Accent Systems, Suprasegmental Phonetics and Phonology

Abstract

This paper examines suprasegmental properties in Slavic, including stress, vowel length (quantity) and tone (pitch accent). For each property, the phonological patterning and phonetic realization are examined. Special attention is given to secondary stress in contemporary Slavic languages, with a typology of footing. The paper also discusses the relationship between suprasegmental and segmental properties, as well as interactions among suprasegmental properties.

All three types of prosodic properties are contrastive in at least one Slavic language: the position of stress within the word, vowel length (or quantity), and tone. At the same time, there are key typological differences among the languages. To start with, three languages have predictable (non-contrastive) stress within a word, without other notable prosodic properties. In Sorbian, stress is always word-initial; in Polish it is penultimate; and in Macedonian it is antepenultimate. These patterns differ from the second group of languages, which exhibit contrastive stress. In Russian, for instance, stress can fall on any syllable of the word and its position is largely unpredictable. Moreover, stress can shift throughout a given paradigm. A third pattern is observed in Czech and Slovak, where stress is always initial, but where vowels can be either short or long. Beyond these groups, two languages remain: Slovenian and Bosnian-Croatian-Serbian (henceforth, BCS). These two languages distinguish all three prosodic properties. Their prosodic patterns are usually analyzed as pitch accents in the phonological literature (Hyman 2006; van der Hulst 2011), which means that individual prosodic properties are interdependent. For instance, in BCS there are two tonal patterns that are contrastive only in stressed positions. Note that a variety of other patterns are observed in regional dialects, including absence of contrasts in tone and/or quantity. The prosodic typology in Slavic languages is summarized in Table 1. Combinations of non-contrastive stress and contrastive tone are unattested in Slavic, even though those possibilities are attested cross-linguistically (e.g. in Norwegian, Kristoffersen 2000; Rice 2006).

Table 1: Contrastive prosodic properties in contemporary Slavic languages.

	Contrastive			
#	Stress	Length	Tone	Languages
1	✗	✗	✗	Polish, Sorbian, Macedonian
2	✓	✗	✗	Russian, Ukrainian, Belarusian, Bulgarian, BCS (Kajkavian)
3	✗	✓	✗	Czech, Slovak
4	✗	✗	✓	*not attested*
5	✓	✓	✗	Slovenian, BCS (Kajkavian)
6	✓	✗	✓	Slovenian
7	✗	✓	✓	*not attested*
8	✓	✓	✓	BCS, Slovenian

In the remainder of this contribution, I review each prosodic property separately in order to explore the typological differences in detail.

Stress

Slavic languages are split nearly evenly between those with predictable stress and those with contrastive stress. Upon closer examination, however, it turns out that this distinction is more fine-grained. On the one hand, languages with predictable stress can have numerous, albeit systematic, exceptions. On the other hand, stress patterns in languages with contrastive stress may be partially predictable or restricted. These are reviewed in the first part of this section. Next, I review the phonetic realization of stress in Slavic languages. As we will see, stressed vowels are generally longer, have higher intensity, and exhibit different pitch contours. Stressed positions may also allow more vowel contrasts, and more peripheral or different vowel qualities. The remaining parts of this section are devoted to secondary stress and footing.

Distribution

West Slavic and Macedonian have predictable stress. Consider the data in (1) from Macedonian, organized by word length. Stress in Macedonian falls on the antepenultimate syllable in words of three or more syllable, or on the initial syllable in shorter words. Antepenultimate stress is

cross-linguistically much rarer than final, penultimate, or initial stress (Gordon 2002).

(1) Antepenultimate stress in Macedonian (Lunt 1952; Hammond 1989; Franks 1991)

ˈσ	ˈzbɔr	‘word’
ˈσσ	ˈraka	‘hand’
ˈσσσ	ˈrabɔta	‘work’
σˈσσσ	maˈkɛdɔnɛʦ	‘Macedonian man’
σσˈσσσ	ʦɛlɛˈvizɔri	‘televisions’
σσσˈσσσ	vɔdɛniˈʧaritɛ	‘the millers’

Two other types of fixed stress are attested in Slavic: Polish has penultimate stress, whereas the remaining West Slavic languages have initial stress, as in Upper Sorbian, where prefixes also receive stress (2).

(2) Initial stress in Upper Sorbian (Šewc Schuster 1984)

ˈswɔwɔ	‘word’	ˈɕet	‘grandfather’
ˈdɔ-swɔwɔ	‘epilogue’	ˈpʀa-ɕet	‘great-grandfather’

The remaining Slavic languages have lexical stress, and the information about the position of stress needs to be lexically prespecified, or is underlying. In Ukrainian, roots can have underlying stress or not, even when segmentally identical, as in (3). When stress is underlying, it remains on the same syllable throughout the declension, as in ‘sheaf’. Roots without underlying stress, on the other hand, have final stress, which means that stress can fall on the suffix, as in ‘grouse’. Languages with lexical stress, like Ukrainian, typically exhibit different accentual paradigms, which means that stress can appear on different syllables throughout the paradigm, and in the derivation. Stress is computed as part of the language’s phonological operations. In all Slavic languages with lexical stress, stems with fixed/underlying stress throughout the paradigm are by far the most numerous, typically comprising over 90% of all nouns (see Melvold 1989, Alderete 1999 for Russian, Butska 2002, Osadcha 2018 for Ukrainian, Biryla and Shuba 1985, Biryla 1986

for Belarusian, and Jurgec 2019, Becker and Jurgec 2020 for Slovenian).

(3) Contrastive stress in Ukrainian (Butska 2002:5)

		‘sheaf’	‘grouse’
		/ˈkulɪk/	/kulɪk/
NOM.SG		ˈkulɪk	kuˈlɪk
GEN.SG	/-a/	ˈkulɪka	kulɪˈka
NOM.PL	/-ɪ/	ˈkulɪkɪ	kulɪˈkɪ
GEN.SG	/-iw/	ˈkulɪkiw	kulɪˈkiw

There are two situations that blur the differences between fixed stress and lexical stress languages. First, languages with fixed stress often allow exceptional stress in some lexical items. Second, languages with lexical stress nevertheless exhibit restrictions on stress or preferences as to where the stress mostly falls. Thus, fixed stress languages sometimes exhibit lexical stress, while lexical stress languages sometimes exhibit predictable stress.

Sorbian, Polish, and Macedonian are known to have exceptional stress in specific classes of words, which include loanwords or exceptional affixes that can attract or repel stress. In Macedonian (4-a), loanwords can have penultimate or final stress even in trisyllabic or longer words. The native stem ‘miller’ has penultimate stress throughout the paradigm, but the loanword stem ‘television’ has penultimate stress and ‘candidate’ has final stress, mirroring the position of stress in the source words. In these loanwords, the position of stress is maintained throughout the paradigms as long as it does not fall outside the trisyllabic window at the end of the word (Lunt 1952; Franks 1991; Gussmann 2007). If enough syllables are added through affixation, stress will shift to the antepenultimate syllable within the paradigm, as we see in ‘television-DEF-PL’.

Another exceptional pattern is found in Polish. Polish has penultimate stress in native words, as in ‘human being’ (4-b). Loanwords can depart from this generalization in that stress is sometimes antepenultimate. In ‘mathematician’, stress is penultimate in the nominative, but remains on the same syllable even when followed by a monosyllabic suffix, as in the genitive

singular. This is true of all monosyllabic suffixes, suggesting that those suffixes are extrametrical (Franks 1991), thus invisible to stress assignment. However, at most one syllable can be extrametrical: a disyllabic suffix receives stress on the penultimate syllable, as in 'mathematician-DAT.SG'. The same generalization applies to 'university': in this case the nominative form has antepenultimate stress, but all forms with segmental suffixes have penultimate stress. As Abramowicz (2008) shows, these descriptions are a simplification: antepenultimate stress is highly variable within the speech community, with women, urban speakers, and word list pronunciation displaying more antepenultimate stress, in addition to there being various phonological, lexical, and frequency effects.

(4) Exceptional stress in loanwords (Franks 1991; Gussmann 2007)

a. Macedonian

'miller'	'television'	'candidate'	
vɔˈdɛnitʃar	tɛlɛˈvizɔr	kandiˈdat	
vɔdɛˈnitʃari	tɛlɛˈvizɔri	kandiˈdati	'-PL'
vɔdɛniˈʧaritɛ	tɛlɛviˈzɔritɛ	kandiˈdatitɛ	'DEF-PL'

b. Polish

'human being'	'mathematician'	'university'	
ˈʦwɔvʲɛk	matɛˈmatɨk	uɲiˈvɛrsɨtɛt	
ʦwɔˈvʲɛka	matɛˈmatɨka	uɲivɛrsɨˈtɛtu	'-GEN.SG'
ʦwɔvʲɛˈkɔvʲi	matɛmatɨˈkɔʊʲi	uɲivɛrsɨtɛˈtɔvʲi	'-DAT.SG'

Lexical stress languages tend to exhibit processes that restrict their stress patterns. The first type of restriction is morphological. In all Slavic languages with lexical stress, stem stress is generally preferred over suffix stress. In Russian, for instance, fixed stress on the stem is present in 92% of all nouns, while fixed stress on the suffix is observed in only 6% (Zaliznjak 1977). Moreover, the default position for root stress in Russian is root-final: Crosswhite et al. (2003) report a nonce-word experiment in which participants assigned stress most commonly to the stem-final

syllable throughout the paradigm (see Alderete 1999 and Dubina 2012 for an in-depth discussion of other literature on this topic). In Slovenian, stress is similarly morphologically restricted (Jurgec 2019): stem stress trumps suffix stress and the last syllable of the stem is stressed in words without underlying stress.

The position of stress has also played a role in paradigmatic contrast in Belarusian (Osadcha 2018) and to a lesser extent Ukrainian (Steriade and Yanovich 2015). In both languages, there are disyllabic stems that have stress on one of the two syllables in all singular forms, and on the other syllable in all plural forms.

Finally, Slovenian exhibits a further restriction on the position of stress that has to do with vowel quality (Becker and Jurgec 2020). Stress depends on vowel quality in disyllabic trochaic stems: if the first syllable contains a stressed lax vowel [ɛ, ɔ], stress is shifted to the following syllable in all cases but the nominative. No stress shift obtains with other vowels. This pattern is by far the most common in real Slovenian words and speakers extend it to nonce words in experiments.

Phonetic realization

Across languages, stress can be realized phonetically in a variety of ways (Lehiste 1970; Hayes 1995): as increased duration, raised pitch, higher intensity, and more peripheral vowels. As we will see, stress may also interact with other prosodic properties in Slavic. In this section, the discussion is limited to the phonetic realization of stress and its interaction with segmental properties of vowels.

Stress is often linked to vowel distribution, the chief pattern involving vowel reduction in unstressed syllables (Delattre 1969; Crosswhite 2001; de Lacy 2006). Russian exhibits perhaps one of the best documented cases. In Russian, vowel distinctions are neutralized in unstressed positions, but the reduction pattern depends on the position of the unstressed syllable, palatalization, and whether the vowel is in a hiatus context. In (5), we see reduction in one specific context, in the immediately pretonic syllable after a palatalized consonant, where the

vowel qualities are reduced to just two and most vowels reduce to [ɪ] (Padgett and Tabain 2005; Iosad 2012).

(5) Russian reduction in the immediately pretonic syllable after a palatalized consonant (Iosad 2012)

ˈnʲos	‘he carried’	nʲɪsˈła	‘she carried’
ˈpʲatʲ	‘five’	pʲɪˈtʲi	‘five-GEN.SG’
rɐzˈdʲeł	‘(a) divide’	rəzdʲɪˈlʲił	‘(he) divided’
ˈpʲił	‘(he) drank’	pʲɪˈła	‘(she) drank’
ˈlʲudʲɪ	‘people’	lʲʊ̟tˈskoj	‘people’s’

In Russian, reduction is not a function of duration: the amount of unstressed vowel centralization does not correlate with vowel duration (Barnes 2004). Phonetically, stressed vowels are longer than pretonic and unstressed vowels (Padgett and Tabain 2005; Gouskova and Roon 2013).

The smaller vowel space of unstressed vowels is widely attested in the world’s languages (Becker-Kristal 2010), but other than Russian, only a handful of Slavic languages exhibit clear phonological reduction. Sorbian mid vowels (Šewc Schuster 1984) and Bulgarian pairs of front, central and back vowels (Scatton 1993) are reported to likely overlap in unstressed positions. Belarusian shows reduction patterns that limit the distribution in certain vowels: mid vowels lower in pretonic syllables (Zelle 2013; Bird and Litvin to appear). Slovenian has robust neutralization of the tense/lax contrast in unstressed position (Toporišič 1976/2000; Jurgec 2006, 2011), and its dialects show additional reduction patterns (Crosswhite 2001; de Lacy 2006; Jurgec 2019).

In Slavic languages without vowel reduction, stress nevertheless has clear phonetic correlates. Stressed vowels are generally longer, have higher intensity and, in some languages, have higher/steeper pitch (Lehiste and Ivić 1986; Pletikos 2008; Newlin-Łukowicz 2012; Łukaszewicz and Mołzcanow 2018), and these patterns are found even in languages with reduction (Gouskova 2010; Petek et al. 1996; Bird and Litvin to appear).

Secondary stress

Regardless of whether primary word stress is lexical or predictable, many languages also show evidence for secondary stress. Secondary stress is generally predictable: it can be aligned with a word edge (Hayes 1995; Kager 2007), specific to morphological domains (Liberman and Prince 1977; Nespor and Vogel 1986), dependent on the position of primary stress (Gordon 2002), or determined by lexical factors (Pater 2000).

Several Slavic languages have been described as having secondary stress. Upper Sorbian has secondary stress on the penultimate syllable in words with four or more syllables (e.g. *ˈprɔdʁustwɔwˌnitsa* 'cooperative farmer'), which is realized as increased vowel length (Šewc Schuster 1984). Czech is described as having optional secondary stress (Hayes 1995:203; Kučera 1961:54; Dogil 1999; Dvořak 2008). Secondary stress can be realized variably on every even-numbered syllable counting from the end of the word (*ˈnɛjnɛvɪˈkupɔˈvanɛjˈʃiːmɪ* 'the most unsalable.INSTR.') or alternatively, on every non-initial odd-numbered syllable counting from the beginning of the word (*ˈnɛjnɛˌvɪkuˌpɔvaˌnɛjʃiːmɪ*). Secondary stress cannot be final (**ˈnɛjnɛˌvɪkuˌpɔvaˌnɛjʃiːˌmɪ*) or adjacent to primary stress (**ˈnɛjˌnɛvɪˌkupɔˌvanɛjˌʃiːmɪ*).

In Slovenian, secondary stress falls on every even syllable counting from the stressed syllable in either direction, but inflectional suffixes cannot receive secondary stress (Jurgec 2007, 2010c). Because native roots are fairly short, the pattern only becomes clear in loanwords (6). In Slovenian, tense and lax mid vowels can appear in stressed positions, while the immediately posttonic vowels are phonetically lax, that is, lower in quality when compared to schwa (Jurgec 2006). Yet, when mid vowels appear two syllables away after the stressed syllable, the vowel quality is tense, as in (6-a). This is consistent with the distribution of secondary stress in Slovenian, which has other correlates in addition to vowel quality. The connection between secondary stress and mid vowel quality becomes apparent in when the posttonic vowel deletes. In the pronunciations in the first column of (6-b), the posttonic mid vowels are two syllables away from the stressed position. As such, the mid vowels receive secondary stress and are realized as tense. In the second column we see that the unstressed [i] between the two syllables can be

deleted, and when that happens, the mid vowel becomes immediately posttonic. Thus, the mid vowel no longer bares secondary stress and is realized as lax.

(6) Secondary stress in Slovenian (Jurgec 2010c)

a. Vowels with secondary stress are tense

ˈmaɾaˌtɔ̲n	*ˈmaɾaˌtɔ̲n	‘marathon’
ˈsaɾaˌjɛ̲vɔ	*ˈsaɾaˌjɛ̲vɔ	‘Sarajevo’

b. Variant pronunciations

[ijo]	[jɔ]	
ˈuniˌjɔ̲n	ˈunjɔ̲n	‘Union’
ˈoriˌjɔ̲n	ˈoɾjɔ̲n	‘Orion’

Ukrainian secondary stress builds from the edge of the word rather than relative to the position of primary stress. If stress is final within the word, secondary stress will fall on every odd syllable counting from the beginning of the word, but it cannot be adjacent to the syllable with primary stress. Łukaszewicz and Mołzcanow (2018) provide evidence for long words that have stress on the sixth syllable: the acoustic measurements (primarily syllable duration) provide clear evidence that the first and third syllable have secondary stress. These facts suggest that Ukrainian can have two unstressed syllables immediately before the stressed syllable, which is well-attested outside Slavic (Elenbaas and Kager 1999; Martínez-Paricio and Kager 2015). The Ukrainian stress pattern will be examined further in (7).

Polish has also been described as having secondary stress on every odd-numbered syllable within the word, as long as that syllable is not adjacent to the syllable with primary stress (e.g. Rubach and Booij 1985; Franks 1985; Hammond 1989). A detailed acoustic investigation by Newlin-Łukowicz (2012), however, suggests that Polish does not have this type of secondary stress: the vowels appearing in odd-numbered syllables have similar length, pitch and intensity than those appearing in even-numbered syllables. Newlin-Łukowicz (2012) nevertheless revealed that multiple stress is present in compounds, but the two stressed syllables need to be at least two

syllables away from one another (*ˈnɔvɔ-mɔdˈnɛmu* 'modern.GEN', but *nɔvɔ-ˈmɔdnɨ* 'modern') . The data was reexamined by Łukaszewicz (2018) who found that relative onset duration was highly significant in determining where secondary stress falls. She proposes that secondary stress falls on every odd-numbered syllable of the word, but not when adjacent to primary stress, mirroring the cross-linguistic tendency to avoid stress clashes (Alber 2005). Therefore, Polish seems to have both secondary stress within non-compounds and additional compound stress.

Compound stress is fairly well studied in Russian. Unlike Polish compounds which are considered to be separate prosodic words, each with its own stress, the evidence suggests that Russian compounds are part of the same prosodic word. Gouskova (2010) notes the lack of final devoicing in the middle of the compounds and vowel reduction of the linking vowel which depends on the following stress. Phonetically, secondary stress is realized as increased vowel duration (when compared to unstressed vowels) and higher intensity (Gouskova and Roon 2013). In compounds, the final stem retains stress, while the presence of secondary stress on the initial stem is determined by several factors (Avanesov 1964; Roon 2006). In order to receive secondary stress, the first stem must have underlying stress (Revithiadou 1999). Second, secondary stress is more likely the more distant it is from the primary stress (Avanesov 1964; Yoo 1992). Third, secondary stress is more frequent or acceptable in low frequency compounds, and less acceptable in high frequency compounds (Gouskova and Roon 2009; Gouskova 2010). Finally, stress is also dependent on sonority in short stems (Gouskova and Roon 2013).

Footing

The typological differences across Slavic languages are consistent with a phonological analysis using metrical feet (Liberman and Prince 1977; McCarthy 1982; Idsardi 1992; Hayes 1995; Kager 2007), that is, prosodic units consisting of up to two syllables, of which exactly one bares stress. Unstressed syllables can form a foot with another stressed syllable or remain unfooted. To illustrate, consider the forms from Ukrainian in (7), which are transcribed based on the acoustic results of Łukaszewicz and Mołzcanow (2018). As we can see, the words exhibit both primary

and secondary stress. Recall that primary stress is lexical, whereas secondary stress falls on every odd-numbered pretonic syllable (in the words shown), but cannot be immediately adjacent to the stressed syllable. The binary distribution of secondary stress presents evidence for footing. Feet in Ukrainian are mostly binary, as we can see in the first example. The first foot in 'an American' consists of a syllable with secondary stress and a syllable with primary stress. The second foot is headed by the syllable with primary stress. This can be represented abstractly with the symbols for syllables, being grouped into feet.

(7) Footing in Ukrainian (data based on Łukaszewicz and Mołzcanow 2018)

Stress only	Footing		
ˌamɛrɪˈkanɛtsʲ	(ˌamɛrɪ)(ˈkanɛtsʲ)	(ˌσσ)(ˈσσ)	'an American'
ˌarɔˌmatɪzuˈvatɪ	(ˌarɔ)(ˌmatɪ)zu(ˈvatɪ)	(ˌσσ)σ(ˈσσ)	'to flavor'
ˌmunʲiˌtsɪpalʲiˈtɛt	(ˌmunʲi)(ˌtsɪpa)lʲi(ˈtɛt)	(ˌσσ)(ˌσσ)σ(ˈσ)	'municipality'

Not all syllables are grouped into disyllabic feet in Ukrainian. In 'to flavor' the antepenultimate syllable is not footed, as it is unstressed. When stress is final, Ukrainian has monosyllabic feet, as in 'municipality'.

Feet are widely used in phonology, and they predict not only the distribution of stress, but also other suprasegmental and segmental patterns. Slavic languages differ in whether they have fixed or lexical stress, and if they have fixed stress, it can be towards the beginning or end of the word, which mirrors the cross-linguistic stress typology. Secondary stress introduces additional phonological distinctions. In Polish, for instance, we can make generalizations about secondary stress by referring to the beginning of the word, whereas primary stress is built towards the end of the word (Hammond 1989). Polish further allows unfooted syllables at the end of the word in certain loanwords (4-b). Other languages offer segmental evidence for stress. In Slovenian, mid vowels under secondary stress are tense while they are lax when unstressed (6).

Table 2 presents an overview of footing in Slavic languages. The languages differ whether they allow only one foot or more. For instance, in Bulgarian and Macedonian there is no evidence for secondary stress, and hence for more than one foot per word. In Upper and Lower (Gordon

2002) Sorbian, primary stress is initial, whereas secondary stress is penultimate, suggesting that only two feet are allowed per word—each aligned with the opposite end.

By a large margin, most languages of the world have trochaic feet, where the first syllable of the foot is stressed (Kager 2007). Within Slavic, Russian is typically analyzed as having iambic feet (e.g. Gouskova 2010), which has to do with the fact that the pretonic syllable has different reduction facts than all other syllables. This way it is possible to formally distinguish the unstressed syllable within the foot from the stressed syllable and all other unstressed syllables (outside the foot). Belarusian resembles Russian in terms of reduction, suggesting an iambic foot, but there are no analyses of stress in compounds and in other unstressed positions.

Footing is generally not affected by vowel length. In Czech, for instance, feet are disyllabic regardless of whether those syllables contain long and short vowels. There are two known exceptions to this. Bethin (1998) suggests that the distribution of feet in Slovak is dependent on vowel length. Zec (1999) shows that in BCS, footing depends on vowel length, and interacts with tone as well. While BCS offers no evidence of secondary stress, the distribution of tone is informative of the footing in the language. Both patterns are discussed in detail in the following sections.

Vowel length

Vowel length is a contrastive property in four Slavic languages: Czech, Slovak, BCS, and Slovenian. I first discuss the phonological patterns affecting vowel length, followed by the phonetic factors.

Distribution

Generally speaking, languages can distinguish long and short vowels in both stress and unstressed positions. This is found in Czech in Slovak. In BCS, however, unstressed long vowels are possible only in posttonic positions, while in the traditional description of Slovenian long vowels are limited to the stressed position. In addition to monophthongs, vowel length can affect other

Table 2: Footing in Slavic languages. Example footing is shown for words of 5 and 6 syllables. Lexical stress is assumed to be on the initial syllable, except for Russian and Ukrainian where primary stress is on the antepenultimate syllable. Quantity affects footing, but it is not included in this table, with the exception of Slovak and BCS (see text for further discussion).

	Foot					Examples	
			Secondary				
#	Type	Primary	Allowed	Alignment	Languages	σσσσσ	σσσσσσ
1	trochee	right	multiple	initial	Polish	(ˌσσ)σ(ˈσσ)	(ˌσσ)(ˌσσ)(ˈσσ)
2	trochee	right	none		Macedonian	σσ(ˈσσ)σ	σσσ(ˈσσ)σ
3	trochee	left	one	final	Sorbian	(ˈσσ)σ(ˌσσ)	(ˈσσ)σσ(ˌσσ)
4	trochee	left	multiple	final or initial	Czech	(ˈσσ)σ(ˌσσ) (ˈσσ)(ˌσσ)σ	(ˈσσ)(ˌσσ)(ˌσσ)
5	trochee	left	multiple	long vowel	Slovak	(ˈσσ)(ˌσːσ)σ	(ˈσσ)(ˌσːσ)(ˌσːσ)
6	trochee	lexical	none		Bulgarian	(ˈσσ)σσσ	(ˈσσ)σσσσ
7	trochee	lexical	multiple	tone/morpheme	BCS	σσ(ˈσ́)(σ́)σ	(ˈσ́)(σσ)(σσ)σ
8	trochee	lexical	multiple	word edges	Ukrainian	(ˌσσ)σ(ˈσσ)	(ˌσσ)(σσ)(ˈσσ)
9	trochee	lexical	multiple	primary stress	Slovenian	(ˈσσ)(ˌσσ)(ˌσ)	(ˈσσ)(ˌσσ)(ˌσσ)
10	iamb	lexical	compounds	lexical	Russian	σσ-(σˈσ)σ	(σˌσ)-σ(σˈσ)σ

segments as well. In Slovak, for instance, syllabic liquids distinguish vowel length.

Multiple long vowels are often restricted. An example comes from the Slovak rhythmic law: two long vowels cannot occur in sequence, as shown in (8). The nominative plural suffix is underlyingly long (a), but it becomes short when the preceding vowel is long (b). Diphthongs are phonologically long, so the nominative plural suffix is realized as short in (c).

(8) Slovak rhythmic law: NOM.PL surfaces as short (Kenstowicz and Rubach 1987)

	‘NOM.SG’	‘GEN.SG’	‘NOM.PL’	
	/-ɔ/	/-a/	/-aː/	
a.	ˈmɛstɔ	ˈmɛsta	ˈmɛstaː	‘town’
	ˈpiːsmɛnɔ	ˈpiːsmɛna	ˈpiːsmɛnaː	‘letter’
b.	ˈdlaːtɔ	ˈdlaːta	ˈdlaːta	‘chisel’
	ˈviːn	ˈviːna	ˈviːna	‘wine’
c.	ˈhniɛzdɔ	ˈhniɛzda	ˈhniɛzda	‘nest’

Vowel length is considered to be distinct from quantity, or syllable weight (Newman 1972; Allen

1973; Zec 1988/1994, 1995). Some languages distinguish two types of syllables: heavy syllables, which contain long vowels or closed syllables; and light syllables, which contain short vowels in open syllables. Within Slavic, there is little evidence that syllable codas contribute to phonological weight.

Phonetic realization

Long vowels are primarily distinguished from short vowels in terms of their duration, but this differs from language to language. In Czech, for instance, long vowels are about twice as long as short vowels (see Palková 1997:179 for a review). This length difference is, however, often accompanied by a difference in vowel quality, possibly through undershoot, that is, the articulatory overlap from adjacent consonants (Lindblom 1963). This difference in vowel quality is, however, not uniform across all vowels in Czech. The high front vowel contrast is typically transcribed as qualitative in addition to quantitive ([iː] versus [ɪ]), as confirmed by studies of vowel quality (Palková 1997; Dankovičová 1997; Šimácková et al. 2012). Podlipský et al. (2009) show that long vowels are between 1.25 and 2.24 times longer than short vowels. This range is affected by the position in the phrase, with phrase-final syllables being longer overall and having somewhat smaller relative length differences). The length distinction is more substantially affected by vowel quality: for the high front vowel [i] in non-final positions, the length ratio is only 1.25, the smallest among all vowels (the next vowel is [u] at 1.40). Podlipský et al. (2019) provide results of a perception experiment showing that Czech speakers make use of spectral cues (that is, vowel quality) in addition to duration to distinguish vowel length.

Similar duration differences between long snd short vowels are found in Slovak and BCS. Sabol (1984) reports that long sonorants, which includes the liquids, are about 1.6 times longer than short sonorants (125 ms versus 79 ms), although this varies depending on speech style: the smallest ratio is found in colloquial speech and the largest in journalistic style (1.34 versus 1.66 in Sabol and Zimmermann 1986). In BCS, long stressed vowels are about 1.7 times as long as short stressed vowels (Lehiste and Ivić 1986).

In this context, Slovenian stands out, with long vowels being only between 3% and 11% longer than short vowels if averaged by vowel quality across all existing studies (Jurgec 2011). In some studies, "long" vowels are in fact shorter. For instance, long [u] reaches only 94% of the duration of short [u] in Srebot Rejec (1988). This led to a consensus among Slovenian researchers according to which Standard Slovenian no longer distinguishes vowel length (Petek et al. 1996; Srebot Rejec 2000; Jurgec 2010a). The only exception is the low vowel [a] (with a difference of 28%), which has been interpreted as a qualitative ([a] vs. [ʌ]) rather than a quantitive distinction (Jurgec 2011).

Tone

I now turn to BCS and Slovenian, which have been described as having pitch accent systems (Hyman 2006; van der Hulst 2011). This means that the languages distinguish both tone and stress, with interactions between the two. As we will see, however, the two languages differ: in Slovenian, stress is predictable from tone, whereas in BCS stress can affect the distribution of tone, and vice versa (Zec 1999). In addition, BCS distinguishes vowel length, which adds an additional layer of complexity. I first review BCS, followed by Slovenian. Finally, I examine tone in regional dialects of both languages and in other Slavic languages.

BCS

BCS distinguishes all three suprasegmental properties: stress, vowel length, and tone. Stressed syllables are about 40% longer than unstressed syllables of the same quantity and typically have higher intensity (Lehiste and Ivić 1986). Posttonic vowels in particular are significantly shorter than stressed short vowels (70 versus 110 ms; Pletikos Olof and Bradfield 2019). As well, the vowel space of stressed vowels is larger than that of unstressed vowels, which is particularly true for short vowels (Lehiste and Ivić 1986:§2.5). Long vowels have longer duration than short vowels, and this is true for both stressed and unstressed vowels. Lehiste and Ivić (1986) report that that long stressed vowels are about 1.7 longer in duration than short stressed vowels;

Pletikos Olof and Bradfield (2019) report a factor of 1.4. Finally, the pitch and intensity contours of words that are otherwise identical in terms of stress and vowel length are distinctive: Lehiste and Ivić (1986) show that the key measure is the peak of fundamental frequency (F0). The so-called Falling tone has this peak earlier in the duration of the stressed syllable. The F0 peak is typically at 20–30% of the stressed syllable for long vowels and 40–50% for short vowels. This differs from the Rising tone where the vast majority of realizations have the F0 peaks at the very end of the stressed syllable or, even more commonly, in the following syllable (Lehiste and Ivić 1986:§2.2). Perceptually, it is this F0 peak that is the most prominent cue to the discrimination of pitch contrasts.

The prosodic contrasts are shown in (9), with stress, tone and quantity clearly indicated. I follow a large body of literature in interpreting the pitch tracks as follows. Falling contours are realized as a High tone on the first mora of the stressed vowel, be it short [á] or long [áa]. Low tone is not marked in these transcriptions and will be omitted in what follows. Rising contours are conversely marked as a sequence of two High tones, one of which appears on the posttonic syllable, reflecting the phonetic realization. In these transcriptions, all three suprasegmental properties are transcribed separately.

(9) BCS prosodic contrasts (data from Godjevac 2000; Landau et al. 1999)

		Long		Short	
Stressed	Falling	ˈrá͡aʋan	‘plain’	ˈɔ́raɔ	‘he plowed’
	Rising	ˈra͡áʋán	‘flat’	ˈɔ́ráɔ	‘eagle’
Unstressed		ˈkúuʈ͡ca͡a	‘house.GEN.PL’	ˈkúʈ͡ca	‘house.NOM.SG’

These phonetic descriptions obscure the fact that the three suprasegmental properties are interdependent. The relationship between stress and tone is what characterizes BCS as a pitch-accented language. There are three separate restrictions. First, the position of stress is predictable from the tone in most accounts (to be elaborated below). Second, stress can fall on any syllable of the word but not on the final syllable of a polysyllabic word. Third, tone is entirely predictable in monosyllabic words and in non-initial syllables of polysyllabic words. In

monosyllables, tone is always Falling. In non-initial positions in polysyllables, tone is always Rising. Put differently, the only position where the tonal contrast is possible is in initial positions of polysyllables. An additional restriction affects vowel length, which is contrastive in stressed and posttonic syllables, but all vowels are short in pretonic positions.

How can we account for the distribution of the three prosodic properties phonologically? In most accounts, vowel length is lexical. Moreover, if tone is underlyingly linked to a particular position within the morpheme, then stress is also predictable (Inkelas and Zec 1988; Zec 1993; Langston 1997; Gvozdanovič 1999). For instance, the distinction between 'plain' and 'flat' is the position of the High tone in the underlying representation: in 'plain' it is marked on the first mora of the initial syllable /ˈráavan/ whereas in 'flat' it is marked on the last mora /ˈraaván/, and the tone subsequently spreads to the preceding vowel: this leftward spread is a general rule in BCS.

An alternative interpretation of these facts was proposed by Zec (1999), who argues that BCS presents a rare case of a language in which stress and tone interact, so that stress is not entirely predictable from tone. There are both conceptual and empirical facts to favor this analysis. To start with, tone in BCS prefers to dock at the end of morphological domains, whereas stress gravitates towards the beginning of the word. Zec (1999) proposes that BCS morphemes are either toneless or have a High tone (10). Toneless morphemes receive initial stress by default: *bɔɔg* → *(ˈbɔɔg)* 'god'. Because toneless stressed vowels are illicit in BCS, an initial High tone is inserted by default: *(ˈbɔɔg)* → *(ˈbɔ́ɔg)*. In this system, tones must be represented phonologically (e.g. as autosegments, Goldsmith 1976), and they interact with footing. BCS has trochaic feet, which can consist of a single long syllable or two short syllables. Toneless roots with a single short vowel must be lengthened to satisfy the prosodic minimum—hence *lud* → *luud* 'human being'. The second class of morphemes has a High tone, which docks towards the end of the relevant morphological domain (root or specific derivational morphemes). In 'madness', for instance, the High tone is realized on the suffix *-ost*, because it marks the edge of the relevant morphological domain. Subsequently, the High tone spreads to the immediately preceding syllable in order for the stress to be as close as possible to the beginning of the word, but it cannot spread farther.

(10) BCS interaction of stress and tone (after Zec 1999)

Toneless roots	/lud/	(ˈlúud)	‘mad’	(ˈlúdɔst)	‘madness-GEN’
	/bɔɔg/	(ˈbɔ́ɔg)	‘god’	(ˈbɔ́)ga	‘god.GEN’
	/ɔpaak/	(ˈó)(paak)	‘vicious’	(ˈó)(paa)(kɔst)	‘viciousness-GEN’
	/dɛvɛr/	(ˈdɛ́)(ver)	‘brother-in-law’	(ˈdɛ́)(vɛra)	‘brother-in-law-GEN’
H-toned roots	/rak$_H$/	(ˈrák)	‘crab’	(ˈrá)ka	‘crab.GEN’
	/gluup$_H$/	(ˈgluú)(pá)	‘stupid-FEM’	(ˈgluú)(pɔ́st)	‘madness’
	/junaak$_H$/	(ˈjú)(náak)	‘hero-NOM’	ju(ˈnaá)(ká)	‘hero-GEN’
	/prɔtagɔnist$_H$/	prɔta(ˈgɔ́)(níst)	‘protagonist’		

The advantage of this view of BCS pitch accents is in the interplay between tone and stress patterns, which are interrelated. Zec’s analysis also captures new generalizations about the directionality of stress and tone in the language. Under this view, the pitch patterns are entirely predictable from morphological information (where the domain boundaries are found and which morpheme contains a High tone). Finally, this approach helps us identify the foot domain in BCS. Trochees in BCS are sensitive to quantity (they are at most bimoraic), tone (they cannot contain two High tones nor have a High tone on the second mora). An added benefit is the successful account of quantity alternations found in monomoraic roots without segmental suffixes.

Slovenian

Pitch accent is also found in Slovenian. Slovenian resembles BCS in limiting the tonal contrast to the stressed position (and its phonetic realization to the tonic and immediately posttonic syllables), but the phonological patterns of the two languages are quite different.

First, Slovenian does not restrict tone in terms of the position of the word: the two contrastive tones can appear in any position within the word. Consider the paradigms of disyllabic roots in (11). While the majority of disyllabic roots have root-final stress, there is also substantial number of nouns with penultimate stress. The two tones are contrastive in both positions. Notice the optional tonal alternation in the instrumental plural, where all nouns may have the same tone. In

BCS, we saw that tone is predictable from the position of stress, such as in non-initial syllables of polysyllables, but this is not the case in Slovenian.

(11) Slovenian tonal patterns in disyllabic nominal stems

	'step'	'fool'	'snow'	'July'
NOM.SG	koˈrák	beˈdàk	ˈkájak	ˈjùlij
GEN.SG	koˈrák-a	beˈdàk-a	ˈkájak-a	ˈjùlij-a
NOM.PL	koˈrák-i	beˈdàk-i	ˈkájak-i	ˈjùlij-i
INSTR.PL	koˈrák-i	beˈdák-i	ˈkájak-i	ˈjúlij-i

Phonetically, Slovenian pitch contrasts are realized primarily on the stressed and the following syllable. Srebot Rejec (1988) describes the key difference in the F0 peak. As in BCS, the Falling tone has the F0 peak at around two thirds of the stressed syllable, whereas the Rising tone has the F0 peak in the immediately posttonic syllable. In addition, the vowels with Rising tone are between 14% and 31% longer, depending on the speaker. Jurgec (2010b) instead characterizes these distinctions in terms of the relative pitch in the tonic and posttonic syllables. In (11), I transcribe these tonal patterns with the High tones corresponding to what is traditionally termed Falling tone, and Low tones corresponding to Rising tones. Phonetically, there is a second tone on the final syllable, but its identity is entirely predictable: High tones are followed by Lows, and vice versa (e.g. *koˈrák-à* in the narrow transcription). In words with final stress, the phonetic realization is falling or rising (e.g. *koˈrâk*).

In addition to a tonal contrast, Slovenian distinguishes stress. Stressed syllables are longer than unstressed syllables (Srebot Rejec 1988; Tivadar 2008) and they exhibit a substantially different vowel inventory. Phonetically, the vowel space is much smaller in posttonic syllables and even more reduced in pretonic positions (Jurgec 2006, 2011). Phonologically, there is neutralization of the tense/lax contrast in mid vowels. Most traditional description of Slovenian also report contrastive vowel length distinctions (e.g. Toporišič 1976/2000; Herrity 2000), but systematic length have never been documented in the literature, despite several comprehensive

studies. As such, I transcribe all forms without length distinctions.

Another difference between Slovenian and BCS has to do with vowel quality. BCS shows vowel length alternations across paradigms, but Slovenian shows vowel quality distinctions in non-high vowels instead (e.g. *proˈmɛ́t* 'traffic-NOM' ∼ *proˈméta* '-GEN'). In terms of the analysis, while the BCS tonal contrasts may interact with vowel length in this case, this analysis is impossible in Slovenian. This alternation is part of the larger pattern affecting mid lax vowels, which have largely predictable tone: Low in non-final syllables and High in final syllables (Becker and Jurgec 2017).

The final difference between the two languages regards footing. Slovenian has robust secondary stress, which is reflected in vowel quality (6). The distribution of secondary stress, and hence footing, is syllabic and predictable from lexical stress, which means that a quantity-sensitive connection with tone, as found in BCS, in unavailable.

In summary, we have seen that BCS has morphological tone and stress distribution governed by phonological operations, but Slovenian cannot be analyzed similarly. Most approaches thus assume that Slovenian has lexical High and Low tones (Gvozdanovič 1999; Jurgec 2007; Becker and Jurgec 2017), while the position of stress is predictable.

Other varieties

The previous discussion was limited to the standard varieties of BCS and Slovenian. For BCS, it was the Neo-Shtokavian variety. Beyond that, the Chakavian variety distinguishes three pitch accents—see Langston (2006) for an extensive analysis within the framework of Autosegmental Phonology. The Kajkavian dialects are non-tonal, and some, including that of Zagreb, have lost the vowel length distinction (Pletikos 2008). Similar variation is found in Slovenian. There are varieties that distinguish both pitch and vowel length (although note the paucity of acoustic data, Neweklowsky 1973), varieties without tonal distinctions but with contrastive vowel length (Jurgec 2019), and finally varieties without tone or quantity (also considered standard). In fact, the tonal distinctions in Slovenian are on the vane (Srebot Rejec 1988, 2000). Perhaps unique in Slavic is

the dialect of Žiri, which contrasts all three prosodic properties: vowel length and tone are contrastive both in stressed and immediately posttonic syllables (Stanonik 1977).

Turning to other branches of Slavic, recall that East Slavic languages have distinctive stress. There are, however, a few dialects with additional long pretonic vowels and a fixed tonal contour that depends on vowel quality (Bethin 2006). For instance, in the Malyja Aucjuki dialect of Belarusian, words with a pretonic non-high vowel have different prosody depending on the stressed vowel. When the stressed vowel is high, the pretonic vowel is long with a rising pitch contour (e.g. [nă꞉ ˈwùlʲitsu] ‘onto the street’), while a non-high stressed vowel is preceded by a short vowel and Low pitch ([nà ˈpʲênʲ] ‘onto a/the tree stump’). In this dialect, both pitch and quantity are non-contrastive. This situation resembles the interactions between stress and vowel quality (Becker and Jurgec 2020) or between tone and vowel quality (Becker and Jurgec 2017) in Slovenian, even though tone is contrastive in the language.

Conclusions

This paper provides an overview of the prosodic systems of contemporary Slavic languages with a focus on the phonetic characteristics and typological differences. The first key typological difference concerns whether stress is chiefly determined by morphological factors, as in the lexical stress systems of East Slavic and most of South Slavic, or mostly by prosodic factors, as in the fixed stress systems of West Slavic and Macedonian. The second typological difference has to do with the presence of tone. In BCS and Slovenian, tone interacts with stress, affecting stress patterns. This differs from some regional dialects in East Slavic, where tone is predictable from the position of stress and segmental patterns. Not attested in Slavic are prosodic systems in which tone is entirely divorced from stress (found in Angaatiha, Hopi, and Eastern Popoloca, among many others; de Lacy 2002). Future research into the prosodic systems of Slavic, including the expansion of our comprehension of regional and sociolinguistic variation, might uncover other ways in which stress can interact with the morphological structure as well as with other suprasegmental and segmental properties.

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