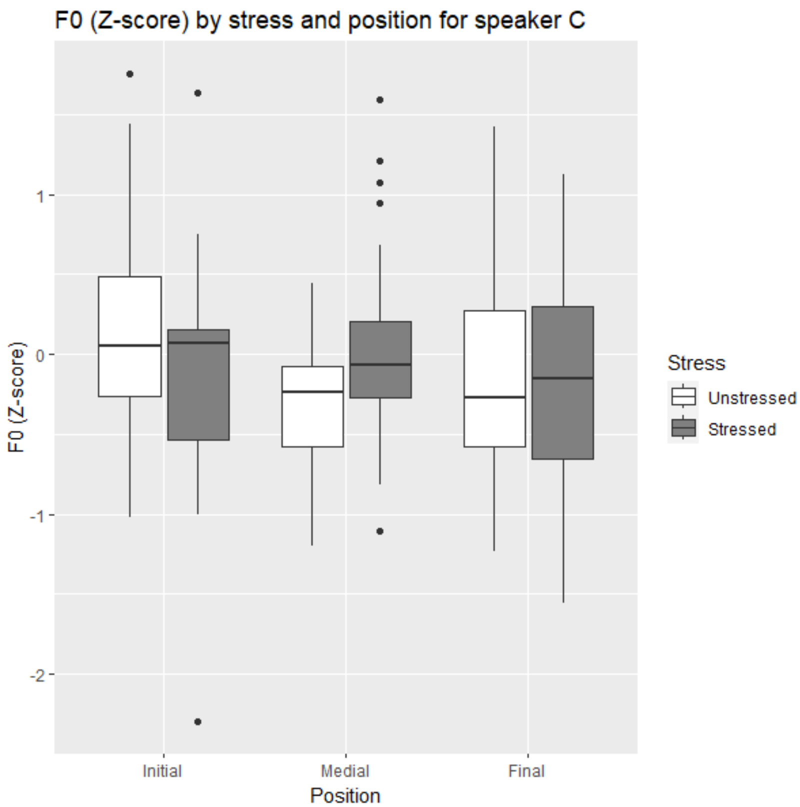
(23) Figure A.23



Duration (Z-score) by stress and vowel (Experiment 1, speaker C)

There are no clear effects of position on stress for F0, although F0 values for initial vowels are higher than for medial and final vowels.

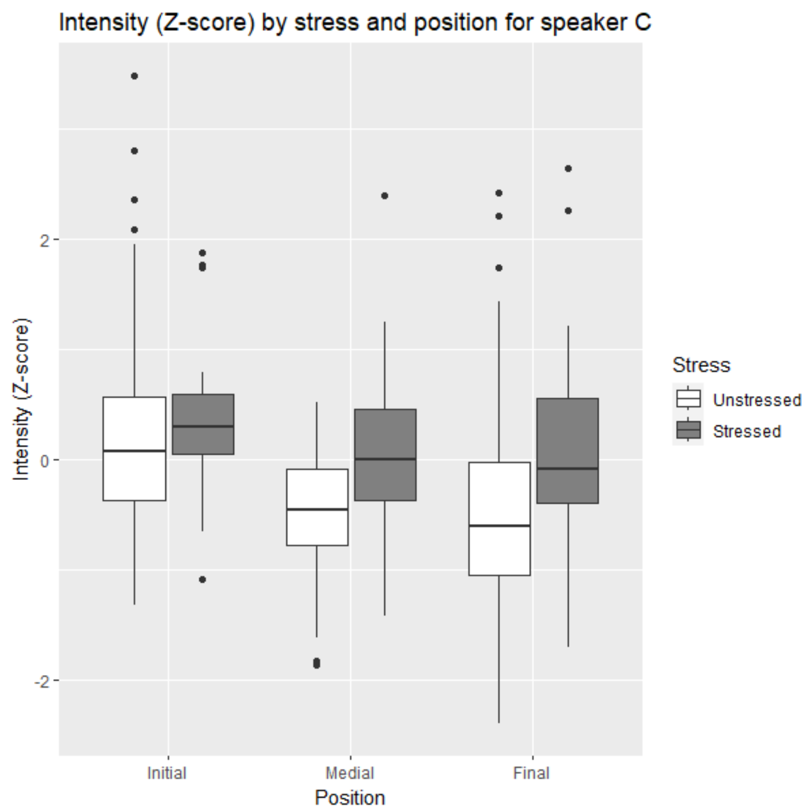
(24) Figure A.24



F0 (Z-score) by stress and position (Experiment 1, speaker C)

Stressed vowels in medial and final position have greater intensity than their corresponding unstressed vowels. Initial vowels show a smaller effect in the same direction.

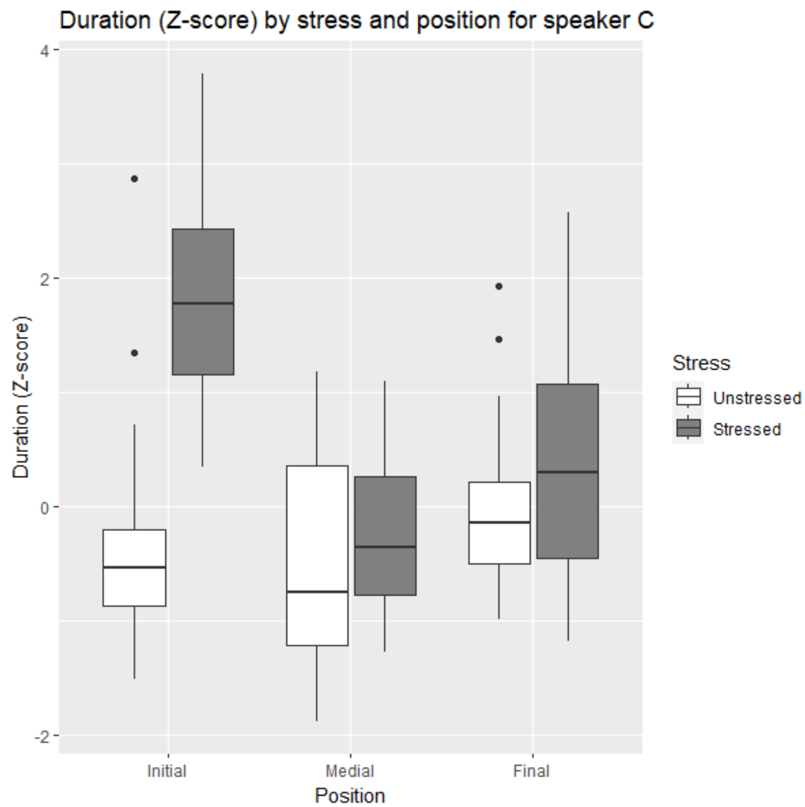
(25) Figure A.25



Intensity (Z-score) by stress and position (Experiment 1, speaker C)

Initial stressed vowels are much longer than initial unstressed vowels. Medial and final vowels show similar effects but of a smaller magnitude.

(26) Figure A.26



Duration (Z-score) by stress and position (Experiment 1, speaker C)

A.3.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + Position + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, Unstressed for Stress, and Initial for Position. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(27) Figure A.27

Measure	Intercept	Stressed	[a]	Stressed * [a]	Medial	Final
F0	0.29±0.23	0.19±0.21	-0.19±0.22	-0.37±0.25	-0.42±0.15	-0.29±0.09
Intensity	0.21±0.34	0.65±0.30	0.01±0.33	-0.42±0.36	-0.61±0.22	-0.63±0.13
Duration	-0.57±0.30	0.47±0.26	0.31±0.27	1.02±0.31	-0.34±0.18	0.00±0.10

Fixed effect summaries for the full models (Experiment 1, speaker C)

The positive estimates of the fixed effects for stress in intensity and duration models show that stressed vowels are louder in intensity and longer in duration than their unstressed counterparts. The estimate for the fixed effect of stress on F0 is also positive, but the estimate plus or minus the standard error includes 0, i.e. no effect. The vowel [a] appears to be slightly longer than [ə]. The fact that the interaction terms for F0 and intensity are negative suggests that the measures for [a] tend to be lower than would be expected based on the effect of stress and the effect of [a] alone. Duration shows the opposite pattern with a large positive estimate for the interaction term. Medial vowels have lower values for all measures than initial vowels. Final vowels show the same differences relative to initial vowels, except that there is no effect of final position on duration.

In (28) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(28) Figure A.28

	Baseline	Intermediate	Full
F0	410.68	411.51	411.60
Intensity	607.50	602.55	603.23
Duration	639.32	523.71	514.80

AIC values (Experiment 1, speaker C)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(29) Figure A.29

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	1.17	1	0.28	1.92	1	0.17
Intensity	6.95	1	0.01	1.33	1	0.25
Duration	117.61	1	$< 2.2 * 10^{-16}$	10.91	1	$9.6 * 10^{-4}$

ANOVA results (Experiment 1, speaker C)

The comparison between the base and intermediate models is significant for intensity and duration, resulting in a lower AIC. This means that adding information about stress helps significantly in predicting this participant's values for intensity, and duration, suggesting that the two are used to cue primary stress. There is no significant effect of F0, matching the description from Chapter 3 that speaker C does not use F0 to cue stress. The full (interaction) model only improves on the intermediate model without an interaction term for duration, again resulting in a lower AIC. The positive interaction term estimate for this model in (27) tells us that stressed [a] has a longer duration than would be expected based on the effects of stress and [a] alone. This matches the visualizations in Section A.3.1.

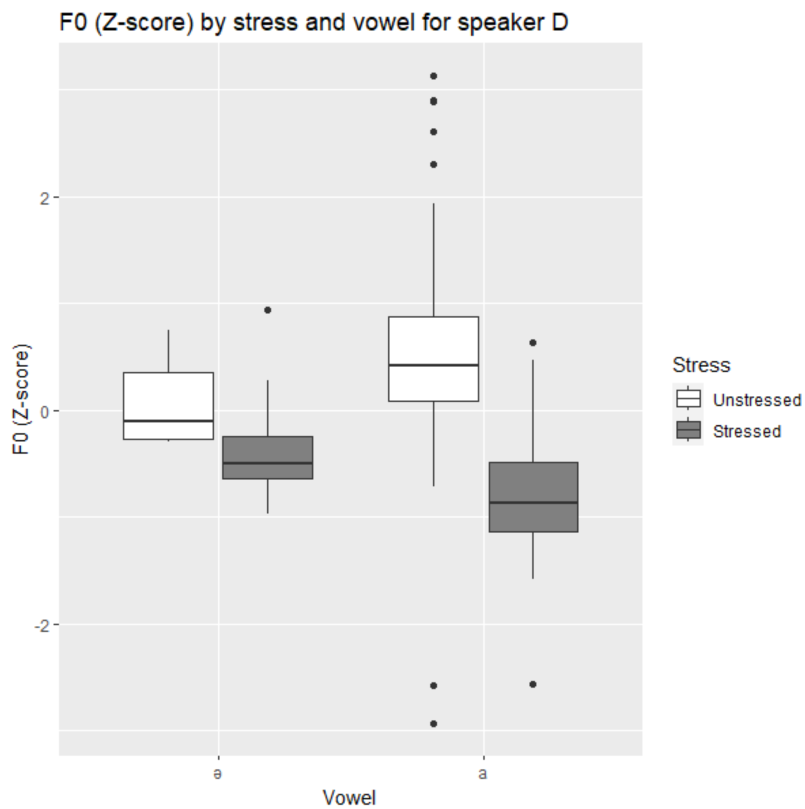
A.4 Speaker D

In this section I show that stressed vowels for speaker D are significantly lower in F0, louder in intensity, and longer in duration than unstressed vowels. Note that the effect of F0 on stress is the opposite to that found for other participants, as discussed in Chapter 3. There is a statistically significant interaction for intensity, so that the difference between stressed and unstressed vowels is greater for [a] than [ə] for this participant.

A.4.1 Visualization of data

For both vowels, stressed vowels have a lower F0 than unstressed vowels. The difference is greater for [a] than for [ə].

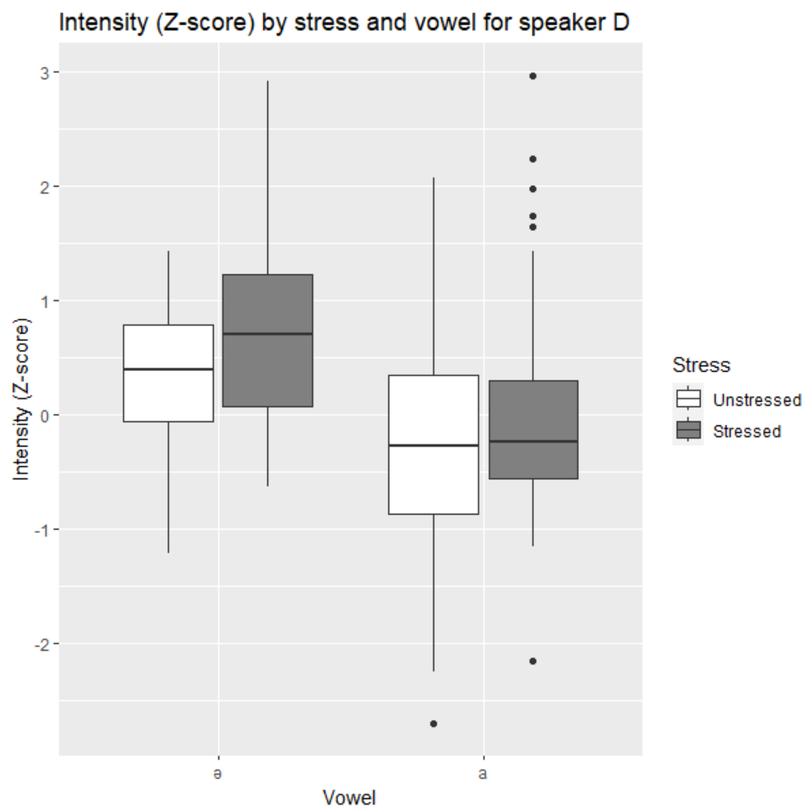
(30) Figure A.30



F0 (Z-score) by stress and vowel (Experiment 1, speaker D)

For [ə] there is a small difference between stressed and unstressed vowels, with the former having a higher intensity than the latter. There does not appear to be any effect of stress for [a], which is lower in intensity than [ə] overall for this participant.

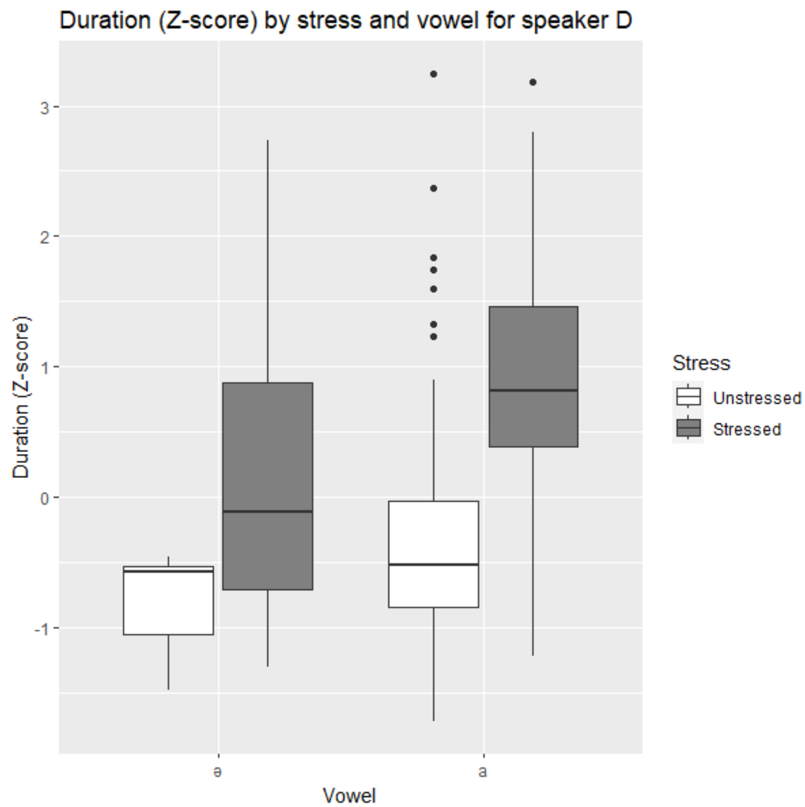
(31) Figure A.31



Intensity (Z-score) by stress and vowel (Experiment 1, speaker D)

[a] is generally longer than [ə]. Stressed vowels are longer than unstressed vowels, and this effect is greater for the low vowel [a].

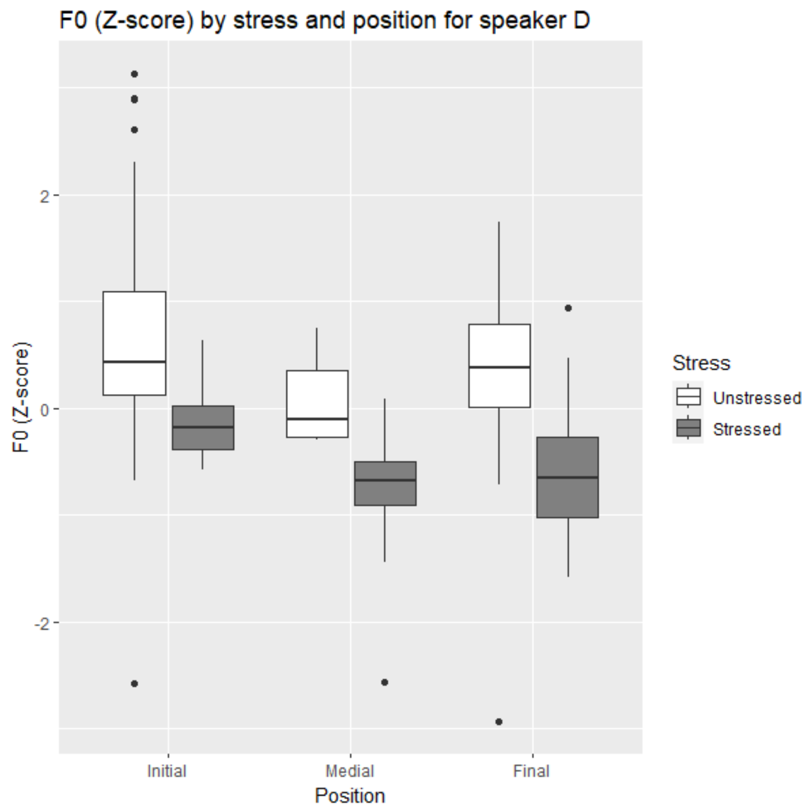
(32) Figure A.32



Duration (Z-score) by stress and vowel (Experiment 1, speaker D)

The F0 of stressed vowels is lower than that of unstressed vowels in all word positions. The effect appears to be greatest for final vowels.

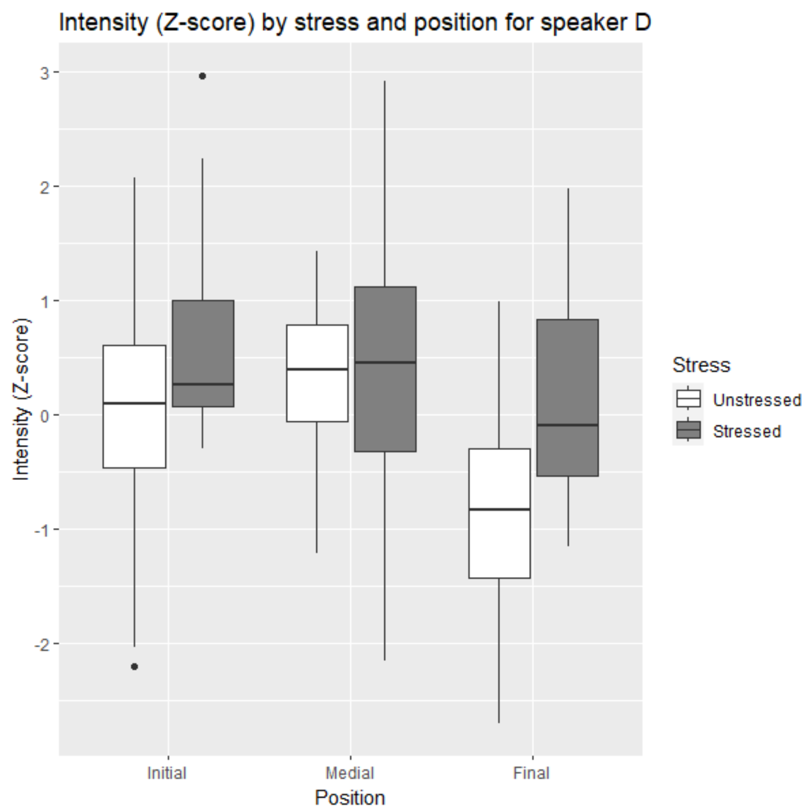
(33) Figure A.33



F0 (Z-score) by stress and position (Experiment 1, speaker D)

Only final vowels clearly show higher intensity in stressed position than unstressed position, with initial and medial vowels not obviously being affected by stress as far as intensity is concerned.

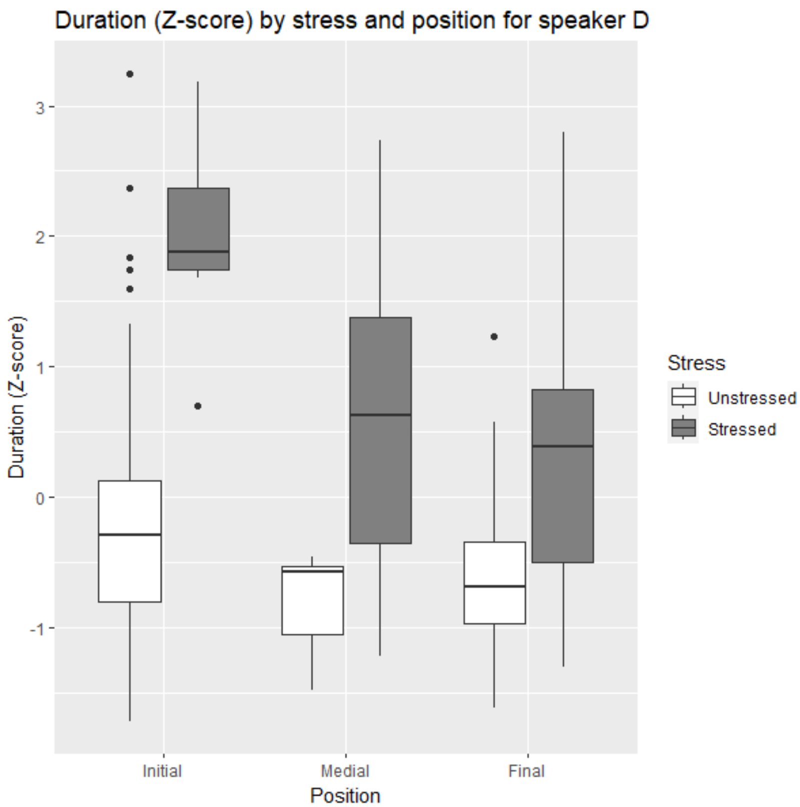
(34) Figure A.34



Intensity (Z-score) by stress and position (Experiment 1, speaker D)

All word positions show greater duration in stressed position than in unstressed position. However, the effect size is far larger for initial vowels.

(35) Figure A.35



Duration (Z-score) by stress and position (Experiment 1, speaker D)

A.4.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + Position + (1| Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, Unstressed for Stress, and Initial for Position. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(36) Figure A.36

Measure	Intercept	Stressed	[a]	Stressed * [a]	Medial	Final
F0	0.64±0.30	-0.54±0.27	0.03±0.30	-0.49±0.32	-0.68±0.19	-0.39±0.11
Intensity	1.74±0.42	-0.10±0.36	-1.65±0.41	0.91±0.44	-1.00±0.25	-1.00±0.13
Duration	0.15±0.41	1.09±0.34	-0.28±0.38	0.57±0.41	-1.03±0.24	-0.76±0.12

Fixed effect summaries for the full models (Experiment 1, speaker D)

The positive estimates of the fixed effect for stress on duration show that stressed vowels are longer in duration than their unstressed counterparts. By the same token the corresponding negative estimate for F0 shows that stressed vowels have a lower F0 than their unstressed counterparts. The estimate for the fixed effect of stress on intensity is also negative, but with a very large standard error. The vowel [a] appears to have a lower intensity than [ə]. The fact that the interaction terms for intensity and duration are positive suggests that those measures for [a] tend to be higher than would be expected based on the effect of stress and the effect of [a] alone. The interaction term in the F0 model is estimated to be negative, meaning that [a] shows a lower F0 than otherwise expected. Medial and final vowels all have lower values than initial vowels in all models.

In (37) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(37) Figure A.37

	Baseline	Intermediate	Full
F0	533.49	484.39	484.08
Intensity	602.03	586.23	584.01
Duration	657.45	548.12	548.21

AIC values (Experiment 1, speaker D)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(38) Figure A.38

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	51.10	1	$8.8 * 10^{-13}$	2.31	1	0.13
Intensity	17.80	1	$2.5 * 10^{-5}$	4.22	1	0.04
Duration	111.33	1	$< 2.2 * 10^{-16}$	1.91	1	0.17

ANOVA results (Experiment 1, speaker D)

The comparison between the base and intermediate models is always significant, resulting in a lower AIC. This means that adding information about stress helps significantly in predicting this participant's values for F0, intensity, and duration, suggesting that all three are used to cue primary stress. The full (interaction) model only improves on the intermediate model without an interaction term, lowering AIC, for intensity. The positive interaction term estimate for this model in (36) tells us that stressed [a] has a higher intensity than would be expected based on the effects of stress and [a] alone. However, the p-value (0.04) is only just under the significance threshold of 0.05 for this model comparison.

Appendix B: Acoustics of Secondary Stress

In this appendix I present visualizations and statistical analysis of an experiment on secondary stress in Abkhaz separately for four speakers. The results for all speakers considered together were presented in Chapter 4, Section 4.3, where I noted that some of the statistical models I fitted have problems due to singular fits. The models presented in this appendix do not have such problems. The appendix contains four sections, one for each participant in the experiment. Each section begins with a visualization of the data for that participant, followed by a statistical analysis using linear mixed effects models.

The statistical models in this appendix are based closely on those in Chapter 4, where each measure (F0, intensity, duration) had four nested models. Two of these differed only in a random slope for the effect of stress by participant. Since the models fitted here only have one participant each, there is no need for such a random slope. I therefore use the following three nested model structures for each measure and for each participant, illustrated with the measure F0 in (1). Vowel has the possible values {[ə], [a]}, while Position may be {Initial, Medial, Final} and Stress {Unstressed, Secondary, Primary}.

(1) Figure B.1

Base model:	F0 ~ Vowel + (1|Word)
Intermediate model:	F0 ~ Stress + Vowel + (1|Word)
Full model:	F0 ~ Stress * Vowel + (1|Word)

Model specifications (Experiment 2)

I use the *lsmeans* package (Lenth 2016) to look for significant differences between fixed effects, notably between the unstressed and secondary conditions. The *contrast()* function of this package uses the Tukey method to adjust p-values for multiple pairwise post-hoc comparisons. I continue to predict Z-scored values rather than unnormalized values (in Hz, dB, and ms). This is not necessary since there is only one participant in each model, but it makes the numbers reported in this appendix more comparable to the Z-scored values already reported in Chapter 4.

The results from comparing the models in (1) with ANOVAs are summarized in (2) below. Cells marked (int.) denote the presence of an interaction effect where the relevant cue is used differently for the two vowels [ə] and [a] for the relevant participant. Cells marked (sec.) have a significant difference between unstressed and secondary stress conditions in the intermediate models. This table uses a significance threshold of 0.05. Note that speakers B and D have evidence for secondary stress distinct from absence of stress, as discussed in Chapter 4. Speakers A and C use combinations of F0, intensity (for speaker C), and duration to cue stress, but do not have evidence for significant differences between the unstressed and secondary stress conditions.

(2) Figure B.2

	F0	Intensity	Duration
Speaker A	✔		✔
Speaker B	✔ (int.) (sec.)	✔	✔ (sec.)
Speaker C	✔	✔	✔
Speaker D	(int.)	✔	✔ (sec.)

Summary of results by participant (Experiment 2)

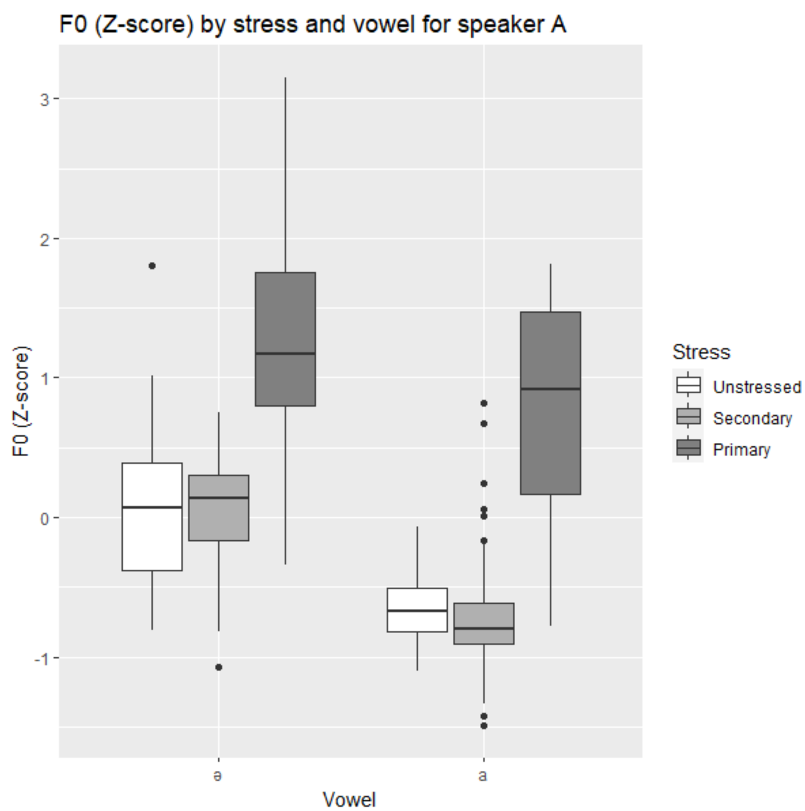
B.1 Speaker A

In this section I discuss the realization of stress for speaker A, focusing on the secondary stress condition in particular. This participant shows no statistically significant evidence for secondary stress acoustically.

B.1.1 Visualization of data

Primary stress is cued by higher F0 for this participant, but there are no clear differences between the unstressed and secondary stress conditions.

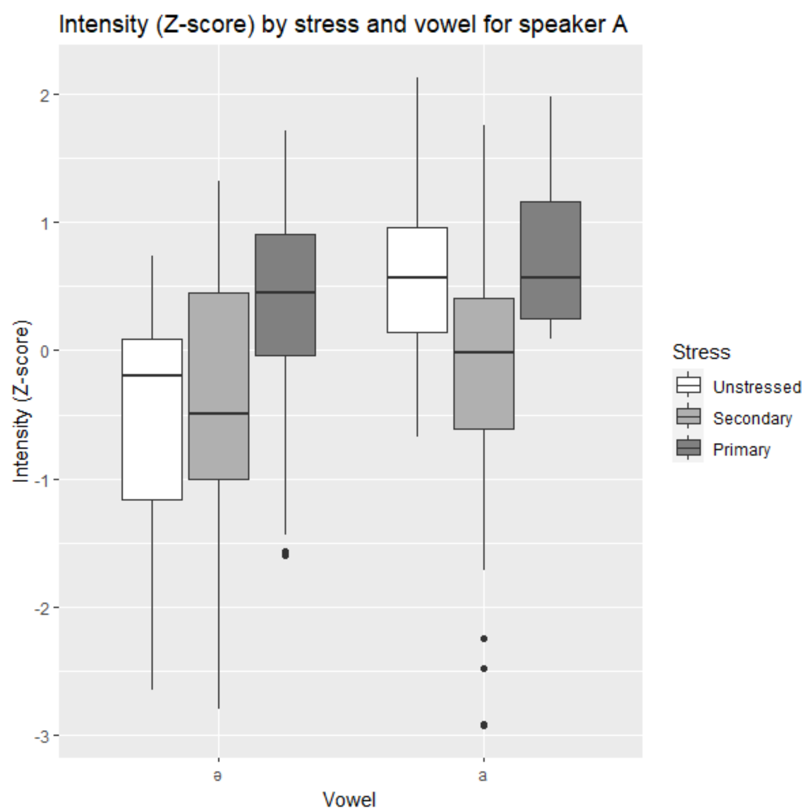
(3) Figure B.3



F0 (Z-score) by stress and vowel (Experiment 2, speaker A)

For [ə] the intensity is highest in the primary stress condition, but unstressed [a] and [a] with primary stress have the same intensity. [a] in the secondary stress condition has a lower intensity. For [ə] intensity is also lowest in the secondary stress condition, but the difference compared to the unstressed condition is smaller for [ə] than for [a].

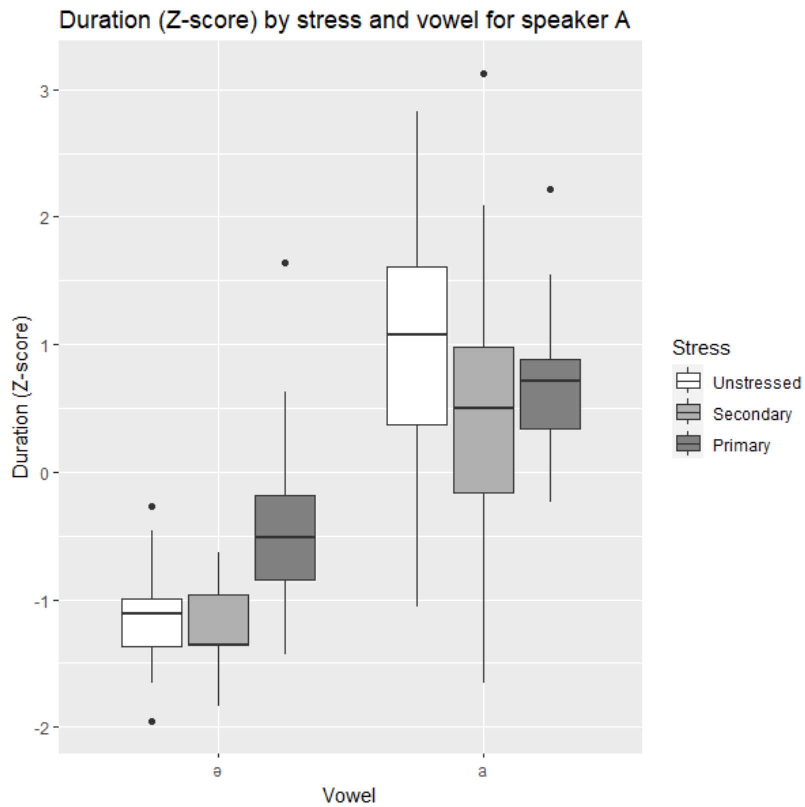
(4) Figure B.4



Intensity (Z-score) by stress and vowel (Experiment 2, speaker A)

[a] is generally longer than [ə]. While [ə] shows longer duration under primary stress, [a] does not. Vowels in the secondary stress condition are the shortest for both vowels.

(5) Figure B.5



Duration (Z-score) by stress and vowel (Experiment 2, speaker A)

B.1.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, and Unstressed for Stress. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(6) Figure B.6

Measure	Intercept	Secondary	Primary	[a]	Secondary * [a]	Primary * [a]
F0	0.15±0.15	0.00±0.25	0.98±0.17	-0.72±0.20	-0.13±0.30	0.35±0.32
Intensity	-0.44±0.22	0.47±0.29	0.63±0.25	0.61±0.31	-0.76±0.39	-0.07±0.53
Duration	-1.19±0.18	0.20±0.24	0.52±0.20	1.80±0.25	-0.27±0.32	-0.44±0.43

Fixed effect summaries for the full models (Experiment 2, speaker A)

The positive estimates of the fixed effects for primary stress in all three models show that stressed vowels are higher in F0, louder in intensity, and longer in duration than their unstressed counterparts. However, there is no effect of secondary stress on F0, and given the standard error only a negligible effect on duration. Vowels in the secondary stress condition do appear to have greater intensity than unstressed vowels, however. The vowel [a] appears to be lower in F0 than [ə], but higher in intensity and duration. The fact that the interaction terms are almost all negative suggests that the measures for [a] tend to be lower than would be expected based on the effect of stress and the effect of [a] alone. However, [a] with primary stress has a higher F0 than would otherwise be expected.

In (7) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(7) Figure B.7

	Baseline	Intermediate	Full
F0	408.39	372.20	373.88
Intensity	547.35	546.80	546.04
Duration	460.63	458.31	461.28

AIC values (Experiment 2, speaker A)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(8) Figure B.8

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	40.19	2	$1.9 * 10^{-9}$	2.32	2	0.31
Intensity	4.55	2	0.10	4.76	2	0.09
Duration	6.32	2	0.04	1.03	2	0.60

ANOVA results (Experiment 2, speaker A)

The comparison between base and intermediate models is significant for F0 and duration, resulting in a lower AIC. None of the interaction models significantly improve on identical models without an interaction term. However, both model comparisons for intensity are close to reaching significance, and lower AIC slightly. Some of these model comparisons may reach significance due to large differences between unstressed and primary stress conditions, so they do not directly address whether the unstressed and secondary stress conditions differ. Below I report the p-values from post-hoc pairwise comparisons of the unstressed and secondary stress conditions in the intermediate and full models, computed using *lsmeans* (Lenth 2016). Cells which are shaded gray are from models which significantly improved on the next most simple model according to (8). In the full (interaction) model separate p-values are given for the two vowels, while the intermediate (no interaction) model has only one p-value for both vowels.

(9) Figure B.9

	F0		Intensity		Duration	
	[ə]	[a]	[ə]	[a]	[ə]	[a]
Intermediate	0.79		1.00		0.99	
Full	1.00	0.96	0.60	0.85	0.96	1.00

Unstressed vs. secondary stress conditions (Experiment 2, speaker A)

None of these values are close to a significance threshold of 0.05, so there is no clear evidence for an acoustic difference between the unstressed and secondary stress conditions for this participant.

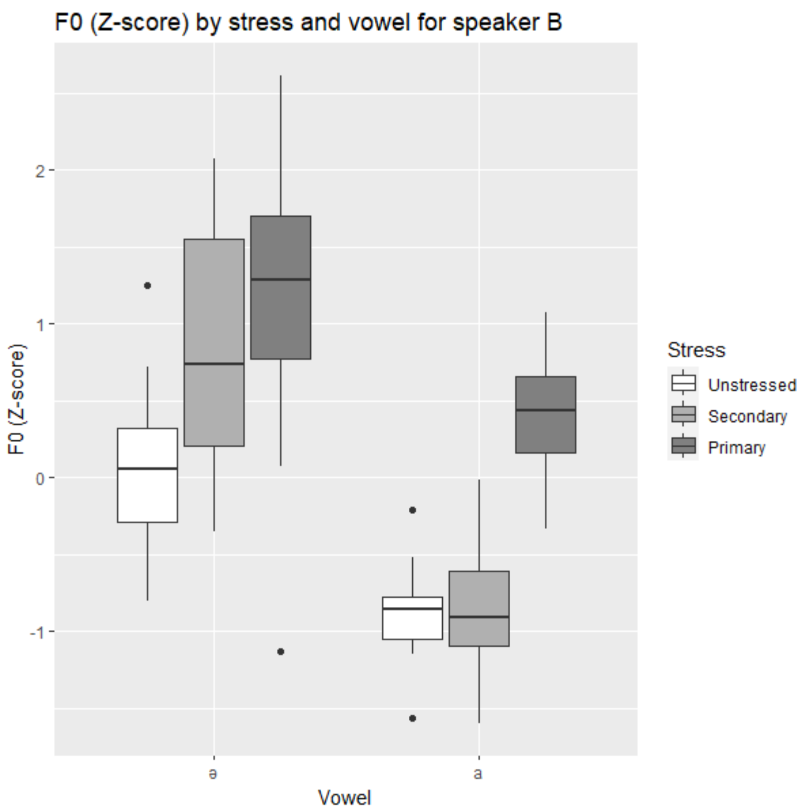
B.2 Speaker B

In this section I discuss the realization of stress for speaker A, focusing on the secondary stress condition in particular. This participant shows statistically significant evidence for secondary stress in terms of F0 and duration.

B.2.1 Visualization of data

For [ə] there appears to be a threeway distinction between unstressed, secondary stress, and primary stress. However, although [a] with primary stress has a high F0, there is no difference between unstressed and secondary stress conditions for [a].

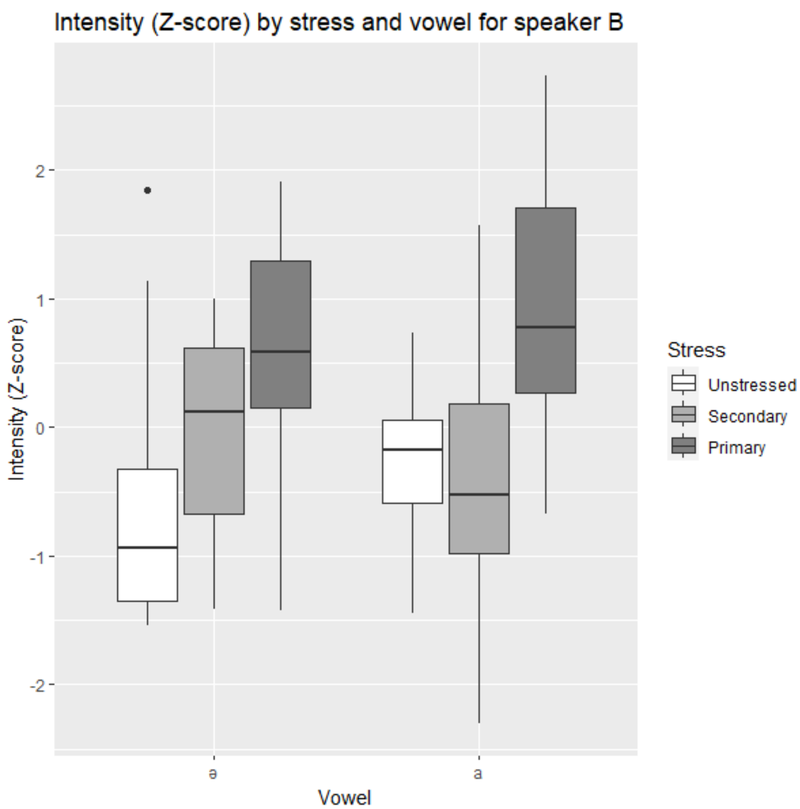
(10) Figure B.10



F0 (Z-score) by stress and vowel (Experiment 2, speaker B)

Like for F0, there seems to be a threeway distinction in intensity levels for [ə], and [a] also has the highest values in the primary stress condition. However, [a] in the secondary stress condition is, if anything, characterized by lower values than unstressed [a].

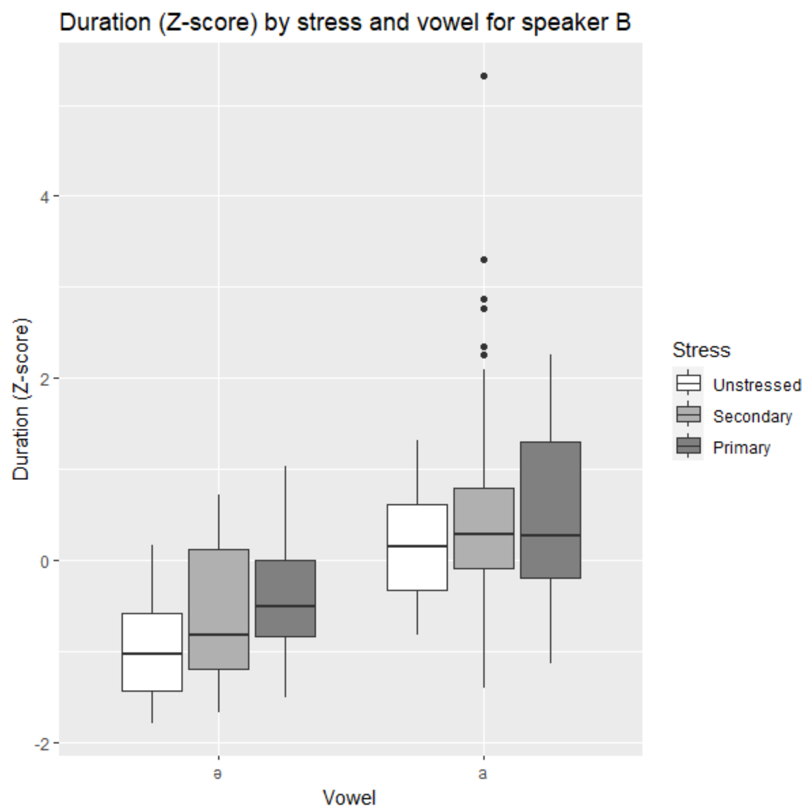
(11) Figure B.11



Intensity (Z-score) by stress and vowel (Experiment 2, speaker B)

[a] is generally longer than [ə]. There is no apparent effect of stress for [a]. For [ə], we do see higher values for primary stress than for the other conditions, and higher values for secondary stress than for the absence of stress. However, these differences are very small.

(12) Figure B.12



Duration (Z-score) by stress and vowel (Experiment 2, speaker B)

B.2.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, and Unstressed for Stress. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(13) Figure B.13

Measure	Intercept	Secondary	Primary	[a]	Secondary * [a]	Primary * [a]
F0	0.07±0.13	0.88±0.17	1.07±0.14	-1.09±0.21	0.69±0.25	0.36±0.30
Intensity	-0.58±0.21	0.66±0.29	1.23±0.24	0.12±0.33	-0.61±0.41	0.25±0.46
Duration	-1.12±0.21	0.62±0.30	0.85±0.24	0.93±0.33	0.09±0.42	-0.22±0.46

Fixed effect summaries for the full models (Experiment 2, speaker B)

The positive estimates of the fixed effects for primary and secondary stress in all three models show that vowels with any degree of stress are higher in F0, louder in intensity, and longer in duration than their unstressed counterparts. The vowel [a] appears to be lower in F0 than [ə], but longer in duration. The fact that the interaction terms are positive for F0 suggests that the F0 values for [a] tend to be higher than would be expected based on the effect of stress and the effect of [a] alone. However, [a] with secondary stress has a lower intensity than would otherwise be expected.

In (14) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(14) Figure B.14

	Baseline	Intermediate	Full
F0	371.18	319.08	305.87
Intensity	599.26	568.64	567.22
Duration	594.18	579.27	582.61

AIC values (Experiment 2, speaker B)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the

Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(15) Figure B.15

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	56.09	2	$6.6 * 10^{-13}$	17.21	2	0.0002
Intensity	34.62	2	$3.0 * 10^{-8}$	5.42	2	0.07
Duration	18.91	2	$7.8 * 10^{-5}$	0.66	2	0.72

ANOVA results (Experiment 2, speaker B)

The comparison between base and intermediate models is significant for all three measures, resulting in a lower AIC. The full (interaction) model improves on a model without an interaction term only for F0, again lowering AIC. However, the corresponding model comparison for intensity is very close to reaching significance, and does show a lower AIC. Some of these model comparisons may reach significance due to large differences between unstressed and primary stress conditions, so they do not directly address whether the unstressed and secondary stress conditions differ. Below I report the p-values from post-hoc pairwise comparisons of the unstressed and secondary stress conditions in the intermediate and full models, computed using *lsmeans* (Lenth 2016). Cells which are shaded gray are from models which significantly improved on the next most simple model according to (15). In the full (interaction) model separate p-values are given for the two vowels, while the intermediate (no interaction) model has only one p-value for both vowels.

(16) Figure B.16

	F0		Intensity		Duration	
	[ə]	[a]	[ə]	[a]	[ə]	[a]
Intermediate	0.002		0.83		0.005	
Full	< 0.0001	0.90	0.23	1.00	0.32	0.16

Unstressed vs. secondary stress conditions (Experiment 2, speaker B)

This participant shows acoustic evidence for a distinction between unstressed vowels and vowels with secondary stress in F0 and duration. The full (interaction) model for F0 demonstrates that only [ə] shows evidence for a distinction between unstressed and secondary stress conditions.

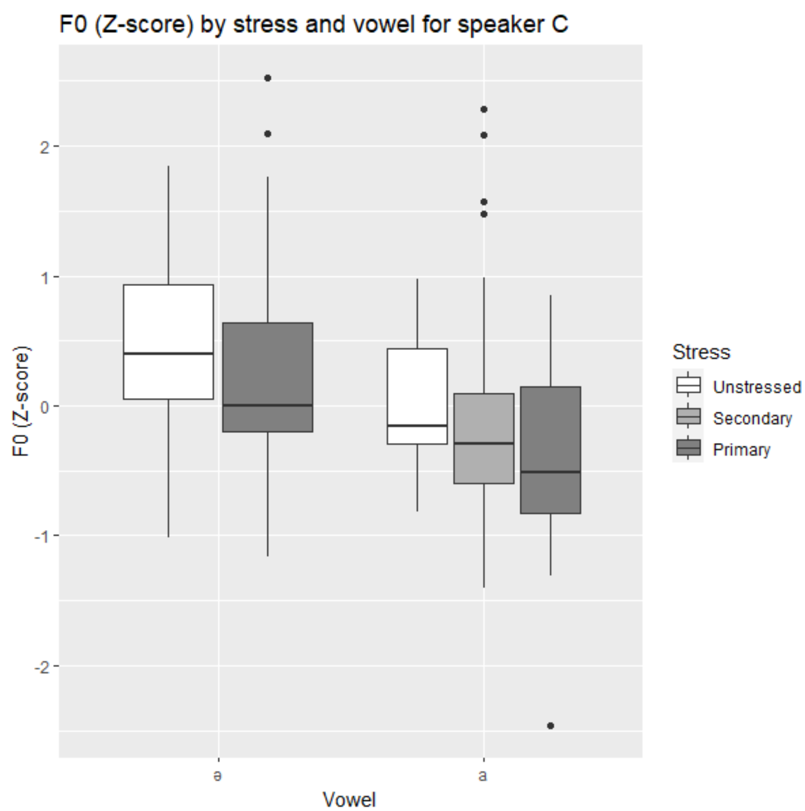
B.3 Speaker C

In this section I discuss the realization of stress for speaker A, focusing on the secondary stress condition in particular. This participant shows no statistically significant evidence for secondary stress acoustically. Due to the exclusions discussed in Chapter 2, Section 2.1.5 this participant has no tokens for [ə] in the secondary stress condition.

B.3.1 Visualization of data

Vowels with any degree of stress appear to be slightly lower in F0 for this participant than unstressed vowels. However, the difference between unstressed and secondary stress conditions is small.

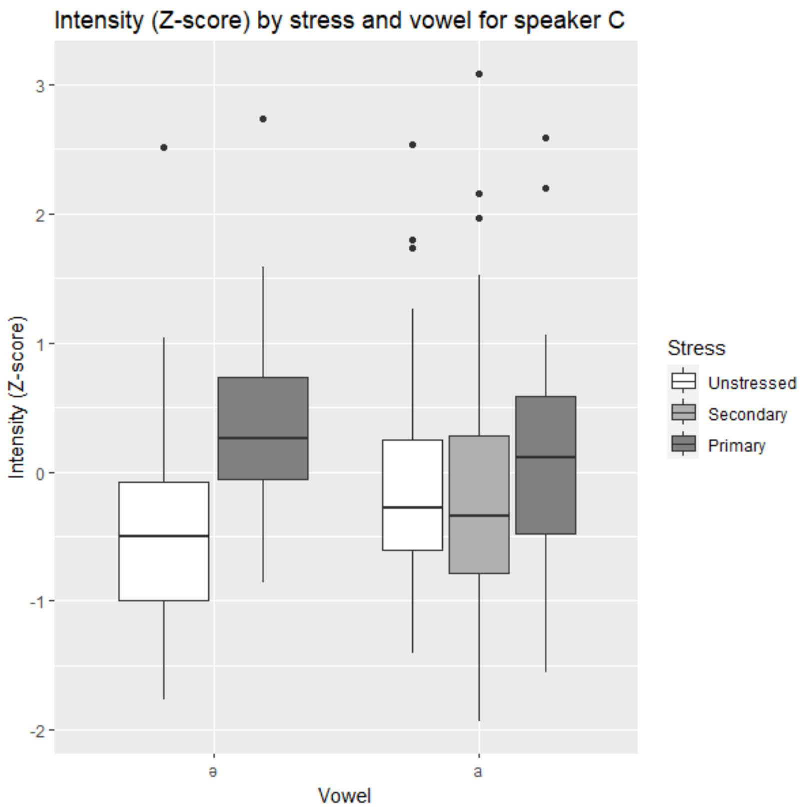
(17) Figure B.17



F0 (Z-score) by stress and vowel (Experiment 2, speaker C)

Vowels with primary stress have higher intensity than vowels in other conditions. However, there is no clear difference between unstressed and secondary stress conditions.

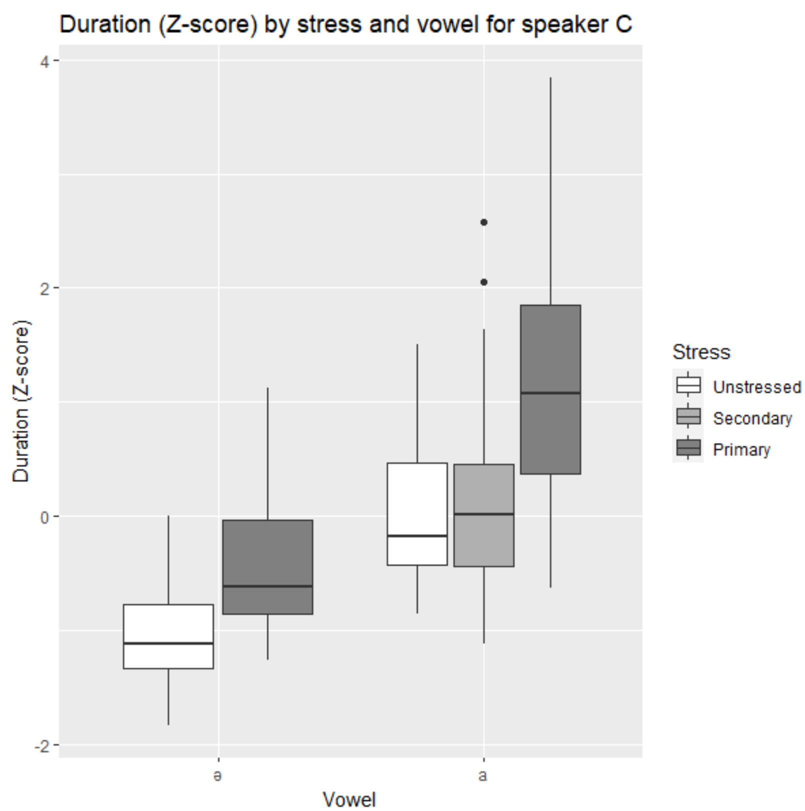
(18) Figure B.18



Intensity (Z-score) by stress and vowel (Experiment 2, speaker C)

The data for duration look similar to the data for intensity immediately above, with no clear difference between unstressed and secondary stress conditions. [a] is generally longer than schwa, and the difference between stressed and unstressed [a] is greater than the difference between stressed and unstressed [ə].

(19) Figure B.19



Duration (Z-score) by stress and vowel (Experiment 2, speaker C)

B.3.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, and Unstressed for Stress. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row. Since this participant has only the vowel [a] in the secondary stress condition, there are no separate estimates for the ‘Secondary * [a]’ interaction column.

(20) Figure B.20

Measure	Intercept	Secondary	Primary	[a]	Secondary*[a]	Primary*[a]
F0	1.02±0.20	0.15±0.27	-0.79±0.21	-1.21±0.31	N/A	0.56±0.48
Intensity	-0.40±0.19	-0.35±0.26	0.80±0.24	0.50±0.31	N/A	-0.79±0.40
Duration	-1.06±0.21	0.18±0.29	0.70±0.23	0.93±0.33	N/A	0.86±0.48

Fixed effect summaries for the full models (Experiment 2, speaker C)

The positive estimates of the fixed effects for primary stress in intensity and duration show that vowels with primary stress are louder in intensity and longer in duration than their unstressed counterparts. For F0 vowels with primary stress instead have lower values than unstressed vowels. Vowels in the secondary stress condition are slightly lower in intensity than vowels in the unstressed condition. The vowel [a] appears to be lower in F0 than [ə], but louder and longer. The fact that the interaction terms are positive for F0 and duration suggests that the F0 and duration values for [a] tend to be higher than would be expected based on the effect of stress and the effect of [a] alone. However, [a] with primary stress has a lower intensity than would otherwise be expected.

In (21) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(21) Figure B.21

	Baseline	Intermediate	Full
F0	378.65	369.97	370.64
Intensity	506.53	501.35	499.55
Duration	446.66	430.24	429.19

AIC values (Experiment 2, speaker C)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(22) Figure B.22

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	12.68	2	0.002	1.34	2	0.25
Intensity	9.18	2	0.01	3.80	2	0.05
Duration	20.42	2	$3.7 * 10^{-5}$	3.06	2	0.08

ANOVA results (Experiment 2, speaker C)

The comparison between base and intermediate models is significant for all three measures, resulting in a lower AIC. The full (interaction) model does not improve on a model without an interaction term for any measure. However, both intensity and duration are on or very close to the significance threshold of 0.05, and both lower AIC. Some of these model comparisons may reach significance due to large differences between unstressed and primary stress conditions, so they do not directly address whether the unstressed and secondary stress conditions differ. Below I report the p-values from post-hoc pairwise comparisons of the unstressed and secondary stress conditions in the intermediate and full models, computed using *lsmeans* (Lenth 2016). Cells which are shaded gray are from models which significantly improved on the next most simple model according to (22). In the full (interaction) model separate p-values are given for the two vowels, while the intermediate (no interaction) model has only one p-value for both vowels.

(23) Figure B.23

	F0		Intensity		Duration	
	[ə]	[a]	[ə]	[a]	[ə]	[a]
Intermediate	1.00		1.00		0.99	
Full	N/A	0.98	N/A	0.66	N/A	0.97

Unstressed vs. secondary stress conditions (Experiment 2, speaker C)

None of these values are close to a significance threshold of 0.05, so there is no clear evidence for an acoustic difference between the unstressed and secondary stress conditions for this participant.

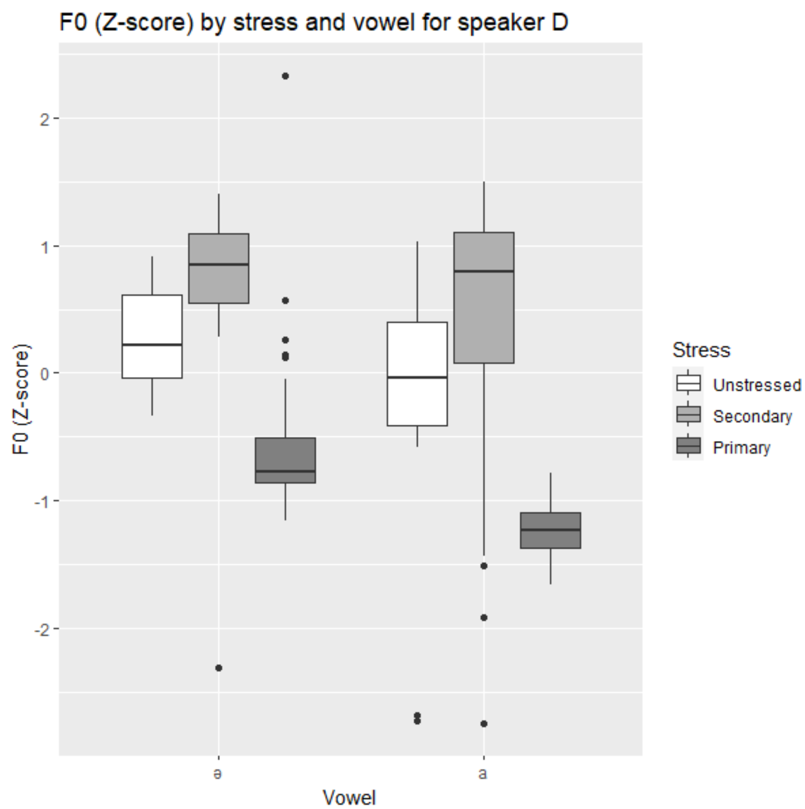
B.4 Speaker D

In this section I discuss the realization of stress for speaker A, focusing on the secondary stress condition in particular. This participant shows statistically significant evidence for secondary stress in terms of duration.

B.4.1 Visualization of data

For both vowels, the primary stress condition is lower in F0 than the unstressed condition, while the secondary stress condition is higher in F0.

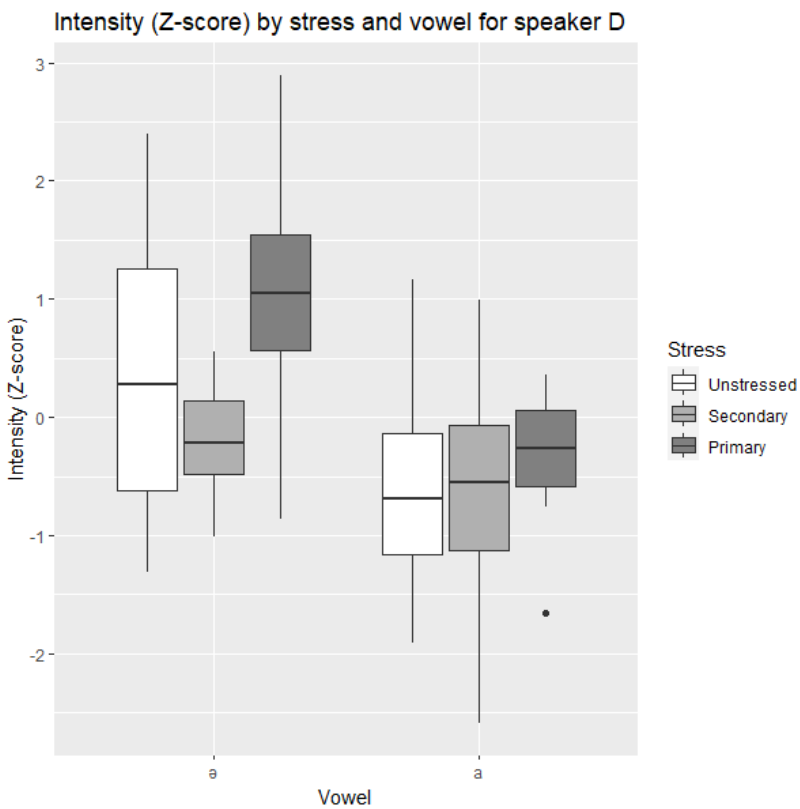
(24) Figure B.24



F0 (Z-score) by stress and vowel (Experiment 2, speaker D)

For intensity there is only a very small difference between unstressed and secondary stress conditions for [a]. The difference is larger for [ə], but also in the opposite direction. Whereas [a] is slightly louder under secondary stress than when unstressed, [ə] is quieter.

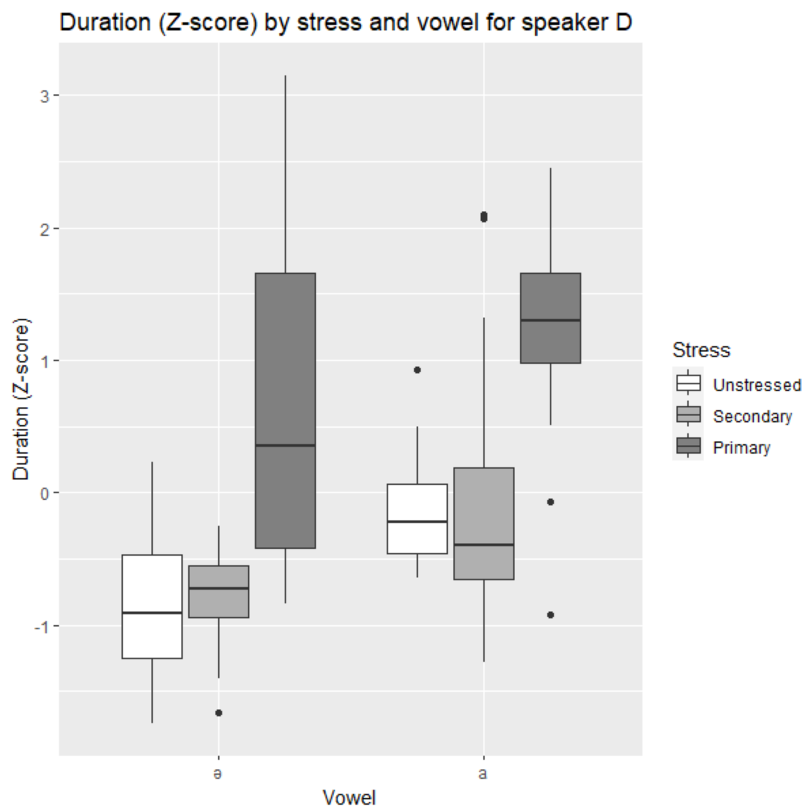
(25) Figure B.25



Intensity (Z-score) by stress and vowel (Experiment 2, speaker D)

The duration data resemble the intensity data in terms of secondary stress. However, here it is [a] which has lower values under secondary stress than when unstressed, and [ə] which has higher values. However, both differences are very small.

(26) Figure B.26



Duration (Z-score) by stress and vowel (Experiment 2, speaker D)

B.4.2 Statistical analysis

Below I give summary outputs for the fixed effects of the full models fitted for this participant. Recall from (1) that the structure is F0 ~ Stress * Vowel + (1|Word), with identical models for intensity and duration. The reference levels for the factors are [ə] for Vowel, and Unstressed for Stress. I give the estimates for the fixed effects and the intercept, plus or minus the standard error. Each model is shown on a separate row.

(27) Figure B.27

Measure	Intercept	Secondary	Primary	[a]	Secondary*[a]	Primary*[a]
F0	-0.17±0.22	0.13±0.26	-0.18±0.22	0.36±0.34	0.10±0.40	-1.26±0.57
Intensity	0.10±0.20	0.21±0.25	0.91±0.21	-0.48±0.32	-0.46±0.38	-0.83±0.52
Duration	-0.67±0.23	0.27±0.24	1.36±0.20	-0.45±0.32	0.77±0.38	0.96±0.62

Fixed effect summaries for the full models (Experiment 2, speaker D)

The positive estimates of the fixed effects for primary stress in intensity and duration show that vowels with primary stress are louder in intensity and longer in duration than their unstressed counterparts. Vowels in the secondary stress condition have positive estimates (i.e. higher values), but with large standard errors. The vowel [a] appears to be higher in F0 than [ə], but quieter and shorter. The fact that the interaction terms are positive for duration suggests that the duration values for [a] tend to be higher than would be expected based on the effect of stress and the effect of [a] alone. However, with the exception of [a] with secondary stress, the other interaction term estimates are negative, so that [a] has lower values than would otherwise be expected.

In (28) I give the AIC values for all models, which will be useful in the model comparisons immediately below.

(28) Figure B.28

	Baseline	Intermediate	Full
F0	420.54	421.07	418.19
Intensity	420.06	406.50	407.75
Duration	459.34	391.77	391.38

AIC values (Experiment 2, speaker D)

Below I show the results of comparing the base model with the intermediate model, and the intermediate and full models, with ANOVAs. Since there are two model comparisons and three measures of stress, this results in six total comparisons. For all six I report the Chi-squared value (χ^2), the degrees of freedom (df), and the p-value (p).

(29) Figure B.29

Measure	Base-intermediate comparison			Intermediate-full comparison		
	χ^2	df	p	χ^2	df	p
F0	3.46	2	0.18	6.99	2	0.03
Intensity	17.56	2	0.0002	2.76	2	0.25
Duration	71.56	2	$2.9 * 10^{-16}$	4.40	2	0.11

ANOVA results (Experiment 2, speaker D)

The comparison between base and intermediate models is significant for intensity and duration, resulting in a lower AIC. The only interaction model which significantly improves on an identical model without an interaction term is for F0, again resulting in a lower AIC. Some of these model comparisons may reach significance due to large differences between unstressed and primary stress conditions, so they do not directly address whether the unstressed and secondary stress conditions differ. Below I report the p-values from post-hoc pairwise comparisons of the unstressed and secondary stress conditions in the intermediate and full models, computed using *lsmeans* (Lenth 2016). Cells which are shaded gray are from models which significantly improved on the next most simple model according to (29). In the full (interaction) model separate p-values are given for the two vowels, while the intermediate (no interaction) model has only one p-value for both vowels.

(30) Figure B.30

	F0		Intensity		Duration	
	[ə]	[a]	[ə]	[a]	[ə]	[a]
Intermediate	0.79		1.00		0.04	
Full	1.00	0.97	0.96	0.95	0.88	0.006

Unstressed vs. secondary stress conditions (Experiment 2, speaker D)

This participant shows acoustic evidence for a distinction between unstressed vowels and vowels with secondary stress in duration. The full (interaction) model for duration demonstrates that only [a] shows evidence for a distinction between unstressed and secondary stress conditions.