Morphological Effects on Default Stress in Novel Russian Words

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1. Introduction

This article presents the results of a nonce-probe experiment conducted with 13 native speakers of Russian and examines the implications of these results for the linguistic analysis of Russian stress. Experimental items were novel words that ended in a sequence of segments either homophonous with a Russian case ending or not. Carrier sentences were manipulated to either morphosyntactically support a case-marked form or not. Results show a strong morphological effect: speakers stressed the last syllable of the stem, i.e., the ultima in words without inflections, and the antepenult or penult in words with inflections (depending on length of the inflection). This is relevant for linguistic analysis of Russian because it uncovers a default location for stress that is not abundantly apparent in the synchronic phonology. A new formal analysis is presented using Optimality Theory, arguing for an interface constraint between prosodic structure (stress) and morphology (the right edge of the stem).

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This article is structured as follows: Section 2 reviews previous work on stress placement in novel Russian words, which is critically assessed and reanalyzed in terms of the stem-final stress hypothesis. Section 3 presents methods and results of the current experiment. In Section 4, results are considered in light of the structure of the Russian lexicon, and two counter-proposals resting on analogy with phonetically similar structures and lexical frequencies are considered. A general stress mechanism that systematically assigns stress to stem-final syllables is argued for. Section 5 provides an OT implementation of this approach, with crucial use of the OT concepts of Faithfulness, Anti-Faithfulness, and Alignment.

2. Previous work

Nikolaeva 1971 investigated Russian stress regularities by presenting unknown foreign words to native speakers. Words were presented in isolation on index cards. Nikolaeva identifies a number of trends, the strongest and most pronounced being a tendency for penultimate stress in vowel-final words and final stress in consonant-final ones. Although Nikolaeva does not offer a formal analysis of her results, her pattern is reminiscent of attested stress patterns based on moraic trochees where coda consonants are moraic (see e.g., Hayes 1995:181). Although such an analysis would account for Nikolaeva's results, it requires assumptions about Russian prosody that are not otherwise supported.

We propose an alternative explanation. Specifically, we suggest the observed pattern results from morphology. Because words were presented in isolation, participants could assume any morphological parse. Given the morphology of Russian, consonant-final items are most likely to be bare stems. Alternative morphological parses are only possible if the ending phoneme sequence is accidentally identical to some consonant-final inflection, which are limited in number. Vowel-final inflections are much more frequent. Any of the phonemic vowel qualities of Russian can be, on its own, a possible nominal case inflection. It is also very uncommon for Russian stems to end in vowels.[1] It is therefore likely that participants interpreted consonant-final forms as bare stems, and vowel-final ones as inflected. This suggests that Nikolaeva's participants may have uniformly placed stress on the rightmost syllable of the stem. To further investigate this possibility, we conducted a new nonce-probe study of Russian stress placement specifically designed to test for morphological effects.

1. There are a small number of Russian vowel-final noun stems, which are all indeclinable foreign borrowings, cf. *ʃimpanzi, kafe.*

3. Results from a new nonce-probe study

3.1. Methodology

Although Nikolaeva used foreign words, we wanted to focus on native Russian phonology. A set of experimental items were randomly generated according to a CVCVC template and general Russian phonotactics. Items were augmented with a one or two syllable ending sequence (ES). ESs were either morphemic (homophonous with existing nominal case endings) or nonmorphemic. Nonmorphemic ESs were chosen to be phonetically similar to morphemic ones (cf. morphemic –om 'instr. pl.' vs. nonmorphemic –on, –ol). The inventory of ending sequences used is provided in Table 1.

Table 1: Inventory of Ending Sequences (ESs)

Non-morphemic ESs		Morphemic ESs	
C final	V final	C final	V final
-ol, -on	-è[2]	-om (m./n. instr. sg.)	-e (n. nom. sg. or acc. sg., f. dat. sg., loc. sg. all genders)
-uv, -av	-an^{j}i	-ov (m. gen. pl.)	-o (n. nom. sg. or acc. sg.)
-um		-am (dat. pl., all genders)	-i (nom. pl., all genders; m./n. acc. pl.; f. gen. sg.)
-ox		-ax (loc. pl., all genders)	-u (m./n. dat. sg., f. acc. sg., m. loc. sg.)
-aj		-oj (fem. instr. sg.)	-a (f. nom. sg., n. nom./acc. pl., m/n gen. sg.)
			-am^{j}i (instr. pl., all genders)

To further constrain assumed morphological parse, each item was placed in a sentential context. Three contexts were used. In the *Suffixed* context, existence of a case suffix was supported by both adjective-noun case agreement and case requirements of governing categories (verbs or prepositions). For example, in (1a), the morphemic ES –am is most likely to be interpreted as the dative plural case ending: the preceding adjective is dative plural and the preposition *po* requires dative case. In the *Bare*

2. The symbol è indicates /e/ that does not trigger morphophonemic palatalization of the preceding consonant, e.g., the transliteration of orthographic э.

context, interpretation of an ES as a case ending was not supported. Experimental items appeared in subject position, or some other position not requiring overt case-marking, as in (1b). In the *Ambiguous* context, morphosyntactic considerations neither require nor preclude a case-marked interpretation. In (1c), the ending sequence –ax can be interpreted as either the locative plural case ending (requiring the preposition *v* to mean 'in'), or as part of the noun stem (requiring the preposition *v* to mean 'to'). Note that the Ambiguous context is only actually ambiguous with a morphemic ESs.[3]

(1) a.

Tur^{j}isti	gul^{j}al^{j}i	po	soln^{j}etʃn^{j}im	**b^{j}atʃ^{j}el^{j}am**
tourists	stroll	along	sunny	n.w.
Nom. pl.	Past pl.		Dat. pl.	

'The tourists strolled along the sunny *byachels*.'

b.

Anne	nrav^{j}its^{j}a	svoj	novij	**b^{j}atʃ^{j}el^{j}am**
Anna	please	self's	new	n.w.
Dat. sg.	3rd Pres.	Nom. sg.	Nom. sg.	

'Anna likes her new *byachelyam*.'

c.

Kaʒdij	d^{j}en^{j}	F^{j}ed^{j}a	xod^{j}it	v	**t^{j}itʃ^{j}agax**
every	day	Fedya	walk	in/to	n.w.
Acc. sg.	Acc. sg.	Nom. sg.	3 Pres.		

'Every day, Fedya goes to the *tichagax*.' or
'Every day, Fedya walks in *tichags*.'

Two lists were prepared, each containing 176 sentences. Both had equal numbers of sentences from the conditions shown in Table 2, and were identical except for the Suffixed/Morphemic and Bare/Morphemic conditions: here, the specific items inserted into the sentence frames were reversed. For example, although all participants saw /b^{j}atʃ^{j}el^{j}am/, it was Suffixed/Morphemic in List A and Bare/Morphemic in List B (cf. (1a-b)).

Sentences were laser printed in Cyrillic on 4.25" x 5.5" cards and arranged in random order. Participants were asked to read each sentence silently, and were encouraged to take some time to familiarize themselves with it. They then read the entire sentence out loud. Subjects were told that the goal was to study pronunciation of novel words, but their attention was not directed to stress placement. Instructions asked participants to use natural intonation and pronunciation; in particular, pronunciation of experimental items syllable-by-syllable was pointed out as non-natural.

3. Given the grammar of Russian, morphemic ESs used in the Ambiguous context are limited to those corresponding to instrumental and locative cases.

Table 2: Experimental items

Condition	Number of Items
Ambiguous/Morphemic	22
Ambiguous/Nonmorphemic	22
Bare/Nonmorphemic	44
Bare/Morphemic	44
Suffixed/Morphemic	44

After pronouncing a sentence, participants rated its experimental item from 1-5 denoting perceived Russianness; these data will not be discussed here due to space considerations. An audio recording was made from each participant, and his/her stress placements were separately transcribed by two different experimenters. In rare instances where the two experimenters recorded different stress placement (< 1%), the difference was resolved by both experimenters again listening to the item in question.

The participants were 14 native speakers of Russian living in New Brunswick (NJ) and Brooklyn (NY). Eight women and six men ranging in age from 21-38 (mean 25) participated. All were raised in Russian-speaking countries of the former Soviet Union, and Russian was their primary language growing up. All received formal education in Russian before emigrating to the US. Many had significant exposure to Ukrainian and/or English, so precautions were taken to ensure robust Russian intuitions; each participant was evaluated for use of Russian in daily life in the United States, contact with other Russian-speaking individuals, and language preference. One participant was excluded based on these criteria.[4]

3.2. Results

Perhaps the most striking result is the remarkable uniformity of responses. Given the experimental design, a total of 264 unique sentences were used (88 seen by all participants, 88 seen only in list A and 88 only in list B; each participant saw 176). Of these, 116 (44%) received unanimous responses, i.e., the novel word was stressed identically by all participants exposed to that sentence. An additional 69 (26%) had agreement rates between 80% and 99%. The agreement rate was below 50% for only 6 of the sentences (2%), indicating that even when responses were not unanimous, there was almost always a clearly favored response.

4. Thanks to Gerald Pirog (Program in Russian and East European Languages and Literatures) and Ziva Galili (History) of Rutgers University and Christine Alito (Slavic Languages and Literatures) of Princeton University for assistance in contacting native speakers for participation in this study.

Results also show that participants' responses differed by condition in a manner consistent with the stem-final hypothesis. shows average rates of initial, medial, and final stress per speaker for the Suffixed/Morphemic and Bare/Nonmorphemic conditions.

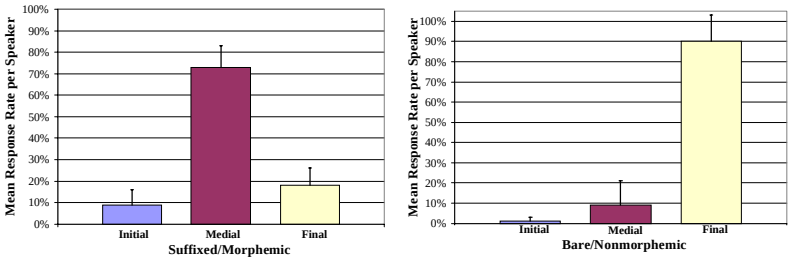

Figure 1: Mean rates of initial, medial, and final stress in the Suffixed/Morphemic (e.g., bʲatʃʲelʲ-am) and Bare/Nonmorphemic (e.g., navʲekum) conditions, per speaker.

In these two conditions we a priori expect the strongest evidence for stem-final stress because the intended morphological parses are very obvious: in the Suffixed/Morphemic condition, presence of a word-medial morpheme boundary is supported both by phonetic similarity of the ES to a case suffix and by sentential context. In the Bare/Nonmorphemic condition, neither factor supports presence of a morpheme boundary.

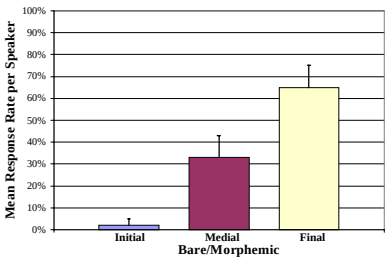

Figure 2: Mean rates of initial, medial, and final stress per speaker in the Bare/Morphemic condition (e.g. bʲatʃʲelʲam).

In the Bare/Morphemic condition (Figure 2), there is conflicting evidence concerning morphological parse. The ESs are phonetically identical to case suffixes, but sentential context supports interpretation as a bare stem. In this condition, distribution of stress responses is intermediate between those in , but more similar to Bare/Nonmorphemic.

In conditions using the Ambiguous context (Figure 3), only phonetic similarity is available: the ES may look like a case ending or not. Both case-marked and bare stem interpretations are morphosyntactically possible. Figure 3 shows essentially the same response distributions as Figure 1.

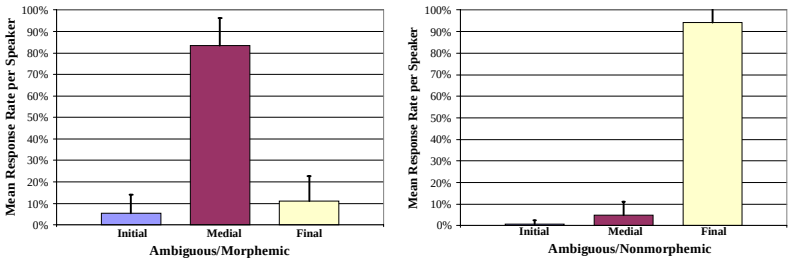

Figure 3: Mean rates of initial, medial, and final stress in the two Ambiguous conditions, per speaker.

4. Discussion

Overall, results are greatly in keeping with the stem-final hypothesis: collapsing over all conditions, 80% of responses were stem-final. In both the Bare/Nonmorphemic and Ambiguous/ Nonmorphemic conditions, this rate is 90% or higher. This is unsurprising: in neither condition are ESs phonetically plausible case suffixes, making the intended parse unmistakable. The Bare/Morphemic condition showed the lowest rate of stem-final stress (65%). This may be due to a propensity to find morphological structure if it is phonetically (but not syntactically) supported. This is supported by similar results in other languages, such as Tagalog and English (Hammond 1999; Zuraw 2000, 2002; Hay et al. 2001).

Our interpretation of these results is that stem-final stress is encoded directly in the phonology of Russian: the default position for stress is the right stem edge. An alternative is that there is no such requirement per se, and that the observed pattern results from some other phenomenon, such as lexical pressure. Since adult native speakers have lexica that are, overall, highly similar, lexical structure is a candidate for accounting for similar behavior among individuals. We argue that while lexical structure no doubt affects linguistic behavior, our results support the claim that the default location for stress is the right stem edge. We consider two alternatives.

One is based on phonetically mediated analogy. A number of researchers have found that linguistic behavior in novel situations is strongly affected by the known behavior of phonetically similar lexical items. Such effects have been found, for example, in English past tense morphology (Albright and Hayes 2001) and stress assignment (Eddington 2000). For concreteness, we provide the following simplified definition:

(2) Phonetically Mediated Analogy
Linguistic behavior with respect to novel words is determined by examining known behavior for familiar words, where amount of influence increases with increased phonetic similarity.

In the case of Russian stress, this could be used to explain part of the experimental results. Assuming that case-marked forms are lexically stored in nondecomposed form, presence of a morphemic ES makes an experimental item phonetically similar to a large number of known words. If we suppose that most of these have stress immediately preceding the case ending, extension of this pattern to novel words is not surprising. Note that this approach does not need to directly link stress and morphology, or even to suppose that case-marked forms have morphological structure. However, this approach does not adequately explain the experimental results. This can be seen by examining the Suffixed/Morphemic and Bare/Morphemic conditions (Figures 1 and 2). Recall that these conditions use phonetically identical items which are placed in different sentential contexts. Phonetic similarity to existing lexical items is therefore strictly controlled, yet different stress behaviors are observed. This is clearly linked to the fact that the Suffixed/Morphemic condition more strongly supports an internal morpheme boundary than does the Bare/Morphemic.

A second counterproposal is based on analogy with more abstract patterns. Research has shown that lexical frequency influences well-formedness judgments (Pierrehumbert 1994; Frisch 1996; Frisch et al. 2000; Treiman et al. 2000), imitative productions (Beckman and Edwards 2000), and application of morphophonological phenomena in novel words (Zuraw 2000). In the case of Russian, it could be that speakers are sensitive to the number of known lexical items that have stress at the right edge of the stem, immediately after the stem, at the left edge of the stem, etc. These frequency distributions could be mirrored in pronouncing novel forms (3).

(3) Analogy Based on Lexical Frequency
Linguistic behavior with respect to a novel word is determined by probabilistically applying a phonotactic pattern from a pool of possible patterns based on their frequency distributions among known words.

For example, if stress pattern X occurs Z% of the time lexically, its rate of occurence among novel words should approximate Z. Although a probabilistic account is needed for certain cases of linguistic behavior (see especially Zuraw 2000), it does not account for the Russian case. Stem-final stress is numerically the most frequent pattern in the lexicon, but does not enjoy the overwhelming preference it shows experimentally. We present statistics from Tornow (1984), which includes the 1360 most common

nouns. As shown in Table 3, stem-final stress occurs lexically much less often (30%) than the 80-90% experimental rate.

Table 3: Lexical Frequency Distributions for Stress Types

Nnon-mobile stress which falls somewhere within the stem.	monosyllables	201	15%
	Stress on initial syllable of stem	153	11%
	Stress on final stem syllable	415	30%
	Stress on some other stem syllable	241	18%
Non-mobile stress which falls on a post-stem suffix.		103	8%
Mobile stress of the A/B type (singular = initial stress, plural = stress on post-stem suffix)		179	13%
Mobile stress of the B/A type (singular=stem-final stress; plural=stress on post-stem ending)		68	5%

This is not to say, however, that lexicon-based frequency statistics are incapable of accounting for Russian stress. We have found that the frequency distribution of stem-final stress is skewed, being more frequent for low-frequency lexical items than high-frequency ones. That this is so was first suggested to us by Cubberly's (1987) observations on "stem stress". Here, stem stress refers to non-mobile stress fixed anywhere in the stem, including but not limited to stem-final stress. Cubberly points out stem stress predominates in the overall lexicon (= 91% based on the corpus of Fedianina 1976) but is significantly less common for high-frequency words (= 73% for the alphabetically first 1000 nouns of Zasorina 1977). Since stem-final stress is the most frequent type of stem stress, we reason that the same pattern will hold for it. This is borne out by the first 100 nouns from Zasorina (1977) that met the following criteria: are non-monosyllabic, not obvious compounds, and had the lowest frequency (i.e., once in 1,056,382 words). Of these, 100% had stem stress, and 60% had stem-final stress.[5] If language learners are sensitive to skewedness, this could explain the boosted experimental rates of stem-final stress. It is known that idiosyncratic, lexically-listed characteristics are preferentially

5. This figure rises to nearly 77% if stems including derivational suffixes with predictable effects on stress are excluded (for example, deverbal nouns in -énie/-ánie, abstract nouns in unstressable –nost', etc.).

preserved in high-frequency lexical items, which are constantly reinforced in memory. A distribution skewed in favor of low frequency items could therefore be taken as evidence for an across-the-board phonotactic which is overridden by lexical stress specifications. This essentially encodes stem-final position as the default location for stress.

5. OT analysis of the stem-final default

The argumentation developed above suggests that the experimental results are due to a systematic preference for stem-final stress. This preference can be formalized in a variety of ways, ranging from connectionist to symbolic computational (i.e., using rules or constraints). Our experiment was not designed to probe distinctions at this level. However, our results are helpful in making analytical decisions within symbolic computational frameworks. Generative analyses of Russian stress have run the gamut for encoding default stress, including analyses that posit default initial stress (Halle 1997; Idsardi 1992; Melvold 1990), final stress (Revithiadou 1999), and stress on the syllable immediately following the stem (Alderete 2001). In this section, we develop an analysis that integrates the experimental results with stress placement in existing Russian words, revealing a role for default stem-final stress in known lexical items.

The stem-final default shows an influence of morphology on phonology: the assignment of stress depends crucially on the position of the right stem boundary. We interpret this influence as the result of an interface constraint, ALIGNRIGHT, that forces the alignment of metrical stress feet and the stem at a designated edge (after McCarthy and Prince 1993).

(4) ALIGNRIGHT: The right edge of the stem coincides with the right edge of some foot.

Because we assume an iambic Russian foot (following Halle and Verguard 1987), ALIGNRIGHT ensures that inputs with no lexical stress get stem-final stress. Since nonce stems and the endings attached to them have no inherent stresses, novel words will be assigned stem-final stress.

The stem-final default is embedded in a larger system of contrast for stress, which accounts for stress in non-default positions in words listed in the Russian lexicon. Following previous work, we assume that deviations from stem-final stress arise from lexically specified stresses of two types. Stress characteristics can be represented as lexically specified foot heads, accounting for fixed stress on a stem syllable (i.e., the behavior of so-called acute stems) or as foot tails, which among other things accounts for fixed inflection stress (= stress in ‘oxytone’ stems). Some logically possible inputs for stems in this system and their inflected outputs are shown below.

	Input stem	Inflected output	
a.	(ó) o	(ó) o + o	Initial (acute)
b.	(o ó)	(o ó) + o	Stem-final (acute)
c.	o (o ´)	o (o + ó)	Ending (oxytone)
d.	o o	(o ó) + o	Stem-final (acute)

We implement an analysis of these input-output pairings using Optimality Theory (Prince and Smolensky 1993) because its concepts of Alignment and Faithfulness offer an especially perspicacious set of formal tools. Furthermore, this approach is supported by the analysis for mobile stress, which we discuss below. Following Itô, Kitigawa and Mester (1996) and Revithiadou (1999), we assume that there are faithfulness constraints that refer to the heads and tails of lexically specified feet. For concreteness we formulate them as anchoring constraints (McCarthy and Prince 1995):

(5) L/R-FOOTANCHOR: The left/right edge of every foot in the input corresponds to the left/right edge of some foot in the output.

The anchoring constraints are ranked above other well-formedness constraints on prosodic structure in Russian (see Prince and Smolensky 1993 for definitions of constraints listed below), producing the system of lexical stress contrasts and stem-final default illustrated above.

(6) Language particular rankings for Russian
FOOT=IAMB >> FOOT=TROCHEE: iambic feet
R-FOOTANCHOR >> FOOTBINARITY: non-binary feet
L/R-FOOTANCHOR >> PARSESYLLABLE: non-iterative stress
L/R-FOOTANCHOR >> ALIGNRIGHT: free stress

The principal support for ALIGNRIGHT in the analysis is its effect in causing the stem-final default in novel words, as well as its (indirect) role in the account of the fact that stem-final stress is the most common pattern in low-frequency words. Additional support for the alignment constraint comes from two patterns of mobile stress. The overwhelming majority of Russian words have fixed stress on a stem syllable or an ending (Cubberly 1987). Only a small percentage have mobile stress, and of those very few have irregular mobile stress. Instead, almost all of them fall into one of two categories. In one, there is ending stress in the singular, *kolbas-ú* ‘sausage (accusative)’, and stem-final stress in plurals, as in *kolbás-ami* (instrumental). This pattern, called metatony, reveals a further role for ALIGNRIGHT, once additional factors are introduced into the system.

Mobile stress patterns mark an opposition between singular and plural forms, showing a role for phonology in marking morphological contrasts. We follow Alderete (2001) in assuming that this morphological influence results from anti-faithfulness. Anti-faithfulness constraints evaluate pairs of morphologically related words, defined as a base and output of some morphological process, and require a phonological change of some kind. The singular-plural pairs in Russian therefore imply anti-faithfulness for stress. The effect of this constraint, however, is only felt in particular words. Following Fukazawa (1998), among others, we assume that certain stems may be specified for a mobile stress correspondence relation and that anti-faithfulness is ranked high for words defined on this correspondence (see Alderete 2001 for the details of formalizing this correspondence theory of stress exceptions). When ranked above the corresponding faithfulness constraint, defined for related singular and plural forms (OO-correspondence), Anti-Faithfulness produces the desired shifts in stress.

The stem-final default observed in plural forms of stems that undergo metatony can be modeled as a direct consequence of alignment. Fixed ending stress in both singulars and plurals, shown below in (7a), does not achieve a phonological change, so it is ruled out by anti-faithfulness. Given a choice between inserting a stress on the stem-final syllable, and some other syllable, ALIGNRIGHT prefers stem-final stress.

(7) Metatony: emergence of stem-final default

	Base	Output	ANTIFAITH	OO-IDENT	ALIGNRIGHT
a.	oo-ó$_{SG}$	o(o–ó)$_{PL}$	*!		*
b. ☞	oo-ó$_{SG}$	(oó)–o$_{PL}$		*	
c.	oo-ó$_{SG}$	(ó)o–o$_{PL}$		*	*!

The role for ALIGNRIGHT is also apparent in a second mobile stress category. So-called circumflex stems have fixed stem stress in the singular, but stress on the first inflectional vowel in the plural, e.g. *kólokol-a* 'bell (genitive singular)', cf. *kolokol-ámi* (instrumental plural). Interestingly, stem stress in the singular rules out stem-final stress in the plural. Shifting stress from the initial to the end of the stem, as in (8b), involves two violations of Faithfulness for stress, OO-IDENT, making this candidate worse than those that shift stress off the stem.[6] The winner therefore shifts

6. The difference in OO-IDENT(STR) violations in (8b) versus (8c-d) is a consequence of Stem-to-Stem correspondence, argued for in Alderete 2001, which assumes that faithfulness constraints defined on an OO-correspondence relation only govern the relation between segments of a shared stem. The insertion of stress in the endings in (8c-d) therefore does not violate OO-IDENT(STR).

stress off the stem, but minimizes distance to the stem edge. In this corner of Russian grammar, AlignRight also has a role in predicting default stress.

(8) Circumflex stems: minimal violation

	Base	Output	ANTIFAITH	OO-IDENT	ALIGNR
a.	óo-o$_{SG}$	(ó)o–oo$_{PL}$	*!		*
b.	óo-o$_{SG}$	(oó)–oo$_{PL}$		**!	
c. ☞	óo-o$_{SG}$	o(o–ó)o$_{PL}$		*	*
d.	óo-o$_{SG}$	oo–(oó)$_{PL}$		*	**!

In summary, Alignment provides a general mechanism for assigning default stress in the absence of lexically specified prosody. It correctly predicts stem-final stress in novel words because they lack lexical specifications. It also correctly accounts for default stress in listed words that lack lexical stress either because they are simply unaccented or because morphophonology actively suppresses lexical specifications (i.e., plurals in mobile stress patterns). The same assumptions required by the experimental data therefore account for synchronic stress patterns as well.

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