ALLOMORPHY IN OPTIMALITY THEORY: POLISH IOTATION

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This article discusses IOTATION, a process that has been analyzed in generative phonology as a palatalization rule. We argue that optimality theory predicts the treatment of this process in terms of allomorphy, which in fact is desirable for a synchronic analysis. The consequence is that, with regard to iotation effects, the task of phonology is to account for the distribution of allomorphs rather than to derive them from a single underlying representation. While, as a result of diachronic changes, the allomorphs are arbitrary, their distribution is not. It follows from the interaction of universal phonological and morphological constraints, and from the considerations of segment markedness.*

All phonological theories address the problem of the surface realization of morphemes. This is often straightforward because many morphemes have one invariable realization; for example, Polish *dom* 'house' is always represented as [dom]. Central to phonology are instances that are realized differently in different contexts. Traditionally, it is said that such instances show allomorphy because allomorphy is understood as a situation in which two or more different morphs share the same grammatical or semantic function and hence are allomorphs of one morpheme. The task of phonology is then to explain the distribution and the phonological shape of allomorphs. The most straightforward way to achieve this goal is to posit a single underlying representation and account for surface allomorphs in terms of phonological generalizations.

A clear example of this situation is an analysis of the surface allomorphs [hut] and [hud] of *hoed* 'hat' in Dutch. The former occurs in the singular while the latter is found in the plural, before the plural suffix *en*: [hut] versus [hud + ən]. The solution is to posit hud/ as the underlying representation and derive [hut] phonologically by FINAL DEVOICING (Booij 1995). The success of this analysis is due to two facts: first, the allomorphs differ from each other in a minimal way (devoicing) and second, the distribution of the allomorphs is governed by a clear phonological generalization (final devoicing). However, there is also another type of allomorphy, one that is dramatically different from the case just described.

One example is the Dutch suffixes *-iteit* (English *-ity*) and *-heid* (English *-hood*). The former is a non-native suffix, and it attaches to non-native stems. The latter is a native suffix, and it attaches to both native and non-native stems. The situation here is different from that described in connection with [hut] and [hud]. First, *-iteit* and *-heid* do not show any phonological similarity and, consequently, are not reducible to a single underlying representation. Second, the distribution of the suffixes is governed by a purely morphological generalization: the lexical subcategorization of the stems and the suffixes with regard to their native versus non-native status. The distribution of *-iteit* and *-heid* falls within the realm of morphology rather than phonology.

To summarize, allomorphy is found at both of the two extreme points along the dimension of the phonology-morphology interface: some allomorphy is purely phonological, some is purely morphological. In the former case, the typical analysis is to

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posit a single underlying representation and appeal to phonological generalizations in order to account for the surface differences between allomorphs. In the latter case, we have two or more underlying representations and the distribution of the allomorphs is governed morphologically. The difficulty for all analyses is that languages also exhibit allomorphy that cannot be placed at either of the two extreme points: phonological or morphological. In other words, there is a continuum between these two points, with allomorphy being phonological or morphological to a varying degree. We illustrate this problem below.

Carstairs-McCarthy (1988) notes that the distribution of the Hungarian suffixes for the second person singular indefinite present indicative *-ol* and *-(a)sz* is governed phonologically. The former occurs after sibilants and the latter after affricates. Yet, there is no reasonable analysis that would reduce these suffixes to a single underlying representation. Aronoff (1976) observes that the English *nominee* is derived from the verbal base *nominate*. The problem is that the *ate* of *nominate* does not occur in *nominee*. The deletion of *ate* cannot be ascribed to any general phonological process. Rather, it needs to be executed by a truncation rule, and truncation rules apply to designated morphemes in the environment of designated morphemes.

In Dutch, there are five allomorphs of the diminutive morpheme: *-tje*, *-kje*, *-pje*, *-etje* and *-je*. They can be related phonologically by assuming a single underlying representation /tjə/. The surface allomorphs are then derived by rules: assimilation, vowel epenthesis and *t*-deletion (see Booij 1995). The difficulty is that these rules are not phonological: they have to be made sensitive to the feature [+ dimin] because they apply to diminutives only.[1]

Mixed phonologically/morphologically governed allomorphy, such as that just exemplified, is problematic for all phonological frameworks. One difference among theories is the determination of the point in the phonology-morphology continuum where allomorphy should be analyzed by reducing the surface variants to a single underlying representation.

Classic generative phonology places the cutoff point for phonological analysis rather high toward the morphological end of the continuum. That is, it subsumes under phonology much of what other theories would subsume under morphology and posits single underlying representations also in instances in which the surface variants are significantly different from each other. The success comes at a price: we have highly abstract underlying representations, complex derivations, and allomorphy rules, that is, rules that account for morphologically restricted alternations in lexically specified inputs.

Optimality theory (Prince & Smolensky 1993, McCarthy & Prince 1994a and 1995), with its emphasis on output representations, places the cutoff point for phonological analysis well below the morphological end of the continuum. One reason for this placement is that allomorphy rules/constraints are not available in this framework. Phonological analysis is carried out in terms of general constraints that have to be universal and cannot be language-specific. As we will argue below, this clean phonological picture comes at a price: optimality theory (OT, henceforth) requires much more listing of allomorphs than classic generative phonology would call for.[2] However, we intend to show that this listing does not mean that we give up completely on the phonological

[1] On rules of this type, see Anderson 1975, Lieber 1980, Spencer 1986, 1988 and 1991.

[2] It should be stated very clearly that all phonological theories, and not just OT, must admit the listing of allomorphs since, as pointed out earlier, some allomorphs cannot be reduced to a single underlying representation in any reasonable analysis.

analysis of allomorphy. While the allomorphs themselves are arbitrary, their distribution is not. Following Mester 1994, Kager 1996 and Drachman et al. 1996, we argue that the distribution of allomorphs is governed by universal prosodic constraints, but we extend their concept of allomorph selection and claim that this selection can also be made by faithfulness constraints, nonprosodic markedness constraints and morphological constraints which, rather interestingly, are interspersed among phonological constraints. Also raised is the issue of the emergence of the unmarked in allomorph selection. OT offers a radically different perspective on allomorphy from that assumed in the earlier theories. Consider an example from Dutch that illustrates the idea of prosodically driven selection of the optimal allomorph.

The formation of plural nouns is carried out by appending either *-s* or *-en* [ən]. Descriptively, the generalization is as follows (see Booij 1997 and 1998).

(1) *-s* after nominal stems ending in an unstressed syllable, *-en* /ən/ after nominal stems ending in a stressed syllable

The effect of this 'rule' is that a plural noun will always end in a trochee, the optimal foot of Dutch.

(2) a.	dam 'dam'	dámm + en
	kanón 'gun'	kanónn + en
	kanáal 'channel'	kanál + en
	lèdikánt 'bed'	lèdikánt + en
b.	kánon 'canon'	kánon + s
	bézem 'sweep'	bézem + s
	tóga 'gown'	tóga + s
	proféssor 'professor'	proféssor + s

The output constraint that a noun must end in a trochee predicts that the suffixes could not be reversed in 2. Had this happened, the trochee would be lost: **dams* and **kánon* + *en*. In fact, the insight is still deeper.

Dutch deletes the final schwa when a vowel-initial suffix is appended. Given this generalization and the trochee requirement, we predict, correctly, that nouns ending in a schwa can form the plural in two ways: either by appending the *-s* and keeping the stem-final schwa, or by appending the *-en* and deleting the stem-final schwa. In either case the output has a trochee.

(3)	kade 'quay'	kades, kaden
	bode 'messenger'	bodes, boden
	lade 'drawer'	lades, laden

In sum, the Dutch data show that the selection of the correct allomorph can only be made in terms of output constraints. In the remainder of this article, we look at Polish, a highly inflecting language that shows many phonological alternations and is thus interesting for our purposes.

1. BACKGROUND. Polish has the high tense vowels /i ɨ u/, the mid lax vowels /ɛ ɔ/, and the low vowel /a/. In what follows, we will simplify the transcription and represent /ɨ ɛ ɔ/ as /y e o/, respectively. These vowels occur in both underlying and surface representations. In addition, Polish, like other Slavic languages, has YERS, vowels that alternate with zero, as exemplified in 4. The examples are represented in phonetic transcription rather than in the notoriously confusing Polish spelling. We adopt this

practice here, but, for clarity of presentation, we will suppress irrelevant phonetic detail, including the effects of voice assimilation and final devoicing.

(4) zev 'call' (N, NOM.SG.) zv + õ[3] 'they call'
os*e*sek 'suckling' (NOM.SG.) ss + õ 'they suck'
viɲ + *e*n 'guilty' (MASC.) vin + n + a 'guilty' (FEM.)

Whether a vowel alternates with zero or not is unpredictable. Thus, next to the alternating *otset* 'vinegar' (nom.sg.)–*otst* + *y* (nom.pl.), we have the nonalternating *fatset* 'guy' (nom.sg.)–*fatset* + *y* (nom.pl.). Consequently, a simple rule of *e*-deletion is not a viable option. Epenthesis as a way of explaining vowel-zero alternations is not an option either, since next to the alternating *oset* 'thistle' (nom.sg.)–*ost* + *y* (nom.pl.), we have the nonalternating *post* 'fasting' (nom.sg.)–*post* + *y* (nom.pl.). In sum, the alternating vowels, yers, must be distinguished from the nonalternating vowels at the underlying level (Lightner 1965, Laskowski 1975, Gussmann 1980, Rubach 1984). The exact way to draw this distinction need not concern us here. Suffice it to say that the now widely accepted interpretation is to treat yers as moraless or X-slotless vowels (Kenstowicz & Rubach 1987, Rubach 1986). The surface [e] is then derived from /E/, a floating vocalic segment. The feature makeup of /E/ is the same as that of the surface [e] but the vowel has no mora in the underlying representation. In order to be able to surface, yers need to be vocalized by a rule that inserts a mora: $E \rightarrow e$. The exact circumstances under which YER VOCALIZATION takes place are highly complex and controversial. Let us only note that it is standard to assume that a yer is vocalized if it is followed by another yer with no intervening vowel. (Intervening consonants do not matter.) Yers are also vocalized in the final syllable of the word.[4] Unvocalized yers are ill-formed vowels and are deleted context freely.

The consonantal system is quite complex. In particular, it diverges from the commonly found systems by distinguishing two series of strident coronals, which contrast at both the underlying level and the phonetic level.

(5) a. postalveolar fricatives and affricates /ʃ ʒ ʧ ʤ/:
ʃary 'grey', ʒaba 'frog', ʧas 'time', ʤuma 'black death'
b. prepalatal fricatives and affricates /ɕ ʑ tɕ dʑ/:
ɕarka 'sulphur', ʑarno 'grain', tɕotɕa 'aunt', dʑura 'hole'

The system of prepalatals in 5b is straightforward. In addition to the segments in 5b, it includes also /ɲ/, as in *ɲaɲa* 'nanny'. These segments are traditionally referred to as 'soft palatals', and they are characterized as [−anter, +high, −back]. In contrast, the consonants in 5a as well as the alveolar /ts dz l/, as in *tso* 'what', *dzvon* 'bell', and *lub* 'or', are known in Polish grammars as HARD PALATALS or FUNCTIONAL PALATALS. The term FUNCTIONAL refers to the fact that these consonants occur in contexts of morphophonemic palatalization rules and thus function as palatals, even though the rules themselves have lost their grounding in phonetics. These hard or functional palatals are indeed phonetically hard rather than soft, that is, they are characterized as [+back] rather than [−back] consonants, where [back] refers to the position of the tongue body (see Wierzchowska 1963, Rubach 1984). Until the sixteenth century, they were soft

[3] The pronunciation of the third person plural ending is [õw̃], but we will ignore the nasalized glide [w̃] here. On a more general level, the question is whether Polish nasal vowels are underlying segments or whether they are derived from sequences of oral vowels and nasal consonants. The issue is irrelevant to our discussion and, consequently, will be ignored in this article. See Rubach 1984 and Bethin 1992.

[4] This is a simplification, see Gussmann 1980, Rubach 1984 and Bethin 1992 for details.

[ts' dz' l' ʃ' ʒ' ʧ' ʤ'] but then they 'hardened' and became [+back]. A different historical process, LATERAL VOCALIZATION, changed the dark *ł* into [w] in the nineteenth century. This change is reflected in all dialects of Polish except those spoken in the east, where the clear [l] contrasts phonetically with the dark [ɬ], as in *laska* 'stick' versus *łaska* 'grace' ([waska] in the noneastern dialects). To simplify the presentation, we ignore lateral vocalization in this article and retain [ɬ], as found today in eastern Polish.

In Table 1 we summarize the discussion of Polish vowels and consonants, using the traditional SPE features (Chomsky & Halle 1968). The consonantal chart is limited to the segments that play a role in the subsequent analysis.

TABLE 1. Polish vowels and consonants.

Vowels						
	i	y	u	e	o	a
high	+	+	+	−	−	−
back	−	+	+	−	+	+
low	−	−	−	−	−	+
round	−	−	+	−	+	−

Consonants (voiceless and voiced consonants are grouped together)

	t d	s z	ts dz	n	ʃ ʒ	ʧ ʤ	ɕ ʑ	tɕ dʑ	ɲ
coronal	+	+	+	+	+	+	+	+	+
anterior	+	+	+	+	−	−	−	−	−
strident	−	+	+	−	+	+	+	+	−
continuant	−	+	−	−	+	−	+	−	−
back	+	+	+	+	+	+	−	−	−
high	−	−	−	−	−	−	+	+	+

The role of soft palatals (5b) and hard palatals (5a) is best illustrated by verb inflection: infinitives, conjugational paradigms, present participles, passive participles, past participles, and imperatives. We begin by looking at the structure of verb stems in the infinitive.

Polish has both simplex and derived verbs. The former have stems ending in a consonant or a glide and are therefore called C-verbs. The latter are derived from nouns, adjectives or roots that are unspecified for grammatical category. Verbalization is then a matter of adding a verbalizing suffix. There are several such suffixes, and their distribution is unpredictable. In Table 2 we exemplify both C-verbs and derived verbs

VERB CLASS	STEM TYPE	EXAMPLE	
Class 1	C-verbs	$paɕ]_V + tɕ]_{inf}$	'graze'
Class 2	*a*-verbalization	$pis]_R + a]_V + tɕ]_{inf}$	'write'
Class 3	*i*-verbalization	$głoɕ]_N + i]_V + tɕ]_{inf}$	'voice'
Class 4	*e*-verbalization	$viɕ]_R + e]_V + tɕ]_{inf}$	'hang'
Class 5	*ova*-verbalization	$głos]_N + ova]_V + tɕ]_{inf}$	'vote'

TABLE 2. Polish verb classes.

but limit the list to the classes that are relevant for the discussion in this article. We look at stems that end in /s/ in the underlying representation. The /s/ surfaces as [ɕ] before front vowels (palatalization) or before a prepalatal consonant (assimilation).

Note: V means verb, N is noun, R stands for morphological root unspecified for category, inf. is an abbreviation for infinitive.

Two observations need to be made at this point. First, the infinitive suffix is /tɕ/. Second, classes 1-4 are closed in the sense that they are not used for productive verbalization (but see n. 45 below). Class 5 is open and the suffix *ova* may form new verbs, for example, *sejvovatɕ* which is based on the English *save*. The verbs *głoɕ + i + tɕ* (class 3) and *głos + ova + tɕ* (class 5) are derived from the same stem: the noun *głos* 'voice, vote'.

The central role of palatalization is best seen in conjugational paradigms. While such paradigms include three persons in the singular and in the plural, it is sufficient to look at the second person singular and the third person plural only. These are the diagnostic forms, because the phonological effects in the second person singular are also found in the third person plural as well as in the first person plural and the second person plural. In contrast, whatever is true in the third person singular is also true in the first person singular.[5] We will therefore limit our discussion of conjugation to the second person singular and the third person plural. The relevant data are given in Table 3.

PRESENT TENSE	2ND P.SG	3RD P.PL	
Class 1	paɕ + eʃ	pas + õ	'graze'
Class 2	piʃ + eʃ	piʃ + õ	'write'
Class 3	głoɕ + iʃ	głoʃ + õ	'voice'
Class 4	viɕ + iʃ	viʃ + õ	'hang'
Class 5	głos + uj + eʃ	głos + uj + õ	'vote'

TABLE 3. Polish conjugation.

Several important observations follow from the inspection of the data in Table 3. First, the second person singular ending appears either as *-eʃ* or as *-iʃ*. The distribution is governed by morphological class: *-eʃ* in classes 1, 2 and 5, and *-iʃ* in classes 3 and 4.[6] Second, the verbalizing suffixes shown in Table 2 that are made up of a single vowel do not appear in surface representations (*a, i* and *e* in classes 2, 3 and 4, respectively). Third, the suffix *-ova* of class 5 is turned into *uj*. Fourth, stem consonants palatalize in two different ways: /s/ becomes either [ɕ] or [ʃ]. The circumstances under which these palatalizations take place are to a large extent mysterious. Thus, before *e* the /s/ of the verb 'graze' palatalizes to [ɕ] while the /s/ of the verb 'write' palatalizes to [ʃ]: *paɕ + eʃ* 'you graze' versus *piʃ + eʃ* 'you write'. Also, before *-õ*, the /s/ of 'graze' does not palatalize, which is to be expected (the vowel is back), but the /s/ of 'write', 'voice' and 'hang' palatalizes to [ʃ]! In sum, little sense can be made of the palatalization effects in Table 3. One point is clear, however: we have two different types of palatalization: $s \rightarrow ɕ$ and $s \rightarrow ʃ$. The former is known as CORONAL PALATALIZATION and the latter as IOTATION. Below we give further data showing that the two types of palatalization affect also segments other than /s/, but we limit the data to coronal obstruents as inputs, because with other inputs, the effects of the two palatalizations are nondistinct. They are thus irrelevant for our purposes and will be disregarded in this article.

[5] As is well known, the first person singular ending, nasalized *ẽ*, is nonpalatalizing because historically it derives from a back vowel. No theory has ever been able to make sense of the odd behavior of *-ẽ* in modern Polish. The *-ẽ* must simply be marked diacritically as functioning phonologically with back rather than with front vowels.

[6] The *e* and *i* are known in standard descriptions as the so-called present tense extension vowels.

The range of relevant alternations is best shown by looking at class 3 verbalization and conjugation.

NOUN	INFINITIVE	2ND P.SG	3RD P.PL	
głos	głoɕ + i + tɕ	głoɕ + iʃ	głoʃ + õ	'voice' (N & V)
raz	raʑ + i + tɕ	raʑ + iʃ	raʒ + õ	'bash' (N & V)
pot	potɕ + i + tɕ	potɕ + iʃ	pots + õ	'sweat' (N & V)
sad	sadʑ + i + tɕ	sadʑ + iʃ	sadz + õ	'orchard', 'plant'
post	poɕtɕ + i + tɕ	poɕtɕ + iʃ	poʃtʃ + õ	'fast' (N & V)
jazd(+ a)[a]	jeʑdʑ + i + tɕ	jeʑdʑ + iʃ	jeʒdʒ + õ	'travel' (N & V)
goɕtɕ	goɕtɕ + i + tɕ	goɕtɕ + iʃ	goʃtʃ + õ	'guest', 'host' (N & V)
kopeɕ	kopɕ + i + tɕ	kopɕ + iʃ	kopts + õ	'soot' 'smoke' (N & V)

TABLE 4. Polish conjugation.

[a] This is a feminine noun, hence the nom.sg. has the ending *-a*. The other nouns in the list are masculine and have no ending in the nom.sg.

The effects of coronal palatalization are seen in the infinitive and in the present tense second person singular, that is, before *i* in Table 4, but Table 5 shows that these effects are also found before *e*.

3RD P.PL	2ND P.SG	
pas + õ	paɕ + eʃ	'graze'
gryz + õ	gryʑ + eʃ	'bite'
plot + õ	pletɕ + eʃ	'weave'
kład + õ	kładʑ + eʃ	'put'

TABLE 5. Polish conjugation.

The generalization covered by coronal palatalization is summarized schematically in 6.

(6) Coronal Palatalization: s z t d → ɕ ʑ tɕ dʑ / __ i e

That is, dentals are changed into prepalatals before front vowels, and stops become affricates.

In contrast to coronal palatalization, iotation produces hard consonants. The alternations illustrated in the third person plural in Table 4 are as follows:

(7) Iotation: s z t d → ʃ ʒ ts dz AND st zd → ʃtʃ ʒdʒ[7]

That is, alveolar fricatives become postalveolar. Dental stops are changed into alveolar affricates unless they are preceded by a fricative. In the latter case, they become postalveolar affricates.

Iotation occurs not only in the conjugational forms, as shown in Table 4, but also in the present participle suffix, which is invariably *-onts*. This suffix triggers Iotation in classes 2, 3, 4 and, indirectly, in class 5 (see §3.3), that is, in those classes whose verbalizing suffix is a vowel. Class 1 C-verbs, which have no verbalizing vowel, do not show iotation effects.

(8) Class 2: piʃ + onts 'writing'
Class 3: głoʃ + onts 'voicing'
Class 4: viʃ + onts 'hanging'
versus Class 1: pas + onts 'grazing'

Similarly, iotation effects are found in the passive participle *-on* forms, for example,

[7] The last two verbs given in Table 4 are discussed in §3.1.

głoʃ + on + y 'voiced'.[8] We conclude that no sense can be made of iotation in terms of surface representations.

In the remainder of this article we will simplify the presentation by limiting it to the alternations that are related to /s/. However, whenever we talk about [ʃ] and iotation, we mean the whole series of alternations shown in 7. And, whenever we talk about [ɕ] and coronal palatalization, we mean the whole series of alternations shown in 6.

In contrast to the present and the passive participles, the past participle looks simple. It is formed by adding the morpheme *ł* to the verb stem. The masculine form of the participle has no gender marker, the feminine has *-a* and the neuter has *-o*, as shown in Table 6, where we look at the verbs 'write' and 'voice'.

		PAST PARTICIPLE		
INFINITIVE	STEM	MASC.	FEM.	NEUT.
pis + a + tɕ	pis + a	pis + a + ł	pis + a + ł + a	pis + a + ł + o
głoɕ + i + tɕ	głoɕ + i	głoɕ + i + ł	głoɕ + i + ł + a	głoɕ + i + ł + o

TABLE 6. Polish conjugation.

A real challenge for any analysis comes in the imperative, which has four different phonetic realizations.

(9) a. Phonetic zero in C-stems ending in [j] and class 5 *ova* stems (*ova* is replaced by *uj*): *truj* 'poison', *głos + uj* 'vote'
b. Reflexes of iotation in class 2 *a*-stems: *piʃ* 'write'
c. Reflexes of coronal palatalization in C-stems (other than those ending in *j*), class 3 *i*-stems and class 4 *e*-stems: *paɕ* 'graze', *głoɕ* 'voice', *viɕ* 'hang'
d. Phonetic *-ij* in stems of all classes if the stem ends in a sonorant preceded by a consonant: *nagl + ij* 'hurry', *ɕɲ + ij* 'dream', *utrudɲ + ij* 'make difficult', *ɥɲeviɲɲ + ij* 'acquit'

These data are puzzling: in terms of surface representations, little, if anything, can be understood about the stem alternations.

2. ALLOMORPHY: RULES OR LISTING? We begin our discussion of allomorphy in OT by looking at a minor class of verbs known as extended stem verbs, which are uncontroversial in the sense that any framework, regardless of its theoretical orientation, has to treat them as instances of allomorphy. That is, their analysis cannot be improved by increasing the abstractness of underlying representations, by permitting derivational stages, or by bringing in special subtheories that handle opacity.

The reason for discussing extended stem verbs is twofold. First, they occasion a comparison between allomorphy rules and the listing of allomorphs. Second, they give us an opportunity to introduce constraints and explain the mechanics of OT analysis.

[8] The passive participle suffix *-on* derives historically from *en* by a vowel retraction rule that operated in the twelfth century. The consequence in modern Polish is that obstruent-final C-verbs (some six or seven morphemes) show palatalization before *-on*, for example, *ɲeɕ + tɕ* 'to carry'–*ɲos + õ* 'they carry'–*ɲeɕ + on + y* 'carried'. (This irregular behavior does not extend to other classes of verbs, see §3.) It is unclear how this overapplication of palatalization can be handled, and no theory has ever had a good answer to this dilemma, since the modern reflexes of the twelfth-century retraction *e* → *o* are erratic. One obvious way is to assume that the passive participles of the relevant C-verbs are simply listed. In the instance at hand, the listing is motivated independently by the alternations in the root: *e* in *ɲeɕ + tɕ* 'to carry' versus *o* in *ɲos + õ* 'they carry'. Historically, these are the same alternations as in the passive participle *en*/*on*. Synchronically, they are idiosyncratic (see Gussmann 1980 and Rubach 1984).

Polish has three verbs that show an alternation between *a* and zero: *zva* + *tɕ* 'call', *ssa* + *tɕ* 'suck' and *rva* + *tɕ* 'pull'.[9]

(10) a. zva + tɕ 'to call', zva + ł 'called' (MASC.), zva + ł + a 'called' (FEM.)
versus
b. zv + õ 'they call', zv + onts 'calling'

The *a* in 10a looks like the class 2 verbalizing suffix but in fact is not. The reason is that the real class 2 *a* induces iotation of the stem: palatalization with labial stems and *s* → *ʃ* with stems in *s*, as exemplified in 11a. The extended stem verbs do not show such effects (11b), hence cannot have an underlying *a*, and the stems must be *zv* and *ss* rather than *zva* and *ssa*.

(11) a. kopa + tɕ 'to dig' kop' + õ or kop'j + õ (depending on the dialect) 'they dig'
pisa + tɕ 'to write' piʃ + õ 'they write'
b. zva + tɕ 'to call' zv + õ, not *zv' + õ or *zv'j + õ 'they call'
ssa + tɕ 'to suck' ss + õ, not *ʃʃ + õ 'they suck'

If *a* in 11b cannot be underlying, then it must be inserted. The context for insertion is straightforward: before a consonant, hence the contrasts between 10a and 10b.

(12) *a*-Allomorphy Ø → a / ___ C
Inputs: *zv*, *ss*, *rv*

This is a classic allomorphy rule: it operates in an identifiable context but it is restricted lexically. Since 12 applies to three morphemes, the generalization it expresses carries little weight, particularly because it is unpredictable that the inserted vowel should be *a*. (In another class of three or four verbs, the inserted vowel is *e*, compare *dʒe* + *tɕ* 'to tear' *–dr* + *õ* 'they tear'.) An alternative analysis is simply to list two stems for each verb, so *zva* and *zv* for *zva* + *tɕ*. The distribution of these stems is then trusted to word formation rules.

From an OT perspective, listing is the only option because constraints are universal and, consequently, we cannot have allomorphy constraints, which would be, by definition, language-specific. The verb 'call' must therefore have two underlying allomorphs /zEva/ and /zEv/. (The yer /E/ is motivated by the *e*/zero alternation in the corresponding noun: *zev* (nom.sg.) *–zv* + *u* (gen.sg.), see §1.) The representations themselves are arbitrary, but their distribution in the paradigm is fully predictable because it follows from the independently motivated universal constraints. A partial list of such constraints is stated informally in 13.[10] Some of these constraints are relevant for *zEva*/*zEv*, others will become useful later, in §3.

(13) a. Max_{Seg}: Do not delete segments
This constraint can be expanded into Max_{Cons} ('do not delete consonants') and Max_{Voc} ('do not delete vowels')
b. Dep_{Seg}: Do not insert segments
c. Max_{μ}: Do not delete moras
d. Dep_{μ}: Do not insert moras
e. Onset: Syllables must have onsets
f. NoCoda: Syllables may not have codas
g. $*\text{Complex}_{\text{Ons}}$: Syllables may not have complex onsets
h. $*\text{Complex}_{\text{Coda}}$: Syllables may not have complex codas
i. HNuc (see below)

[9] Two others, *bra* + *tɕ* 'take' and *pra* + *tɕ* 'wash', show additional irregularities.

[10] For a formal statement of these constraints, see Prince & Smolensky 1993 and McCarthy & Prince 1995.

The analysis of *zva + tɕ* 'to call' and *zv + õ* 'they call' is as follows.

(14) a. zEva / zEv + tɕ

	HNuc	Dep_{μ}	$*Complex_{Ons}$
☞ 1. zvatɕ			*
2. zvtɕ	*!		
3. ze.vatɕ		*!	
4. zevtɕ		*!	

b. zEva / zEv + õ

	Dep_{μ}	Onset	$*Complex_{Ons}$
☞ 1. zvõ			*
2. zva.õ		*!	*
3. ze.va.õ	*!	*	

(Note: The winner is marked by the pointing hand symbol; an exclamation sign means that a candidate has been eliminated from further evaluation; a solid line denotes ranking.)

Let us clarify the constraints used in these tableaux. HARMONIC NUCLEUS (HNuc) defines segments that can be syllabic (Prince & Smolensky 1993). Polish is restrictive in this regard and does not permit syllabic consonants. Thus, the relevant instantiation of HNuc is $*P_{[+cons]}$: no consonantal peaks. This constraint is undominated in Polish, and, consequently, in the remainder of article, we will not consider candidates that would have syllabic consonants. The next constraint, Dep_{μ}, is relevant for candidates that have vocalized their underlying yers. If yers are moraless vowels, a view that has been standard for the past decade, then yer vocalization means the insertion of a mora, so that a yer can become syllabifiable. Dep_{μ}, which is a high ranking constraint in Polish,[11] militates against this option. Tableau 14a shows that Dep_{μ} outranks $*Complex_{Ons}$. That is, it is better to have a complex onset (*zv*-here) than to vocalize a yer.[12] Finally, Onset rejects candidates that show hiatus, here candidate 2 in 14b.

The feminine past participle *zva + ł + a* shows an important point about the way allomorphy works in OT. We shorten the list of candidates to the two relevant ones.

[11] The exact way yer vocalization works in OT is far from clear. We have not investigated this issue, but see Yearley 1995.

[12] One way of looking at yer deletion is to assume that the deletion comes for free, because all unsyllabifiable material is automatically stray-erased (Steriade 1982).

(15) $\left.\begin{matrix}\text{zEva}\\ \text{zEv}\end{matrix}\right\}$ + ł + a

	Dep_{μ}	$*Complex_{Ons}$
☞ 1. zva.ła		*
2. zvła		**!

Candidate 1 wins as its onset is less complex than that of candidate 2. The point of interest is that *zvł-* is a perfectly acceptable onset in Polish and it is attested in, for example, *zvłaʃtʃa* 'particularly'. Couldn't this word have *zvałaʃtʃa* as its optimal output as does *zvała* in 15? In 16 we look at the first syllable of *zvłaʃtʃa*.

(16) zvła

	Dep_{Seg}	$*Complex_{Ons}$
☞ 1. zvła		**
2. zva.ła	*!	*

The different optimal outputs in 15 and 16 are a consequence of the different underlying representations. In 15 we have two allomorphs: one with *a* and the other without. Since both allomorphs are given underlyingly, *zvała* 'called' (fem.) is not an instance of *a*-insertion. The [a] comes from the /zEva/ allomorph. In contrast, *zvłaʃtʃa* 'particularly' has /zvła/ as its only underlying form, and therefore candidate 2 in 16 has an epenthetic *a* between the *v* and the *ł*. That is, Gen has inserted an *a* here, which violates faithfulness, in particular, Dep_{Seg} (and also Dep_{μ}). Consequently, this candidate is suboptimal.

A general point that emerges from the discussion of *zvała* 'called' (fem.) and *zvłaʃtʃa* 'particularly' is that allomorphs always win in competition with otherwise identical outputs whose underlying form does not parallel that of the allomorphs. (Here *zvłaʃtʃa* has no underlying *a* between *v* and *ł*.) This result follows from the fact that allomorphs themselves are the underlying representation and, consequently, they pass on faithfulness constraints (Kager 1996).

Our analysis of *zva + tɕ* 'call' illustrates a typical situation in the treatment of allomorphy: the allomorphs are idiosyncratic but their distribution is not because it is governed by prosodic constraints. This general observation is true also for languages other than Polish. One example is the English allomorphy in 17.

(17) a. Plato: Platon + ic, Platon + ism, Platon + ize
b. Pluto: pluton + ic, pluton + ian, pluton + ium
c. drama: dramat + ic
d. hero: hero + ic

An OT analysis lists two stems for each morpheme in 17a–c: *Plato*/*Platon*, *Pluto*/*pluton* and *drama*/*dramat*. The stems ending in a vowel occur by themselves. This is hardly a surprise because *Platon* does and *Plato* does not violate NoCoda. And conversely, *Platon* is preferred to *Plato* in *Platon + ic* because the candidate **Plato + ic* violates Onset. However, *hero + ic* (17d) is optimal, even though it violates Onset. The reason is that *hero* has no allomorph that ends in a consonant, so *hero + ic* is the best we can get if we do not want to violate Dep_{Seg} by inserting a consonant.

How would the same facts be handled in terms of an allomorphy rule? The analysis is not very attractive. We would need to postulate a rule that inserts *n* before *-ic*, *-ism* and *-ize* for 17a. But *Pluto* (17b) shows that this rule would have to include also the context of *-ian* and *-ium*. An attempt to arrive at a single generalization, $\emptyset \rightarrow n$ / __ *V*, collapses when we consider 17c, where we find *t* rather than *n* in a prevocalic context.

The fact that the contexts for *n*-insertion and *t*-insertion are indistinguishable plus the fact that *heroic* dodges insertion indicate that inputs to our putative rules would have to be restricted to the listed sets of morphemes. In sum, the analysis is as arbitrary as the OT analysis that simply lists stem allomorphs.

An edge of difference in favor of OT comes into view when we attempt to rationalize the alternations in 17a–c as well as those in 10 discussed earlier in this section. Since the outputs of allomorphy rules are arbitrary, there is no a priori reason why Polish should insert a vowel in 10a and English should insert consonants in 17a–c. The allomorphy rules would be just as complex if the situation were reversed: consonants would be inserted in Polish and vowels would be inserted in English. Such a reversal is impossible in OT. This follows not just from the fact that the stems are listed but from universal constraints and the general assumption that constraint violation should be minimal. Similarly, if the stem allomorphs are not listed, then there is no reason why *zva* + *ł* + *a* 'called' (fem.) should have the root *a*. Inserting this *a* by an allomorphy rule makes no sense in the face of the fact that Polish has words such as *zvłaʃtʃa* 'particularly'. Consequently, **zvła* for *zvała* should occur as a well-formed output, but it does not.

In sum, the allomorphy rule approach and the corresponding OT approach both involve arbitrariness, albeit of different types (arbitrary rules versus arbitrary underlying representations). The edge of OT lies in the fact that the determination of what constitutes the correct surface form can be rationalized in terms of prosodic optimization, which gives preference to simple syllable structure.[13]

3. IOTATION. Analysis of iotation contributes to our understanding of allomorphy in several important ways. First, it shows that OT predicts allomorphy in instances of historical fusion where the trigger of the process is not recoverable in any surface alternant of the relevant word. From a synchronic perspective, the opacity of such processes is too deep for it to be within the reach of the OT subtheories designed for handling opacity: OUTPUT-OUTPUT THEORY (Benua 1997, OO theory, henceforth) and SYMPATHY THEORY (McCarthy 1999). Second, analysis of iotation shows that allomorphs may have internal morphological structure. Third, constraints other than the familiar prosodic constraints may play a role in the distribution of allomorphs. Fourth, purely morphological constraints may be interspersed among phonological constraints, which is an interesting fact about the interaction of phonology and morphology. Finally, the listing of allomorphs raises questions about the arbitrariness of representations.

[13] We are certainly not claiming that the distribution of all allomorphs is always predictable from universal constraints. This would be absurd. For example, two nouns in Polish form adjectives from bases that have [ʧ] that corresponds to [t] in the noun: *oxoʧ* + *y* 'willing' and *robotʃ* + *y* 'work' (adj.), compare *oxot* + *a* 'desire' and *robot* + *a* 'work'. The alternation [t]–[ʧ] is inexplicable, regardless of the theoretical framework. The /ʧ/ stems must be prespecified lexically for the context in which they occur: *oxoʧ*]$_{Adj}$ and *robotʃ*]$_{Adj}$. Similarly, the suffix *an* meaning 'inhabitant' has an extended form *aɲ* + *in*. The extended form appears in the singular, compare *Ameryk* + [*aɲ* + *in*] 'American' (nom.sg.) versus *Ameryk* + [*aɲ*] + *e* (nom.pl.) and *ameryk* + [*aɲ*] + *sk* + *i* 'American' (adj.). There is nothing in Polish phonology that would account for the distribution of *an* versus *aɲ* + *in*. The allomorph *aɲ* + *in* must be prespecified lexically: /an + in/ __]$_{sg}$.

In order to minimize confusion, the presentation is organized around descriptive issues. In §3.1 we look at the basic pattern. Section 3.2 addresses the imperatives; apparent exceptions are discussed in 3.3.

3.1. BASIC PATTERN. As explained in §1, the term IOTATION is used in the Slavic tradition to describe the alternations summarized in 7 and repeated here in 18.

(18) Iotation: s z t d → ʃ ʒ ts ʤ AND st zd → ʃʧ ʒʤ

Historically, iotation occurred before *j* and was thus different from coronal palatalization that occurred before front vowels. Synchronically, *j*, the trigger of iotation, is never found in surface representations because it fused with the consonant that it palatalized. These historical changes produced a pattern of synchronically arbitrary alternations which we exemplify in 19 by looking at *pisatɕ* 'to write', a class 2 verb.

(19) a. pis + a + tɕ 'to write', pis + a + ɬ (past participle, masc.), pis + a + ɬ + a (fem.)

b. piʃ + õ 'they write', piʃ + onts 'writing', piʃ + eʃ 'you write'

The iotation in 19 is arbitrary as regards both the output and the environment. The outputs of iotation are phonetically hard, that is, [+back] consonants (see §1), which does not make sense for a palatalization process. Oddly, even when the input consonant is [−back], a hard [+back] consonant is found in the iotation contexts. This is illustrated by the last two examples in Table 4. Thus, *goɕtɕ* + *i* + *tɕ* 'to host' is a verb from *goɕtɕ* 'guest'. The *tɕ* is underlying in *goɕtɕ* and, consequently, also in *goɕtɕ* + *i* + *tɕ*. The surprise is that the underlyingly [−back] *tɕ* changes into a hard [+back] ʧ in the iotation contexts, for example, *goʃʧ* + *õ* 'they host' and *goʃʧ* + *onts* 'hosting'. Similarly, the underlying /tɕ/ in *koptɕ* + *i* + *tɕ* 'to smoke', a verb from *kopetɕ* 'soot', appears as hard [ts] in *kopts* + *õ* 'they smoke' and *kopts* + *onts* 'smoking'. We conclude that iotation has lost all phonetic grounding as a palatalization process (see §1). Its synchronic reflexes are therefore arbitrary outputs.

Comparably arbitrary is the context in which iotation alternations occur. In *piʃ* + *õ* 'they write' and *pi* + *onts* 'writing' in 19b, *ʃ* appears before back vowels, hardly a context for palatalization. The problem is a serious one. We could not assume that the *s* of *pis* + a + *tɕ* 'to write' is replaced by *ʃ* before *õ* and *o*, arbitrary as this replacement would have been. The difficulty is that *s* occurs regularly before *õ* and *o*, and thus *s* and *ʃ* contrast in this context, for example, *kos* + *õ* 'scythe' (instr.sg.) and *bos* + *o* 'bare-footed' versus *piʃ* + *õ* 'they write' and *piʃ* + *onts* 'writing'.

The third example in 19b is also problematic. The *ʃ* in *piʃ* + *eʃ* 'you write' or *piʃ* + *e* 'he writes' contrasts with the [ɕ] in *vy* + *piɕ* + *e* (coronal palatalization), the loc.sg. of *vy* + *pis* 'transcript'. The noun *vy* + *pis* is based on the root *pis*, which is exactly the same root as in *pis* + *a* + *tɕ* 'to write', *piʃ* + *eʃ* 'you write' and *piʃ* + *e* 'he writes'. We conclude that iotation forms are entirely opaque and that there is no trigger of Iotation in the output.[14] Such situations are typical when two segments are fused into one, here *sj* → *ʃ*. In general, fusion can be handled in OT. Diachronically, the case at hand is parallel to, for example, the fusion of a vowel and a nasal consonant

[14] The verbs whose roots end in a labial show palatalization because with labials iotation and palatalization are nondistinct. Thus, we find [p'] in *kop'* + *õ* 'they dig'. The surface representation *kop'* + *õ* occurs today in regional dialects. The standard dialect has developed [j] here by decomposition of soft labials: [kop'j + õ], which must be accounted for by a separate constraint. This [j] has nothing to do with the *j* that was the trigger of the historical process of iotation.

into a nasalized vowel as in French: *bon* → *bõ*. But for fusion to work, the segment that is fused must be present in the underlying representation. This is not the case with Iotation. Not only that there is no evidence for an underlying *j*; worse, there is evidence that the *j* cannot be present in the underlying representation.

Quite obviously, the *j* cannot be part of the verbal stem itself because then, by fusion, *ʃ* would have to occur in all conjugational forms of the verb, which is not what we see in 19. The verb stem in 19 is *pis* + *a*, where *pis* is the root and *-a* is the verbalizing suffix. The root *pis* is unspecified for morphological category because it does not occur independently. It is found, however, in all kinds of formations, for example, *dług* + *o* + *pis* 'ball pen' (literally 'long writer'). This word is a compound, with *dług* 'long' being an adjective and *o* a linking phoneme. In sum, *pis* and *a* in *pis* + *a* can be identified as two morphemes. Since *a* has a verbalizing function, the structure of the stem is *pis*]$_R$ + *a*]$_V$, where R means root and V means verb.

If the *j* is not part of the stem,[15] then perhaps it can be part of the suffixes in the forms that show iotation in 19b. If this were so, then the suffixes would be /jõ/, /jonts/ and /jeʃ/ and we would obtain *piʃ* + *õ* 'they write', *piʃ* + *onts* 'writing', and *piʃ* + *eʃ* 'you write' by fusion: *sj* → *ʃ*. This cannot be right. First, the underlying representations would be /pis]$_R$ + a]$_V$ + jõ/, /pis]$_R$ + a]$_V$ + jonts/ and /pis]$_R$ + a]$_V$ + jeʃ/, respectively. Note that the verbalizing *-a* must be present in the underlying representation since otherwise the words would be ill-formed morphologically: the suffixes attach to verbs because they are verb inflection suffixes. The problem is that the verbalizing *-a* does not occur on the surface in *piʃ* + *õ*, *piʃ* + *onts* and *piʃ* + *eʃ*. So, it would have to be deleted, but this cannot be done because there is no constraint that could ban, for example, the putative output **pisajõ*. Such an output would be well formed since *ajõ* actually occurs in *aj* verbs, for instance, in *ʧytajõ* 'they read'. Second, if the underlying representations are indeed /jõ/, /jonts/ and /jeʃ/, then iotation (fusion) should occur in all paradigms that have these suffixes, but this is not the case. For instance, class 1 verbs such as *paɕ* + *tɕ* /pas + tɕ/ 'to graze' do not show iotation effects: *pas* + *õ* 'they graze', *pas* + *onts* 'grazing' and *paɕ* + *eʃ* 'you graze' (coronal palatalization) rather than **paʃ* + *õ*, **paʃ* + *onts* and **paʃ* + *eʃ*. We conclude that the suffixes must be /õ/, /onts/ and /eʃ/ rather than /jõ/, /jonts/ and /jeʃ/.

In sum, *j* is neither part of the stem nor part of the suffix, that is, *j* does not exist in the underlying representation. Since it does not exist in the surface representations either, the idea that iotation is due to *j* collapses.

Let us consider one further scenario. Suppose we assume that the occurrence of *ʃ* is caused by a certain configuration of vowels in the inflected stem. The contrasting pairs *kos* + *õ* 'scythe' (instr.sg.) versus *piʃ* + *õ* 'they write' are easily distinguished now. The former derives from the noun root *kos* plus the inflectional ending: /kos + õ/. The latter derives from the verb stem *pis*]$_R$ + *a*]$_V$ followed by the 3rd p.pl. ending: /pis + a + õ/. Iotation occurs if the inflected stem has a vowel cluster.[16]

[15] A referee drew our attention to the fact that in class 3 *i*-verbs the *j* as a trigger of iotation could be derived from /i/. Thus, *głoʃ* + *õ* 'they voice' could come from underlying /głos]$_N$ + i]$_V$ + õ]$_{3PL}$/, which would change into *głos* + *j* + *õ* by Gliding. There are two problems with this analysis, however. First, in surface terms, *j* does not exist in the desired output *głoʃ* + *õ*. Consequently, *głos* + *j* + *õ* would have to be an abstract derivational stage between the underlying representation and the phonetic representation, not a preferred option in OT. Second, and this is crucial, there is compelling evidence that *j* from Gliding does not trigger iotation, for example, *Bosi* (a name)–*Bosi* + *ego* [bosj + ego], not *[boʃ + ego].

[16] This has been the assumption in the literature ever since Jakobson 1948, and it has been adopted in all important contributions to Polish phonology, including Lightner 1963, Gladney 1971, Laskowski 1975,

The difficulty with this line of reasoning is that in addition to the rather odd change *s* → *ʃ* / __*V V*, we would need to find a way of simplifying the vowel cluster since the underlying /pis + a + õ/ surfaces as [piʃ + õ]. This simplification cannot be accounted for in an OT analysis of Polish.

From an OT perspective, vowel deletion would have to be treated as a hiatus resolution strategy (see Casali 1997). Thus, /pis + a + õ/ deletes *a* in order to avoid the violation of Onset. But this analysis is incorrect. First, there is evidence that hiatus is not resolved by vowel deletion in Polish. For example, the representation of *Kore + a* 'Korea' (nom.sg.) is /kore + i/ in the gen.sg. *Kore + i*. It is, in all essential ways, identical to the representation /vis + e + iʃ/ of *viɕ + iʃ* 'you hang'. The resolution of hiatus in /kore + i/ is by glide insertion: [kore + ji], but this is not what we need for *viɕ + iʃ*. There, the hiatus would have to be resolved by vowel deletion. Second, OT has no way of accounting for the fact that it is the preceding rather than the following vowel in the vowel cluster that must be deleted. Thus, the hiatus in /pis + a + õ/ could be resolved in two ways: either the /a/ is deleted or the /õ/ is deleted; yet, only the former option is correct. Similarly, *kre + ova + tɕ* 'create' would have two possible outputs that would eliminate hiatus: **kr + ova + tɕ* and **kre + va + tɕ*, but neither is correct. In fact, Polish tolerates vowel clusters rather freely: *geograf* 'geographer', *poet + a* 'poet', *muze + al + n + y* 'museum' (Adj.), *kore + aɲ + sk + i* 'Korean', and others. We conclude that vowel deletion is not a viable generalization from the OT point of view. Consequently, our attempt to connect iotation to some vowel configuration has failed.

Finally, one may wonder whether the OT mechanisms for dealing with opacity, OO theory and sympathy theory, can come to the rescue and permit us to derive iotation effects without resorting to allomorphy. The answer is negative. An OO analysis requires that there be a surface form in which iotation would work transparently. This form would then be used as a base for OO faithfulness constraints that would enforce analogy. The problem is that such forms do not exist.

Sympathy theory does not impose the restriction that the transparent form should be an actually existing word. It permits us to enforce analogy to a failed candidate, one that does not occur on the surface. Relevant here would be a candidate in which *j* has produced an iotation output. But such candidates cannot be found because, as we have shown, *j* is not present in the underlying representation. Furthermore, in order to preserve a unified representation of the verb stem in iotation forms and in non-iotation forms, such as *piʃ + õ* 'they write' versus *pis + a + tɕ* 'to write', we would need to assume that *piʃ + õ* is derived from /pis + a + õ/. However, this representation is not possible because, as we have argued, there is no way in OT of making sure that the desired vowel is deleted.

We conclude that OT cannot derive iotation effects from a single underlying representation. Consequently, we have allomorphs at the underlying level. For our example,

Gussmann 1980, Rubach 1984 and Bethin 1992. Briefly, in one scenario, a special rule of *j*-insertion inserts *j* in a certain configuration of vowels that differs from one Slavic language to another (compare Rubach 1984 for Polish and Rubach 1993 for Slovak). After triggering iotation, the *j* is deleted and the vowel cluster is simplified by Jakobson's (1948) rule that truncates a single vowel verbalizing morpheme before a vowel suffix. Thus, *piʃ + õ* 'they write' is derived as follows: /pis + a + õ/ → *pis + ja + õ* → *piʃ + ja + õ* → *piʃ + a + õ* → *piʃ + õ*. No agreement has ever been reached on the details of this derivation. For example, some authors would posit a special rule *a* → *j* rather than j-insertion. For lack of space, the long debate about the treatment of iotation cannot be summarized here. The reader is referred to the relevant sources mentioned earlier and to the references therein. See also Czaykowska-Higgins 1997.

the verb 'write', the stem allomorphs are: /pis]$_R$ + a]$_V$/ and /piʃ]$_V$/.[17] The former has a transparent surface structure, as in *pis*]$_R$ + *a*]$_V$ + *tɕ*]$_{inf}$. The latter is a reflex of iotation as a historical process and its structure is partially arbitrary from a synchronic point of view.

The fact that we have underlying allomorphs does not mean that their distribution is arbitrary. On the contrary, it is predictable from the familiar prosodic constraints, as shown in tableaux 20–22, where we look at the infinitive *pis* + *a* + *tɕ* (20), the feminine past participle *pis* + *a* + *ł* + *a* (21) and the third person plural present tense *piʃ* + *õ* (22).[18]

(20) pis]$_R$ + a]$_V$ / piʃ]$_V$ } + tɕ]$_{inf}$

	Dep_{Seg}	$*Complex_{Coda}$
☞ 1. pi.s]$_R$ a]$_V$ tɕ]$_{inf}$		
2. piʃ]$_V$ tɕ]$_{inf}$		*!
3. pi.ʃ]$_V$ atɕ]$_{inf}$	*!	

In tableau 20, candidate 2 loses because it has a complex coda. Candidate 3 avoids this problem but loses because the insertion of *a* violates Dep_{Seg}. Notice that in candidate 1, the *a* does not come from insertion since this candidate, unlike candidates 2 and 3, is based on the allomorph *pis*]$_R$ + *a*]$_V$ rather than on the allomorph *piʃ*]$_V$.

(21) pis]$_R$ + a]$_V$ / piʃ]$_V$ } + ł]$_{PP}$ + a]$_{fem}$

	Max_{Seg}	$*Complex_{Ons}$
☞ 1. pi.s]$_R$ a]$_V$.ł]$_{PP}$ a]$_{fem}$		
2. pi.ʃ]$_V$ ł]$_{PP}$ a]$_{fem}$		*!
3. pi.s]$_R$]$_V$ ł]$_{PP}$ a]$_{fem}$	*!	*

The syllabification of candidates 2 and 3 is *pi.ʃła* and *pi.sła*, respectively, and hence they lose to candidate 1 by $*Complex_{Ons}$. However, even if the syllabification were *piʃ.ła* and *pis.ła*, these candidates would still lose, because, unlike candidate 1, they would violate NoCoda. In addition to the prosodic constraints, candidate 3 violates Max_{Seg}, because the *a* of *pis*]$_R$ + *a*]$_V$ is not found on the surface.

[17] This is much in keeping with the traditional grammars, for example, Szober (1962; first published 1921). These grammars give rules such as 'the stem used in the present participle is based on the present tense 3rd p.pl'.

[18] This analysis incorporates Jakobson's (1948) idea that vowel stems do not occur before vowel suffixes but his insight takes on a different guise. We assume that surface forms are derived from underlying allomorphs by prosodic constraints. Jakobson assumed a single representation rather than allomorphs and posited a rule of vowel truncation that was limited to verbalizing morphemes as inputs. See n. 16.

The analysis of *piʃ* + *õ* is straightforward.[19]

(22) $\left.\begin{matrix}\text{pis}]_R + \text{a}]_V \\ \text{piʃ}]_V\end{matrix}\right\} + \text{õ}]_{3PL}$

	Onset	Max_{Seg}
☞ 1. pi.ʃ]$_V$ õ]$_{3PL}$		
2. pi.s]$_R$ a.]$_V$ õ]$_{3PL}$	*!	
3. pi.s]$_R$]$_V$ õ]$_{3PL}$		*!

Our analysis of the verb 'write' leads to an interesting observation. The vocalic allomorph has an internal structure: *pis*]$_R$ + *a*]$_V$. As remarked earlier, the reason for isolating *pis* is morphological: *pis* functions as a separate morpheme in complex words such as *długi* + *o* + *pis* 'ball pen' (literally 'long writer'). Such formations could not be derived if the final morpheme were *pisa*]$_V$ because Polish does not delete final vowels, as shown by, for example, *mas* + *a* 'mass' (fem.nom.sg.). The point about complex allomorphs comes across particularly forcefully when we look at examples that are verbalizations of freely occurring nouns, such as the instance in 23 below.

The idea that allomorphs may show morphological complexity finds support outside the verbal system, both in Polish and in other languages. For example, the adjective of *Tybet* 'Tibet' is *tybet* + *aɲ* + *sk* + *i*. The *aɲ* is a stem extension morpheme since the adjectivizing morpheme is *sk* and not *aɲsk*, compare *Bułgar* 'Bulgarian' (N) –*bułgar* + *sk* + *i* 'Bulgarian' (the *i* is an inflectional ending). Similarly, *ov* is an extension morpheme in *xitler* + *ov* + *sk* + *i*, an adjective from *Hitler* 'Hitler'. Other languages are similar to Polish in this regard. For example, the English adjectivizing morpheme is *al*, as in *coast* ~ *coast* + *al*. Yet, we find *u* before *al* in *habitual*. German is more interesting than English or Polish in the sense that it provides examples of allomorphy that corresponds to two independently existing morphemes. For instance, *zum* and *zur* are the lexicalized forms of *zu dem* (*zu* 'to' plus the article *dem*) and *zu der* (*zu* 'to' plus the article *der*).

The Polish allomorphs in 20 are not as radically different as those in German. The iotation stem *piʃ* corresponds closely to the German *zum* (or *zur*) in the sense that both are products of phonological fusion diachronically. However, /pis + a/ is less transparent than *zu dem* since neither *pis* nor *a* occur on their own. In fact, the verbalizing morpheme /a/ must be listed with /pis/ for independent reasons. These were exemplified in Table 2. Evidently (see the data in Table 2), it is unpredictable whether a stem is a simplex or a derived verb and, in the latter case, which stem takes which verbalizing suffix.

The inflection of class 3 and class 4 verbs shows richer allomorphy than the inflection of class 2 verbs. The difference is that *pis* + *a* + *tɕ* 'write' (class 2) has two allomorphs (*pis* + *a* and *piʃ*) while class 3 and class 4 verbs have three allomorphs. Below we look at the allomorphs of *głoɕ* + *i* + *tɕ* 'to voice' (class 3).

The relevant inflectional forms were discussed in §1 but, for convenience, are repeated in 23.

[19] If Onset and Max_{Seg} are unranked in 22, then Max_{Seg} must be ranked above $*Complex_{Ons}$ in 21. The reason is that, as shown earlier, Onset dominates $*Complex_{Ons}$.

(23) a. głoɕ + i + tɕ (INF), głoɕ + i + ł (PST PART, M), głoɕ + i + ł + a (F)
b. głoʃ + õ (PRES. PL.), głoʃ + onts
c. głoɕ + iʃ (SG. PRES)

The data in 23a–b parallel those in 20 with one difference: in *głoɕ + i + tɕ* the root is identifiable as a noun, compare *głos* 'voice' (nom.sg.). Consequently, the morphological structure of the stem is *głos*]$_N$ + *i*]$_V$. The stem *głoʃ*]$_V$ shows that iotation, as a diachronic process, has fused the noun and the verbal suffix, exactly as in *piʃ*]$_V$ discussed earlier. However, the stem *głoɕ*]$_V$ is new. The motivation for *głoɕ*]$_V$ is as follows.

Inflected forms such as *głoɕ + iʃ* 'you voice' cannot be derived from the underlying /głos]$_N$ + i]$_V$ + iʃ]$_{2SG}$/. This representation is not available in OT since, as pointed out earlier, an OT analysis of Polish cannot deal with the problem of vowel deletion.[20] This being the case, *głoɕ + iʃ* would have to have the representation /głos]$_N$ + iʃ]$_{2SG}$/ but this is ill-formed morphologically: *głos*]$_N$ being a noun cannot function as a stem for the present tense conjugational suffixes. Consequently, the representation must be /głoɕ]$_V$ + iʃ]$_{2SG}$/. There are also other reasons why *głoɕ*]$_V$ must be available as a stem but they can become understandable only after we have discussed the imperative in §3.2 and the distribution of unmarked allomorphs in §4.[21]

The fact that ɕ exists in the underlying representation of the allomorph /głoɕ]$_V$/ may but does not have to entail that /ɕ/ has to exist in the vocalic stem, the one that occurs, for example, in the infinitive *głoɕ + i + tɕ* 'to voice'. This stem can be derived from the underlying /głos]$_N$ + i]$_V$/. This is possible because Polish has an active process of coronal palatalization (see §1). For instance, the vocative singular of *Alan Prince* [alan prins] is [alaɲ + e prinɕ + e].

The question of how coronal palatalization is expressed in OT is an extremely complex one. However, one thing is clear: since coronal palatalization is productive, some constraint accounts for the relevant changes. Here we will assume an informal statement of this constraint.

(24) Coronal Palatalization: Coronal consonants must be prepalatal before front vowels

Coronal Palatalization overgeneralizes, which is shown by the contrast between 25a and 25b.

(25)

	NOM.SG	NOM.PL
a.	Łotysz [łotyʃ] 'Latvian' (N)	Łotysz + e [łotyʃ + e]: hard [ʃ]
b.	Cygan [tsygan] 'Gipsy'	Cygan + ie [tsygaɲ + e]: soft [ɲ]
	Sas [sas] 'Saxon'	Sas + i [saɕ + i]: soft [ɕ]
	Szkot [ʃkot] 'Scot'	Szkoc + i [ʃkotɕ + i]: soft [tɕ]

[20] In the instance at hand, it might look like the relevant generalization is degemination and not vowel deletion. However, an appeal to degemination cannot solve the problem. First, geminate sequences are tolerated in Polish, for example, *lek + k + o* 'lightly' and *indyvidu + um* 'strange creature'. Second, in *viɕ + iʃ* 'you hang' which, in the relevant ways, is parallel to *głoɕ + iʃ*, the putative second person singular representation would be /viɕ]$_R$ + e]$_V$ + iʃ]$_{2SG}$/ since the verbalizing suffix here is /e/ and not /i/, compare the infinitives *viɕ + e + tɕ* and *głoɕ + i + tɕ*. The simplification of *e + i → i* in *viɕ + iʃ* could not be accounted for by appealing to degemination.

[21] Briefly, preceding this discussion, let us say that the incorrect **głoʃ* rather than the correct *głoɕ* would have been predicted as the imperative form. This would also have been the result if we had assumed the representation *głos*]$_V$, which is homophonous with the noun *głos*]$_N$. The reason is that to get the imperative *głoɕ*, we would need to violate faithfulness. Also, if *głos*]$_V$ were an available stem, then we would incorrectly predict that it should occur in the third person plural, since **głos*]$_V$ + *õ* would have a less marked stem than the actually attested *głoʃ*]$_V$ + *õ* (*s* is less marked than *ʃ*); see §4.

The so-called hard or functional palatals (see §1) remain unaffected by coronal palatalization: /ʃ ʒ ʧ ʤ ts dz/. Since the hard palatals are [+back] both underlyingly and phonetically, their exclusion from the domain of coronal palatalization is a matter of $\text{Ident}_{[\text{Feature}]}$ faithfulness constraints. We will not state them here but rather assume an informal collective statement in 26.

(26) Hard: [ʃ ʒ ʧ ʤ ts dz] must be [+back]

With the ranking Hard ≫ Coronal Palatalization, we obtain the desired result of excluding hard palatals from coronal palatalization.[22]

Returning to the data in 23, we note that selecting the correct allomorph is not a problem for the words in 23a that have suffixes beginning with a consonant. The allomorph *głos*]$_N$ + *i*]$_V$, surface [głoɕ + i] by coronal palatalization,[23] will always win over its competitors *głoʃ*]$_V$ and *głoɕ*]$_V$ due to the prosodic constraints. In general, an allomorph ending in a vowel, here *głos*]$_N$ + *i*]$_V$, fares better than an allomorph ending in a consonant before suffixes beginning with a consonant, a point that we amply demonstrated earlier. New for our discussion is a different question: how do we predict that it is *głoɕ*]$_V$ rather than *głoʃ*]$_V$ that appears in *głoɕ* + *iʃ* 'you voice'? The answer is simple: the former but not the latter accords with coronal palatalization.

(27) $\left.\begin{matrix}\text{głos}]_N + \text{i}]_V \\ \text{głoʃ}]_V \\ \text{głoɕ}]_V\end{matrix}\right\}$ + iʃ]$_{2SG}$

	Onset	CorPal
☞ 1. gło.ɕ]$_V$ iʃ]$_{2SG}$		
2. gło.ʃ]$_V$ iʃ]$_{2SG}$		*!
3. gło.s]$_N$ i.]$_V$ iʃ]$_{2SG}$	*!	*

Notice that any output which takes the *głos*]$_N$ + *i*]$_V$ stem as its source cannot win if the following suffix begins with a vowel, as in 27. The reason is that such an output will always violate Onset or some faithfulness constraint (for example, if Onset were to be satisfied by deletion). It will therefore lose to one of the other allomorphs whose underlying representation corresponds to the surface form. Thus, Onset militates against candidate 3, and CorPal excludes candidate 2 as a viable contender.

[22] Actually, in one context, /ʃ ʒ/ (but not the other hard palatals) may palatalize to [ɕ ʑ]. This happens before the *i* suffix of the virile nominative plural, for example, *lepɕ* + *i* and *duʑ* + *i*, compare the nom.sg. *lepʃ* + *y* 'better' and *duʒ* + *y* 'big' (the examples cited by a referee). We are looking here at the process known as SECOND VELAR PALATALIZATION (see Rubach 1984). Technically, there is no problem deriving these effects in OT. All we need to assume is that Second Velar Palatalization outranks Hard. However, on a more general level, this process, like other palatalization processes in Polish, is problematic, since it is unclear how morphophonemic palatalization should be handled in OT. With Second Velar Palatalization, the added difficulty is that the generalization is restricted morphologically.

[23] Looking at the surface representation *głoɕ*]$_N$ + *i*]$_V$, we find no evidence that the phonetic [ɕ] should be derived from an underlying /s/ by coronal palatalization. Therefore, as a referee pointed out, the underlying representation could be simply /głoɕ]$_N$ + i]$_V$/, as found on the surface. While this is an option, the disadvantage is that the nominal base /głoɕ]$_N$/ of /głoɕ]$_N$ + *i*]$_V$/ is then not related phonologically to the freely occurring noun /głos]$_N$/. This relatedness is expressed in a straightforward way if we posit a single underlying representation for the nominal base and the noun: /głos]$_N$/. Then, the underlying representation of the verb is /głos]$_N$ + i]$_V$/, and [ɕ] in the surface *głoɕ*]$_N$ + *i*]$_V$ is a predictable effect of coronal palatalization.

In 27 we saw coronal palatalization in its function of selecting the correct allomorph. Active coronal palatalization is seen in *głoć + i + tć* 'to voice'.

(28) głos]$_N$ + i]$_V$ / głoʃ]$_V$ / głoć]$_V$ } + tć]$_{inf}$

	*Complex$_{Coda}$	CorPal
☞ 1. gło.ć]$_N$ i]$_V$ tć]$_{inf}$		
2. gło.s]$_N$ i]$_V$ tć]$_{inf}$		*!
3. głoć]$_V$ tć]$_{inf}$	*!	
4. głoʃ]$_V$ tć]$_{inf}$	*!	

The active role of coronal palatalization in candidate 1 raises the question of how to avoid *[pić + eʃ] 'you write' as the optimal output in class 2 *a*-verbs that we discussed earlier. The answer is that Hard (26), a set of faithfulness constraints requiring the preservation of hard palatals, must dominate Coronal Palatalization. The evaluation of *piʃ + eʃ* 'you write' is as follows.

(29) pis]$_R$ + a]$_V$ / piʃ]$_V$ } + eʃ]$_{2SG}$

	Onset	Hard	CorPal
☞ 1. pi.ʃ]$_V$ eʃ]$_{2SG}$			*
2. pi.ć]$_V$ eʃ]$_{2SG}$		*!	
3. pi.s]$_R$ a.]$_V$ eʃ]$_{2SG}$	*!		

The crucial difference between *głoć + iʃ* 'you voice' and *piʃ + eʃ* 'you write' is the fact that the former has two consonantal allomorphs while the latter has only one: *głoʃ*]$_V$ and *głoć*]$_V$ versus *piʃ*]$_V$. Coronal Palatalization will therefore give preference to [głoć] before a front vowel suffix. Faithfulness is not violated because *głoć*]$_V$ exists in the underlying representation. In contrast, the output having [pić] violates faithfulness in 29 and thus loses to [piʃ]. In sum, class 2 *a*-verbs have only one consonantal allomorph and it ends in /ʃ/ while class 3 *i*-verbs and class 4 *e*-verbs have two consonantal allomorphs: one ending in /ʃ/ and the other ending in /ć/. The distinction of one versus two consonantal allomorphs plays a crucial role in the analysis of the imperative; this issue is covered next.

3.2. IMPERATIVE. Recall (see 9) that the surface representation of the imperative is [ij], and it occurs in verbs such as *nagl + ij* 'hurry' *ćć + ij* 'suck' and *zv + ij* 'call'. The simplest assumption would be to postulate /ij/ as the underlying representation. However, in most instances [ij] is not found on the surface, for instance, in *pać* 'graze' and *głoć* 'voice'.

As pointed out by Bethin (1987), *ij* surfaces only if otherwise an unsyllabifiable structure would arise (see §1): **nagl* (the *l* cannot syllabify due to sonority violations)

and **zv* (consonants cannot be syllabic in Polish). Now the strategy is clear. The presence versus the absence of the surface *ij* must be due to an interplay of two contradictory constraints: one mandating that the *ij* be retained and the other militating against this option. The first constraint is obvious: it is either Max_{Voc} ('do not delete vowels') or simply Max_{Seg} ('do not delete segments'). The second constraint, that we propose below, has its source in morphology. The observation is that Polish as well as many other languages do not mark the imperative by a special suffix.

(30) Bare Stem: The imperative is a bare verbal stem[24]

This constraint makes sense for the diachronic development of Slavic. In Common Slavic the imperative had an overt surface representation [i] (the regular vowel *i*, not a yer, see Lunt 1955). The reranking of Bare Stem to the higher echelon of constraints led to the deletion of the ending in most but not all verbs. As we have already seen, the pattern of retention in Polish has a prosodic motivation: the need to save a consonant from Stray Erasure.[25] Thus, the verb stem *nagl* 'hurry' retains *ij* in the imperative: *nagl* + *ij*. The reason is that *nagl* is ill formed prosodically because *l* cannot be syllabified into the coda due to a sonority violation: a lateral cannot be further away from the nucleus than an obstruent.[26] The retention of the imperative *ij* solves the problem because *nagl* + *ij* can be syllabified as *na.glij*. Notice that the option of avoiding a sonority violation by deleting the *l* (*nagl* → *nag*) is not exploited. We are looking here at a significant generalization of Polish: sonority violations are never resolved by deleting a consonant, a generalization that is captured by the high ranking Max_{Cons} ('do not delete consonants'). We are now ready to look at the details of the analysis, beginning with instances in which the imperative suffix is not found on the surface.

The difficulty with the imperative is that it causes palatalization, even when the ending does not appear on the surface. Thus, as mentioned earlier, the imperative of /pas/ 'graze', a class 1 C-verb, is [paɕ] rather than *[pas]. How can this be analyzed?

The simplest move is to appeal to $\text{Max}_{\text{Subsegment}}$, a constraint that has been convincingly argued for by Zoll (1998) on the basis of a large body of data.[27] As a consequence of this constraint, subsegments, that is, floating features or place nodes, are not deleted but dock onto other segments in the surface representation. This is what we need in the imperative, but then the imperative suffix must have a subsegment in its underlying representation. The minimal change is to reinterpret /ij/ as /iI/, where /I/ is a yer.[28]

[24] This means that the imperative suffix is not represented on the surface, but, obviously, languages may (and often do) mark other features on the stem such as the person and the plural number, for example, the imperative forms of the verb *rob* + *i* + *tɕ* 'to do' are [rup] in the second person plural but [rup + my] and [rup + tɕe] in the first and the second plural, respectively. The suffixes *my* and tɕe have the status of clitics. Thus, in [rup + my] 'let's do' we see final devoicing (devoicing at the end of words), as if the *my* were not there. Also, the root vowel /o/ of *rob* + *i* + *tɕ* has been replaced by [u], which happens in word-final syllables (see Booij & Rubach 1987, and Bethin 1992).

[25] An OT equivalent of Stray Erasure is a constraint requiring that segments must be parsed prosodically. This constraint is undominated in Polish.

[26] This constraint, known as SSG (SONORITY SEQUENCING GENERALIZATION) and familiar from the work of Whitney (1865), Sievers (1881), Jespersen (1904), Selkirk (1984) and Nespor and Vogel (1986), mandates that the syllable must be structured as follows: stop-fricative-nasal-liquid-nucleus-liquid-nasal-fricative-stop.

[27] Another option would be to postulate two derivational levels. At level 1, Bare Stem is ranked low and, consequently, the optimal candidate is the imperative with the surface [ij] for all verbs. Given the [ij] output, palatalization effects can be implemented easily. At level 2, [ij] is suboptimal because Bare Stem is reranked and becomes dominant. While this is an option, it is not the preferred view in OT, which avoids derivationalism.

[28] This option has been inspired by Bethin's analysis (1992).

However, now yers cannot simply be moraless vowels because then they would have a Root node and hence would be segments rather than subsegments. We need to trim the feature tree. The trimming cannot go below the Place node, because Polish has more than one yer and the different yers must be kept distinct (see Rubach 1986).[29] We thus arrive at the conclusion that yers are floating Place nodes, a suggestion from Zoll 1998.

If yers are floating Place nodes rather than floating segments (moraless vowels), then turning a yer into a full vowel (yer vocalization) involves two changes: addition of a Root node and addition of a mora. The former violates Dep_{Rt} ('do not insert Root nodes') and the latter Dep_{μ} ('do not insert moras'). If, however, a yer is turned into [j], as is the case in the imperative (*iI* → *ij*), then only the violation of Dep_{Rt} is incurred because glides have no moras. In instances in which /iI/ does not surface at all, such as /pas + iI/ → [paɕ] 'graze' (an effect of Bare Stem), the yer docks onto the consonant and turns /s/ into [ɕ].[30] The joint result of postulating a yer in the imperative and activating $\text{Max}_{\text{Subseg}}$ is the surface requirement that imperatives must end in a [+high, −back] segment. In class 1 C-verbs, the consonant becomes palatalized, as in our example *paɕ* 'graze'. In words such as *bij* 'beat', this is fulfilled by the final [j].[31] In class 3 and class 4 verbs, such as *głoɕ* 'voice' and *viɕ* 'hang', $\text{Max}_{\text{Subseg}}$ has the effect of selecting the *ɕ*-allomorph over the *ʃ*-allomorph. The fact that *piʃ* 'write' has a hard [ʃ] in the imperative looks problematic but in fact is not, as we will explain later.[32]

The analysis of *paɕ* 'graze' is now simple.[33]

(31) pas]$_{\text{V}}$ + iI]$_{\text{imp}}$

	BareStem	Max_{Voc}	Dep_{Rt}	$\text{Max}_{\text{Subseg}}$
☞ 1. paɕ]$_{\text{V}}$]$_{\text{imp}}$		*		
2. paɕ]$_{\text{V}}$ ij]$_{\text{imp}}$	*		*!	

Candidate 1 violates Max_{Voc} ('do not delete vowels') since the /i/ of /iI/, which is a segment (that is, it has a Root node) has been deleted. Notice further that not only candidate 2 but also candidate 1, *paɕ*, satisfies $\text{Max}_{\text{Subseg}}$ since [+high, −back] has docked onto the final consonant, which is now palatalized. Candidate 2 loses because,

[29] The other yer seen in this article is /E/, which, when vocalized, surfaces as [e]. Since the yer of the imperative surfaces as [j] in *ij*, the simplest solution is to treat it as being [+high, −back], that is, to assume that it is /I/ rather than /E/. Then, the vocalization of /I/ to [j] does not require a change of [−high] to [+high]. For other yers of Polish, see Rubach 1986.

[30] There must be some principle that tells the yer to dock onto the nearest segment, here on *s* rather than on *a* or *p*. Notice that the yer is situated linearly at the end of the string /pas + iI/.

[31] It is not a problem that [j] itself is [+high, −back] and that exactly this specification is added to satisfy $\text{Max}_{\text{Subseg}}$. There is no contrast between a single and a double or multiple occurrence of a feature on a given segment.

[32] A referee asks whether the imperative morpheme could not have two allomorphs in the underlying representation: /iI/, postulated here, and /I/, an additional allomorph. Our answer is that adding /I/ would not affect the selection of the optimal output in the sense that the same outputs would be selected as optimal. Consequently, there is no reason to complicate the grammar by positing two rather than one underlying representation for the imperative morpheme.

[33] Note that there is no sense in which palatalization triggered by /I/ would apply across *i* since all we look at is the output forms, and Gen can produce freely all kinds of outputs.

as explained earlier, turning a floating Place node into a segment (here *I* → *j*) requires the addition of a Root node, which is a Dep_{Rt} violation.

The evaluation of class 3 *i*-verbs, such as *głoɕ* 'voice' (imper.), highlights three new points. First, $\text{Max}_{\text{Subseg}}$ acts as an allomorph selection constraint by giving preference to the allomorph *głoɕ*, that ends in a soft segment, over the allomorph *głoʃ*, that ends in a hard segment. Second, the familiar Onset constraint is seen at work in the evaluation of the vocalic allomorph, candidate 4 in 32 below, that takes *głos*]$_{\text{N}}$ + *i*]$_{V}$ as the verb stem input. Third, candidates 1 and 3 in 32 tie, and hence the optimal candidate cannot be selected.

(32) $\left.\begin{matrix}\text{głos}]_{\text{N}} + \text{i}]_{\text{V}} \\ \text{głoʃ}]_{\text{V}} \\ \text{gloɕ}]_{\text{V}}\end{matrix}\right\} + \text{iI}]_{\text{imp}}$

	Onset	BareStem	Max_{Voc}	Dep_{Rt}	$\text{Max}_{\text{Subseg}}$
☞ 1. głoɕ]$_{\text{V}}$]$_{\text{imp}}$			*		
2. głoʃ]$_{\text{V}}$]$_{\text{imp}}$			*		*!
☞ 3. gło.s]$_{\text{N}}$ i]$_{\text{V}}$]$_{\text{imp}}$[a]			*		
4. gło.s]$_{\text{N}}$ i.]$_{\text{V}}$ ij]$_{\text{imp}}$	*	*!		*	
5. gło.ɕ]$_{\text{V}}$ ij]$_{\text{imp}}$		*		*!	

[a] The [s] is actually [ɕ] by Coronal Palatalization, but we ignore this fact here.

The tie between candidates 1 and 3 is resolved by appealing to Apocope, a constraint that is familiar from classic historical studies, which have long observed that languages may delete word-final vowels.[34] In terms of OT, Apocope is stated as a prohibition on final vowels.

(33) Apocope: Phonological words cannot end in a vowel

Candidates 1 and 3 from 32 are now evaluated as follows. Notice that *głoɕ*]$_{V}$]$_{imp}$, the desired output, violates NoCoda, which motivates the ranking Apocope ≫ NoCoda.

(34) $\left.\begin{matrix}\text{głos}]_{\text{N}} + \text{i}]_{\text{V}} \\ \text{głoʃ}]_{\text{V}} \\ \text{głoɕ}]_{\text{V}}\end{matrix}\right\} + \text{iI}]_{\text{imp}}$

	Onset	BareStem	Max_{Voc}	Dep_{Rt}	$\text{Max}_{\text{Subseg}}$	Apocope	NoCoda
☞ 1. głoɕ]$_{\text{V}}$]$_{\text{imp}}$			*				*
2. gło.s]$_{\text{N}}$ i]$_{\text{V}}$]$_{\text{imp}}$			*			*!	

[34] Apocope is a well-known phenomenon in the history of many languages. Dutch, for instance, has a considerable number of nouns that lost their final schwa in the course of history: *einde* → *eind* 'end', *ziele* → *ziel* 'soul', *kerke* → *kerk* 'church', and many others (see van Loey 1964). This historical tendency is remarkable in that it created monosyllabic prosodic words and closed syllables, and thus caused the violation of the powerful constraints NoCoda and FootBinarity. See also Prince and Smolensky's (1993) analysis of Lardil and McCarthy's (1993) analysis of English.

Apocope raises the question of why Polish, a highly inflecting language, has an abundance of words that end in a vowel, for example, the genitive singular of *brat* 'brother' is *brat* + *a*. The answer lies in the ranking $\text{Max}_{\text{Voc}} \gg$ Apocope. The effect of this ranking is that the role of Apocope is reduced to allomorph selection because satisfying Apocope by actually deleting a segment would violate the higher ranked Max_{Voc}. With the ranking of Apocope just established, tableau 34 is replaced by 35.

(35) $\left.\begin{matrix} \text{głos}]_{\text{N}} + \text{i}]_{\text{V}} \\ \text{głoʃ}]_{\text{V}} \\ \text{głoç}]_{\text{V}} \end{matrix}\right\} + \text{iI}]_{\text{imp}}$

	Onset	BareStem	Max_{Voc}	Apocope	Dep_{Rt}	$\text{Max}_{\text{Subseg}}$	NoCoda
☞1. głoç]$_{\text{V}}$]$_{\text{imp}}$			*				*
2. gło.s]$_{\text{N}}$ i]$_{\text{V}}$]$_{\text{imp}}$			*	*!			

The beneficial role of Apocope for allomorph selection is documented further by other imperatives. Below we look at the verbs *nagl* + *ij* 'hurry' and *ɕɕ* + *ij* 'suck', that surface with [ij]. In addition to strengthening the evidence for Apocope, these verbs highlight the role of two further constraints: Max_{Cons} and Dep_{μ}.

Verbs that surface with *ij* satisfy $\text{Max}_{\text{Subseg}}$ because they end in [j]. The [j] comes from the yer /I/ and, consequently, violates Dep_{Rt}. In 36 we look at *nagl* + *ij*, a class 3 *i*-verb, whose allomorphs are *nagł*]$_A$ + *i*]$_V$ and *nagl*]$_V$.[35] (The former occurs before consonants and the latter before vowels, a fact that is predicted by the familiar prosodic constraints.) The surfacing of the imperative *ij* is a function of Max_{Cons}, which prohibits the deletion of *l*: **nagl*]$_V$]$_{imp} \rightarrow$ *nag*]$_V$]$_{imp}$. The only way to syllabify the *l* is to retain the vowel of the imperative morpheme /iI/. The option that /iI/ simply surfaces as [i] (candidate 3 below) as well as the option that the imperative is the bare verb stem *na.gl*]$_A$ *i*]$_V$]$_{imp}$ (candidate 5 below) are excluded by Apocope. However, in order for these candidates to lose to candidate 1, *na.gl*]$_V$ *ij*]$_{imp}$, the desired output, it is necessary to rank Apocope above Dep_{Rt}, so that turning /I/ into [j] is a lesser offense than violating Apocope. This reasoning is summed up in 36, where to save space we omit $\text{Max}_{\text{Subseg}}$ and NoCoda.

(36) $\left.\begin{matrix} \text{nagł}]_{\text{A}} + \text{i}]_{\text{V}} \\ \text{nagl}]_{\text{V}} \end{matrix}\right\} + \text{iI}]_{\text{imp}}$

	Max_{Cons}	Onset	BareStem	Max_{Voc}	Apocope	Dep_{Rt}
☞1. na.gl]$_{\text{V}}$ ij]$_{\text{imp}}$			*			*
2. nag]$_{\text{V}}$]$_{\text{imp}}$	*!			*		
3. na.gl]$_{\text{V}}$ i]$_{\text{imp}}$			*		*!	
4. na.gl]$_{\text{A}}$ i.]$_{\text{V}}$ ij]$_{\text{imp}}$		*	*!			*
5. na.gl]$_{\text{A}}$ i]$_{\text{V}}$]$_{\text{imp}}$				*	*!	

Candidate 1 violates Bare Stem and Dep_{Rt}, because it has the imperative suffix and

[35] The root morpheme is the adjective /nagł/, as in *nagł* + *y* 'sudden' (nom.sg.masc.).

the floating Place node /I/ appears as the glide [j]. Candidate 2 offends Max_{Cons} and Max_{Voc} because the /l/ of /nagl]$_V$/ and the /i/ of /iI/ have been deleted. (The /l/ is stray-erased since it cannot syllabify if the *ij* is not there.) In candidate 3 the vowel of the imperative /iI/ has survived, so *l* has been syllabified. However, the yer /I/ has not developed into [j], which is a fatal violation of Apocope. Candidates 4 and 5 are based on the vocalic allomorph *nagł*]$_A$ + *i*]$_V$. This leads to Onset and Bare Stem violations in candidate 4. Candidate 5 has preserved its verbalizing vowel but this is unfortunate since then Apocope is violated. Also, this candidate has deleted the /i/ of the imperative /iI/: a violation of Max_{Voc}. The ranking of Apocope above Dep_{Rt} eliminates candidate 5 and points to candidate 1 as the winner, the desired result.[36]

Evaluation of yer roots, such as *ɕɕ* + *ij* 'suck' (recall the alternations in 4 in §1), shows that yer vocalization (in particular, mora insertion) loses to the surfacing of /iI/ as [ij]. This means that Dep_{μ} either outranks Bare Stem or, minimally, is ranked as high as Bare Stem. We illustrate this in 37.

(37) $\left.\begin{matrix}\text{sEsa}]_V \\ \text{sEs}]_V\end{matrix}\right\}$ + iI]$_{\text{imp}}$

	Onset	Dep_{μ}	BareStem	Max_{Voc}	Apocope	Dep_{Rt}
☞1. ɕɕ]$_V$ ij]$_{\text{imp}}$			*			*
2. seɕ]$_V$]$_{\text{imp}}$		*		*!		*
3. ssa.]$_V$ ij]$_{\text{imp}}$	*		*!			*
4. ssa]$_V$]$_{\text{imp}}$				*	*!	

The violation of Dep_{Rt} in 1 and 3 is caused by the yer /I/ appearing as [j]: a floating Place node (the yer) has surfaced with a Root node. The same violation is found in candidate 2, but there the yer /E/ of the root has surfaced as a vowel, thereby offending Dep_{μ} in addition to Dep_{Rt}.

Finally, class 2 *a*-verbs surface with a hard consonant in the imperative, which violates $\text{Max}_{\text{Subseg}}$, for example, *piʃ* 'write'. This fact is accounted for if Hard (26) dominates $\text{Max}_{\text{Subseg}}$.[37]

[36] Note that a candidate with an unprosodified *l* is not an option because it would violate Stray Erasure (see n. 25) that is undominated in Polish. Two other candidates in which the *l* is forcibly adjoined to the syllable or to the phonological word node are excluded if Bare Stem is dominated by SSG (see n. 26) and Strict Layer (prosodic hierarchy). Thus, it is better to violate Bare Stem than to have brute force adjunction. Two further points should be noted here. First, adjunction is used as a strategy for the treatment of nouns such as *tsykl* 'cycle' and *metr* 'meter'. These nouns have no allomorphs without *l* and *r*, respectively, so the dominant Max_{Cons} forces adjunction (see Rubach & Booij 1990). Second, there are two or three imperatives which show adjunction rather than the expected *ij*: *naɕʃ'jetl* 'irradiate'. These forms do not represent the productive pattern (Bethin 1992) and must simply be listed. Being lexically specified as imperatives, they will not take the /iI/ suffix. Consequently, as in the case of the nouns *tsykl* 'cycle' and *metr* 'meter', adjunction remains as the only option, given that the dominant Max_{Cons} does not permit deletion.

[37] This ranking does not have adverse effects on the evaluation of *głoɕ* 'voice' given earlier in 32. The point is that Hard (a set of faithfulness constraints) is violated only if an underlying /ʃ/ is changed into [ɕ] because only then is faithfulness violated. The case discussed in 32 has two underlying allomorphs /głoʃ/ and /głoɕ/. Consequently, the [ɕ] in the imperative *głoɕ* does not come from the underlying /ʃ/ of /głoʃ/.

(38) $\left.\begin{matrix}\text{pis}]_R + \text{a}]_V \\ \text{pi}\int]_V\end{matrix}\right\} + \text{iI}]_{imp}$

	Onset	BareStem	Max_{Voc}	Apocope	Dep_{Rt}	Hard	Max_{Subseg}
☞1. pi∫]$_V$]$_{imp}$			*				*
2. piɕ]$_V$]$_{imp}$			*			*!	
3. pi.∫]$_V$ ij]$_{imp}$		*			*!		
4. pi.s]$_R$ a]$_V$]$_{imp}$			*	*!			*
5. pi.s]$_R$ a.]$_V$ ij]$_{imp}$	*	*!			*		

Crucially for the analysis in 38 as well as for that given earlier in 29, class 2 *a*-verbs do not have *ɕ*-allomorphs, here *piɕ*]$_V$. Therefore candidate (2), which is based on the allomorph /pi∫]$_V$/, violates faithfulness by changing the underlying /∫/ to [ɕ] and loses to candidate 1. If a palatal allomorph is available (as in the case of *głoɕ*]$_V$, *głoʃ*]$_V$ and *głos*]$_N$ + *i*]$_V$), then it is this allomorph that wins in the imperative, a fact that was illustrated in 32.[38] This is the converse of the situation found in class 2 *a*-verbs: class 3 and class 4 verbs must crucially have prepalatal allomorphs such as *głoɕ*]$_V$ in their inventory. The general observation that holds here is the one made earlier in connection with present tense forms: allomorphs are successful contenders because they pass on faithfulness.

3.3. APPARENT EXCEPTIONS. The treatment of iotation as an allomorph selection process rather than as a generative process has beneficial consequences for explaining the words in Table 7.

NOUN	INFINITIVE	3RD P.PL. PRES
vłos 'hair':	o + vłoɕ + i + tɕ 'grow hair'	o + vłoɕ + õ
las 'forest':	za + leɕ + i + tɕ 'grow forest'	za + leɕ + õ
ʒelaz + o 'iron':	za + ʒelaʑ + i + tɕ 'add iron'	za + ʒelaʑ + õ
gałõʑ 'branch':	roz + gałẽʑ + i + tɕ 'branch out'	roz + gałẽʑ + õ[a]

TABLE 7. Unpredictable absence of iotation.

[a] The last three examples are from Szpyra 1989.

Problematic here are two forms on the right because they have *ɕ* rather than the expected *ʃ* in the third person plural, which is an iotation context, compare the regular *głos* 'voice'–*głoɕ* + *i* + *tɕ* 'to voice'–*głoʃ* + *õ* 'they voice'. If iotation effects were to be generated by some set of generalizations, then the occurrence of [ɕ] in the words on the right could not be accounted for. But if iotation is a matter of allomorph selection, then these words are entirely unproblematic. The analysis is that they have no allomorphs in *ʃ*. Thus, (*za*+)*leɕ* + *i* + *tɕ* 'grow forest' has two rather than three allomorphs: /les]$_N$ + i]$_V$/ and /leɕ]$_V$/. That is, /leʃ]$_V$/ does not exist. The familiar

Rather, *głoɕ* is a fully faithful realization of the underlying /głoɕ/. In sum, the imperative candidates *głoʃ* and *głoɕ* are equal on faithfulness, but *głoɕ* satisfies Max_{Subseg} and hence wins the competition. Note that we would not be able to use Coronal Palatalization to make the allomorph selection because here, as in many other cases of palatalization triggered by yers, there is no overt front vowel in the output form.

[38] The classic generative analysis has a problem accounting for the absence of iotation effects in class 3 and class 4 verbs such as *głoɕ* 'voice', not **głoʃ*. This problem cannot be solved without resorting to an allomorphy rule, see Rubach 1985.

prosodic constraints account for the distribution of the allomorphs. They pick *leɕ*]$_V$ rather than *les*]$_N$ + *i*]$_V$ for the third person plural form because the latter but not the former violates Onset: **leɕ* + *i* + *õ* versus *leɕ* + *õ*. Therefore, *za* + *leɕ* + *i* + *tɕ* must have been formed as a verb at the stage at which iotation was no longer an active process in Polish, hence the *ʃ*-allomorph has not developed.

A further interesting point is that some words tend to lose iotation effects. A questionnaire administered to twenty-two native speakers of Polish shows that, counter to the prescriptive rule, people may use [ɕ] rather than [ʃ] in iotation contexts. The results of the questionnaire are summed up in Table 8.

INFINITIVE	3RD P.PL. IN [−ʃ + õ]/[−ʒ + õ]	3RD P.PL. IN [−ɕ + õ]/[−ʑ + õ]	GLOSS
frantsuʑ + i + tɕ	16	6	to act the French way
gʑ + i + tɕ ɕẽ[a]	15	7	to make love
sołtyɕ + i + tɕ	17	4	to be a village head
ʃarogẽɕ + i + tɕ ɕẽ	10	12	to order around
uv'jẽʑ + i + tɕ	8	14	to put into jail
zb'jeɕ + i + tɕ ɕẽ	11	10	to go mad
zliɕ + i + tɕ ɕẽ	8	11	to become shrewd

TABLE 8. Variation with iotation stems.

[a] This word and others below are reflexive verbs; they appear with the clitic *ɕẽ* 'self'.

Only two out of twenty-two respondents showed a consistent pattern and used the *ʃ*-allomorph, the prescribed norm. The others used either the *ʃ*-allomorph or the *ɕ*-allomorph, depending on the lexical item, but nobody had the *ɕ*-allomorph as the only form for all the words. In some cases the speakers could not decide which allomorph to use and gave no answer, which explains why the figures in Table 8 do not always add up to twenty-two. We conclude that with some words iotation effects are unstable.

This conclusion is unsurprising in an analysis that lists rather than actively generates iotation stems. The *ɕ*-allomorphs survive because they parallel the [ɕ] outputs found in the infinitive where the context for palatalization is fully transparent. Iotation allomorphs are completely arbitrary and hence tend to be lost, that is, not all speakers have the *ʃ*-allomorphs. This is an interesting observation because every verb is fully inflected in Polish and has to have the third person plural form. Thus, in terms of morphology, the pattern is productive and yet it involves the listing of arbitrary allomorphs.

That productivity in inflectional morphology and the listing of allomorphs are not inconsistent is shown further by recent developments in class 2 *a*-verbs. Relevant here are the verbs whose stems end in *t*, such as those in 39.

(39) kłopot + a + tɕ ɕẽ 'worry', xixot + a + tɕ 'laugh', mamrot + a + tɕ 'mumble', dept + a + tɕ 'tread', łaskot + a + tɕ 'giggle', ʃept + a + tɕ 'whisper', bełkot + a + tɕ 'speak unclearly', and others

The expected pattern in the conjugation is that of iotation, which means that we should find *ts* in the present tense, *similar to ʃ* in *piʃ* + *õ*, the 3rd p.pl. from *pis* + *a* + *tɕ* 'write'. (Recall that Iotation says that /t/ → [ts], see (7) in section 1). Indeed, some speakers may use *ts* here: *kłopots* + *õ ɕẽ* 'they worry'. However, the *ts* form is regarded as poetic or archaic. Normative sources such as Doroszewski 1980 describe *ts* forms as 'outdated' or 'old-fashioned'. What we actually find is *tʃ* rather than *ts*, *kłopotʃ* + *õ ɕẽ*, and some speakers are not even aware of the fact that the *ts* forms may exist. In

sum, we witness a historical change: *ts* has been replaced by *ʧ* in the inflectional paradigm of the words in 39.[39]

The interest of this change lies in the fact that there is no generalization in Polish that could produce ʧ in 39. The only context in which [ʧ] can be derived from /t/ is that of the underlying /st/ clusters, as in *xłost + a + tɕ* 'beat'–*xłoʃʧ + õ* 'they beat', where [ʃʧ] comes from iotation. (Recall the pattern in 7 in §1.) But the words in 39 do not have /st/. In sum, the development of [ʧ] in 39 is completely irregular.[40] Let us point out that [ʧ] in 39 cannot be derived in any theoretical framework, irrespective of the degree of abstractness that we might be ready to afford to an analysis. That is, all analyses in all frameworks have to resort to allomorphy.

In our analysis, the underlying representation lists two allomorphs for each stem. Thus, for *kłopot + a + tɕ ɕẽ* 'worry' the allomorphs are /kłopot]$_{N}$ + a]$_{V}$/ and /kłopoʧ]$_{V}$/. The distribution of the allomorphs is determined by prosodic constraints and it is completely regular. The only arbitrary fact is that there is allomorphy in the underlying representation. This arbitrariness is located in the lexicon, where it properly belongs.

In general, all classes of verbs that show iotation are nonproductive.[41] Therefore the listing of iotation allomorphs is not particularly surprising. There is one exception though: class 5 verbs such as *głos + ova + tɕ* 'vote' are an open and very productive class. As mentioned earlier, this class can boast many recent acquisitions, for example, *sejv + ova + tɕ* 'save', *orbit + ova + tɕ* 'space walk', and so forth. The iotation effect here is different from what we have seen before.

(40) a. głos + ova + tɕ 'to vote', głos + ova + ł 'voted' (masc.), głos + ova + ł + a 'voted' (fem.)

b. głos + uj + õ 'they vote', głos + uj + onts 'voting', głos + uj + eʃ 'you vote'

Classic analyses postulated an allomorphy rule that changed *ov* /ow/ into [uj] in iotation contexts, specifically before a *j* that would be first inserted and then deleted (Gussmann 1980, Rubach 1984, and others).[42] Our analysis is different.

The underlying representations of *głos + ova + tɕ* 'to vote' and *głos + uj + õ* 'they vote' are as follows.

(41) a. $\left.\begin{matrix}\text{głos}]_{N} + \text{ova}]_{V} \\ \text{uj}]_{V}\end{matrix}\right\}$ + tɕ]$_{inf}$ b. $\left.\begin{matrix}\text{głos}]_{N} + \text{ova}]_{V} \\ \text{uj}]_{V}\end{matrix}\right\}$ + õ] 3_{PL}

[39] The *ʧ* exists in all the inflectional forms, not just in the third person plural, for example, *kłopoʧ + eʃ ɕẽ* 'you worry', *kłopoʧ + onts ɕẽ* 'worrying', and so forth. Except for the *ʧ* instead of the expected *ts*, the pattern is fully regular, that is, it occurs consistently in all iotation environments.

[40] Some sources, for example, Szober 1962, ascribe the rise of *ʧ* to the analogy to the stems in *k*, since the alternation *k* - *ʧ* is a regular development in iotation contexts.

[41] Class 3 is marginally productive. A referee pointed out that there are new formations such as *u + televizyj + ɲ + i + tɕ* 'adapt for television'. This is indeed true but such new formations are typically restricted to bases with the adjectival /En/, compare *televizyj + n + y* 'television' (adj.). The conjugational forms are then based on the infinitive stem and have [ɲ] throughout the paradigm. Other new class 3 formations, such as *od + ʃkl + i + tɕ* 'devitrify' and *nad + tleɲ + i + tɕ* 'superoxidize' (cited by the referee), are instances of new prefixation, compare the existing *ʃkl + i + tɕ* 'vitrify' and *u + tleɲ + i + tɕ* 'oxidize'. The addition of prefixes does not affect the phonology of the stem. Essential for our purposes is the fact that no new instances of iotation stems are attested. On the contrary, as we pointed out earlier, iotation stems tend to be lost in rarely used words.

[42] The second *a* of *ova* /owa/ would be deleted by Jakobson's (1948) vowel truncation. Thus, in one analysis: /glos + owa + õ/ → *głos + owja + õ* → *głos + uja + õ* → *głos + ujj + õ* → *głos + uj + õ* 'they vote'.

Needless to say, the distribution of /ova/ and /uj/ is fully predictable, as the following tableaux show.

(42) a. $\left.\begin{matrix}\text{głos}]_{N} + \text{ova}]_{V} \\ \text{uj}]_{V}\end{matrix}\right\} + \text{tɕ}]_{inf}$

	Onset	*Complex$_{Coda}$
☞1. gło.so.vatɕ		
2. gło.sujtɕ		*!

b. $\left.\begin{matrix}\text{głos}]_{N} + \text{ova}]_{V} \\ \text{uj}]_{V}\end{matrix}\right\} + \tilde{\text{o}}]_{3PL}$

	Onset	*Complex$_{Coda}$
☞1. gło.su.jõ		
2. gło.so.va.õ	*!	

Why are class 5 verbs productive? The answer is clear: they show allomorphy of the verbalizing suffix *ova/uj* and not of the stem. In consequence, the addition of new lexical items does not add to the complexity of the grammar in the sense that no new allomorphy is created.

4. UNMARKED ALLOMORPHS. Recall that our analysis predicts correctly that a palatal allomorph such as *głoɕ*$]_{V}$ is selected before front vowel suffixes,[43] an effect of Coronal Palatalization (see 27, §3.1), but there is nothing in our system of constraints that would prohibit *głoɕ*$]_{V}$ before back vowels, for example, in the present tense third plural *głoʃ* + *õ* 'they voice', as both *głoɕ*$]_{V}$ and *głoʃ*$]_{V}$ pass successfully on faithfulness and on all other constraints. We propose to solve this dilemma with the help of markedness constraints.

Markedness constraints evaluate segment types (feature combinations) and have the format of negative statements (Prince & Smolensky 1993), symbolically, **ɕ* ('don't be a prepalatal consonant') and **ʃ* ('don't be a nonanterior consonant'). Prepalatal *ɕ*-segments are certainly less typical and less frequent crosslinguistically than nonanterior *ʃ*-segments are.[44] Thus, the ranking **ɕ* ≫ **ʃ* need not be considered a stipulation that

[43] However, the nominative plural personal form of the passive participle is *głoʃ* + *eɲ* + *i* 'voiced' rather than **głoɕ* + *eɲ* + *i*. The odd behavior of /en/ is best illustrated by class 1 C-verbs such as *kładʑ* + *eɲ* + *i* 'put', *s* + *pleʦ* + *eɲ* + *i* 'woven' and *roz* + *v'jedʑ* + *eɲ* + *i* 'divorced'. The observation is that /en/ selects iotation stems in what ostensibly is not an iotation context. The reason is that *kładʑ* + *eɲ* + *i* is derived from the inherent verb stem *kład*, compare the third person plural *kład* + *õ* 'they put'. Consequently, the underlying representation of *kładʑ* + *eɲ* + *i* is /kład + en + i/, but then we would expect coronal palatalization (*d* → *dʑ*) rather than iotation (*d* → *dʑ*). This problem cannot be solved in any general way, regardless of the framework. The passive participle /en/ must be simply marked lexically for selecting hard palatal stems and these stems must be available as allomorphs in the underlying representation. Class 3 verbs have hard palatal allomorphs anyway, for example, *głoʃ*$]_{V}$, but /kładʑ/ as well as the other C-stems (five or six altogether) must be listed. In sum, the reason for selecting *głoʃ* in *głoʃ* + *eɲ* + *i* and *kładʑ* in *kładʑ* + *eɲ* + *i* is the same: the lexical specification of /en/ for hard palatal stems.

[44] Along the same lines, [ʧ] and [ʦ] fare better than [tɕ].

is specific to Polish. Rather, it reflects the facts of universal markedness of segments (Prince & Smolensky 1993) with *ʃ* being less marked than *ɕ*.

Now we have an answer to the question of why *głoʃ + õ* is preferred to *głoɕ + õ*. This preference follows from markedness. If all things are equal, as they certainly are with *głoʃ]$_V$* and *głoɕ]$_V$*, then it is the less marked allomorph that wins: a classic case of the 'emergence of the unmarked' (McCarthy and Prince 1994b). Notice that the third allomorph of the verb 'to voice', *głos]$_N$ + i]$_V$*, is irrelevant. First, it has a vowel while *głoʃ]$_V$* and *głoɕ]$_V$* do not have it. Second, and this is decisive, it cannot compete with *głoʃ]$_V$* and *głoɕ]$_V$* in prevocalic contexts, because it violates Onset while *głoʃ]$_V$* and *głoɕ]$_V$* do not violate it.

We summarize our analysis by looking at the diagnostic forms of the verbal paradigm: *głoʃ + õ* 'they voice', *głoɕ + iʃ* 'you voice' and *głoɕ + i + tɕ* 'to voice'. Incidentally, Coronal Palatalization must be ranked above **ɕ*, since otherwise it could never have any effect.[45]

Our proposal that markedness plays a role in allomorph selection finds independent

(43) a. $\left.\begin{matrix}\text{głos}]_N + \text{i}]_V \\ \text{głoʃ}]_V \\ \text{głoɕ}]_V\end{matrix}\right\} + \text{õ}]_{3PL}$

	Onset	CorPal	*ɕ	*ʃ
☞1. gło.ʃ]$_V$ õ]$_{3PL}$				*
2. gło.ɕ]$_V$ õ]$_{3PL}$			*!	
3. gło.ɕ]$_N$ i.]$_V$ õ]$_{3PL}$	*!		*	
4. gło.s]$_N$ i.]$_V$ õ]$_{3PL}$	*!	*		

b. $\left.\begin{matrix}\text{głos}]_N + \text{i}]_V \\ \text{głoʃ}]_V \\ \text{głoɕ}]_V\end{matrix}\right\} + \text{iʃ}]_{2SG}$

	Onset	CorPal	*ɕ	*ʃ
☞1. gło.ɕ]$_V$ iʃ]$_{2SG}$			*	*
2. gło.ʃ]$_V$ iʃ]$_{2SG}$		*!		**
3. gło.ɕ]$_N$ i.]$_V$ iʃ]$_{2SG}$	*!		*	*
4. gło.s]$_N$ i.]$_V$ iʃ]$_{2SG}$	*!	*		*

[45] Since some words in Polish have underlying /ɕ/ and /ʃ/, the relevant Ident constraints that mandate the preservation of the underlying /ɕ/ and /ʃ/ must be ranked above **ɕ* and **ʃ*, respectively.

c. $\left.\begin{matrix} \text{głos}]_N + \text{i}]_V \\ \text{głoʃ}]_V \\ \text{głoɕ}]_V \end{matrix}\right\} + \text{tɕ}]_{inf}$

	*Complex$_{Coda}$	CorPal	*ɕ	*ʃ
☞1. gło.ɕ]$_N$ i]$_V$ tɕ]$_{inf}$			*	
2. gło.s]$_N$ i]$_V$ tɕ]$_{inf}$		*!		
3. głoʃ]$_V$ tɕ]$_{inf}$	*!			*
4. głoɕ]$_V$ tɕ]$_{inf}$	*!		*	

support in Kager's (1996) analysis of the genitive singular ending in Djabugay, an Australian language (data from Patz 1991).

The genitive singular ending in Djabugay has two allomorphs: /n/ and /ŋun/. The former appears after bases ending in a vowel, for example, *guludu* + *n* 'dove' and the latter after bases ending in a consonant, for example, *gaɲal* + *ŋun* 'gonna'. Kager points out that the selection of the allomorph is governed prosodically. Djabugay does not permit complex codas, hence [ga.ɲal + n] loses to [ga.ɲal. + ŋun]. However, the question is what stops [ŋun] from being adjoined to *guludu*: **guludu* + *ŋun*? Notice that the syllable structure of the incorrect form *[gu.lu.du.ŋun] would be a perfect CV string. Kager's solution is to assume a special constraint: Genitive = /n/ ('the genitive ending must be /n/').

(44) a. gaɲal]$_N$ + $\left\{\begin{matrix} \text{n}]_{gen.sg.} \\ \text{ŋun}]_{gen.sg.} \end{matrix}\right.$

	*Complex$_{Coda}$	Genitive = /n/
☞1. ga.ɲal.]$_N$ ŋun]$_{gen.sg.}$		*
2. ga.ɲal]$_N$ n]$_{gen.sg.}$	*!	

b. guludu]$_N$ + $\left\{\begin{matrix} \text{n}]_{gen.sg.} \\ \text{ŋun}]_{gen.sg.} \end{matrix}\right.$

	*Complex$_{Coda}$	Genitive = /n/
☞1. gu.lu.du]$_N$ n]$_{gen.sg.}$		
2. gu.lu.du.]$_N$ ŋun]$_{gen.sg.}$		*!

Given our proposal that segment markedness plays a role in allomorph selection, an alternative analysis can be suggested. The allomorph /ŋun/ has a velar nasal while the allomorph /n/ is a coronal, and thus fares better on markedness. Now the constraint Genitive = /n/ can be dispensed with. The analysis is as follows.

Our analysis in 45 raises a further question, asked by a referee: couldn't it be the

(45) a. $\text{ga}\jmath\text{nal}]_{\text{N}} + \begin{cases} \text{n}]_{\text{gen.sg.}} \\ \eta\text{un}]_{\text{gen.sg.}} \end{cases}$

	*Complex$_{\text{Coda}}$	*ŋ	*n
☞ 1. ga.ɲal.]$_{\text{N}}$ ŋun]$_{\text{gen.sg.}}$		*	*
2. ga.ɲal]$_{\text{N}}$ n]$_{\text{gen.sg.}}$	*!		*

b. $\text{guludu}]_{\text{N}} + \begin{cases} \text{n}]_{\text{gen.sg.}} \\ \eta\text{un}]_{\text{gen.sg.}} \end{cases}$

	*Complex$_{\text{Coda}}$	*ŋ	*n
☞ 1. gu.lu.du]$_{\text{N}}$ n]$_{\text{gen.sg.}}$			*
2. gu.lu.du.]$_{\text{N}}$ ŋun]$_{\text{gen.sg.}}$		*!	*

case that the preference for *guludu* + *n* in 45b is a matter of segment count? The competitor, *guludu* + *ŋun* is more complex than *guludu* + *n* simply because it has more segments in the suffix: *ŋun* versus *n*. Actually, counting segments is a simplification. Given the philosophy of OT that all structure comes at a cost (*Structure: 'avoid structure'), the occurrence of any segment or, for that matter, any feature is penalized. Thus, both qualitative and quantitative factors play a role in markedness. The former determine that some structure is worse than other structure, for instance, *ŋ $\gg$ *n. The latter require as little structure as possible. The problem of how to exactly compute and balance the qualitative and the quantitative differences in markedness is a matter of future research.

5. CONCLUSION. OT predicts that iotation, which, in accordance with the diachronic facts, has been analyzed in the generative tradition as a palatalization rule triggered by *j*, must be reanalyzed in terms of allomorphs without a common underlying form. This prediction is made on the basis of several independent facts.

As we have shown, there is compelling evidence that *j*, the trigger of iotation, is not present in the underlying representation. Neither is it present in the phonetic representation. Thus, in order to trigger iotation, *j* would have to be first inserted and then deleted, an analysis that calls for multiple derivational stages that OT is reluctant to afford. Furthermore, the putative *j*-insertion would require highly abstract underlying representations with strings of vowels that would function as a context for *j*-insertion. But once such representations are postulated, we need a constraint that would simplify vowel sequences. While vowel deletion seems to be a natural process, its operation in Polish cannot lead to the correct results. First, there is no way to determine correctly the direction of vowel deletion. Second, there is evidence that Polish tolerates vowel sequences (nonhigh vowels) or solves hiatus by glide insertion (high vowels). Finally, iotation has lost all grounding as a palatalization process triggered by *j*. This is shown most clearly by the fact that consonants that are palatalized in the underlying representation actually depalatalize in iotation contexts. In sum, the overall conclusion is that iotation is no longer an active process in Polish. This conclusion is supported by the fact that some words have either lost or are in the process of losing iotation effects.

Polish has inherited from the historical process of iotation a complex system of allomorphs. While the underlying representations of these allomorphs are arbitrary, the distribution of allomorphs shows clear generalizations. It is governed by universal constraints that are ranked in a language-specific fashion. Involved in the selection of allomorphs are constraints of all types, covering all areas of phonology: prosody, faithfulness, and positional markedness. Furthermore, morphological constraints may be interspersed among phonological constraints. The case in point is Bare Stem, a new constraint that we have proposed in this article. A further result is that, in the absence of structural violations, segment markedness plays a role. We thus see 'the emergence of the unmarked', in this case, the unmarked allomorph. Also, rather interestingly, underlying allomorphs may have internal morphological structure.

Viewed against the background of lexical phonology, OT is a theory that predicts allomorphy in many (but not all) instances where lexical phonology would have cyclic rules. In general, OT has the effect of dramatically reducing the abstractness of underlying representations. Thus, it also makes a contribution to the long-standing debate on this subject.

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