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A Realization Optimality-Theoretic approach to affix order

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Abstract The interplay of the main factors affecting affix order in inflection (semantic scope, phonology, and morphological templates) can be accounted for in an inferential-realizational Optimality-Theoretic model of morphology, which we present here. Within this model, phonological form is spelled out by means of individual-language-particular realization constraints that associate abstract morphosyntactic feature values with phonological forms and that are ordered among more general constraints governing factors like scope and feature splitting. The data used to exemplify the application of our theory to affix order are drawn from Haspelmath's (*A grammar of Lezgian*, Mouton de Gruyter, Berlin, 1993) grammar of Lezgian, a language of the Northeast Caucasian family spoken largely in Dagestan (Russia) and Azerbaijan.

Keywords Affix order · Semantic scope · Lezgian · Inflection

1 Introduction

Affix order in inflection depends on three factors: semantic scope, phonology, and morphological templates. We argue for the advantages of an inferential-realizational model of inflectional morphology within Optimality Theory (OT) over other morphological frameworks in accounting for affix order, because such a model

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accommodates the interplay of all these factors. In this model the phonological information of inflectional material is realized through realization constraints that associate morphosyntactic feature values with phonological forms (Russell 1995; Kager 1996; Yip 1998; MacBride 2004). For the most part, we use the Lezgian language to demonstrate how a Realization OT model accounts for affix order. We show that only a theory that recognizes the interplay of scope, phonology, and templatic constraints, both universal and language-particular, can account for the range of affix ordering that is found even in comparatively simple systems like that of Lezgian. Realization OT readily and intuitively incorporates universal generalizations about affix order while also accommodating the peculiarities of individual languages. By contrast, we show that rule-based morphological models such as Paradigm Function Morphology (Stump 2001; Spencer 2003) need to use extraordinary mechanisms to capture these universal generalizations. Additionally, we argue that our model readily incorporates the scope constraint (Rice 2000), which poses a problem for conventional OT models (e.g., McCarthy and Prince 1993b; Paster 2005), because such models do not refer to morphosyntactic information.

This paper is organized as follows. In Sect. 2 we describe the relevant Lezgian data, which are drawn entirely from Haspelmath (1993). We introduce the framework of Realization OT and use it to account for the Lezgian data in Sect. 3. We discuss alternative approaches in Sect. 4 and conclude in Sect. 5. Confining ourselves to the analysis of a well-known set of data might appear old-fashioned, but we have selected Lezgian because the actual generalizations governing the order of affixes are quite clear and uncontroversial. We show that, while other theories have difficulty confronting these generalizations, Realization OT can handle Lezgian in a very straightforward fashion.

2 Lezgian

According to Haspelmath (1993), "Lezgian is spoken by about 400,000 people in southern Daghestan and northern Azerbaijan in the eastern Caucasus ... Lezgian morphology is overwhelmingly suffixing and agglutinating" (p. 4). We focus our discussion on the data of the lowland Güne dialect, which is considered standard Lezgian. Lezgian has a rich inflectional system. We discuss both its nominal and verbal inflections.[1]

2.1 Nominal inflection

According to Haspelmath (1993), Lezgian nouns are inflected for number (singular, plural) and case. "There are eighteen cases in Lezgian: four grammatical ones (absolutive, ergative, genitive, dative) and fourteen local cases divided into five

[1] We use the following abbreviations for features in this paper: 1: first person; 2: second person; ABS: absolutive case; acc: accusative case; ADEL: adelative case; AOR: aorist; ASP: aspect; CND: conditional; CONT/cont.: continuative; DAT: dative case; ERG/erg: ergative case; IMPF: imperfective; ind: indicative; Iness: inessive case; NEG/neg: negation; NUM: number; OBJ/obj: object; obl: oblique; Pl/pl: plural; PERF/perf: perfect; Sg/SG/sg: singular; SUBJ: subject; TNS: tense.

localizations (ad, post, sub, super, in), each of which has three locatives (essive, elative, directive). One combination, the 'in-directive', is missing" (p. 74). We find the following patterns in nominal inflection in Lezgian.

- The absolutive form has no affix while the ergative form has an oblique suffix, which occurs in all other case forms.
- Case markers are farther away from a nominal stem than number markers.
- The locatives scope over the localizations, which is reflected in their order: locative markers are farther away from the nominal stem than localization markers.[2]

The following is an illustrative paradigm for singular forms. The root is *sew*. The suffix *-re* is an oblique suffix or ergative case marker. In (1) the suffix *-re* appears in every paradigmatic cell except the absolutive. In the inelative form *sew-räj* 'out of the bear', the vowel *ä* [æ] coalesces the advancement feature [-back] of the vowel [e] of *-re* and the height feature [+low] of the vowel [a] of *-aj*.

(1) Lezgian singular nominal paradigm: *sew* 'bear' (Haspelmath 1993, p. 74)

Absolutive	*sew*	'the bear'
Ergative	*sew-re*	'the bear'
Genitive	*sew-re-n*	'of the bear'
Dative	*sew-re-z*	'to the bear'
Adessive	*sew-re-w*	'at the bear'
Adelative	*sew-re-w-aj*	'from the bear'
Addirective	*sew-re-w-di*	'toward the bear'
Postessive	*sew-re-q^h*	'behind the bear'
Postelative	*sew-re-q^h-aj*	'from behind the bear'
Postdirective	*sew-re-q^h-di*	'to behind the bear'
Subessive	*sew-re-k*	'under the bear'
Subelative	*sew-re-k-aj*	'from under the bear'
Subdirective	*sew-re-k-di*	'to under the bear'
Superessive	*sew-re-l*	'on the bear'
Superelative	*sew-re-l-aj*	'off the bear'
Superdirective	*sew-re-l-di*	'onto the bear'
Inessive	*sew-re*	'in the bear'
Inelative	*sew-räj*	'out of the bear'

[2] The generalization about the order of the locative and localization markers with respect to semantic scope holds across the board in an earlier stage of the Lezgian language but it remains visible in certain case forms in the modern standard language and is not contradicted in any forms.

The exponents in (1) are listed in (2).[3] We assume that the locatives and localizations roughly denote the following meanings:

(2)	Genitive:		*-n*
	Dative:		*-z*
	Essive:	'in a position of'	ø
	Elative:	'from a position of'	*-aj*
	Directive:	'toward a position of'	*-di*
	Ad:	'nearby'	*-w*
	Post:	'behind'	*-q^h*
	Sub:	'under'	*-k*
	Super:	'on'	*-l*
	In:	'in'	(lowering of a final high vowel)

Additionally, we assume Rice's (2000, p. 24) definition of scope:

> [Scope] concerns semantic compositionality. In particular, given three items X, Y, and Z, items X and Y combine with each other and then combine as a unit with Z. The semantics of Z is added to that of X and Y as a unit.

Rice (2000) shows that in Athabaskan languages morphemes "do not occur in some random order within a word, but their ordering is a reflection of their meaning relationships" (p. 25). The use of the term *scope* in relation to meaning comes from logic, where scope is the range of operation of a logical operator.

The locatives scope over the localizations, which is reflected in their order: locative markers are farther away from a nominal stem than localization markers. For example, in the form *sew-re-k-**aj*** 'from under the bear' *sew-re and -k* first form a unit, which further combines with *-aj*. The reverse order of the locative and localization markers would violate the scope constraint (Sect. 3), which is reflected in the fact that #'under from the bear' is an odd meaning.

According to Haspelmath (1993), except for the subdirective case which "[d]espite its name [...] never expresses the locative notion 'direction toward below'" (p. 98), all the other 13 cases originally expressed the compositional meanings in (1). In the modern standard language most cases in (1) are either rarely

[3] There are ten oblique (or ergative) suffixes in Lezgian: *-di*, *-a*, *-i*, *-u*, *-Adi*, *-rA*, *-Uni*, *-A*, *-U*, *-ci/-c'i/-či/-č'i/-ži*. The capitalized *A* stands for either /a/ or /e/: /a/ appears in the environment of /a, u/; /e/ appears in the environment of /e, i, y, æ/. *U* stands for high vowels, either /u/, /i/, or /y/: /u/ appears in the environment of /a, u/; /i/ appears in the environment of /e, i, æ/; /y/ appears in the environment of /y/. The distribution of six of the ten oblique suffixes is predictable. According to Haspelmath (1993, pp. 75–76), the suffix *-di* is the default oblique suffix which attaches to "polysyllabic nouns (e.g. *bubá*, obl. *bubá-di* 'father')" and "monosyllabic words ending in a vowel, monosyllabic loanwords, and abbreviations." The suffix *-a* attaches to "[p]ersonal names ending in a consonant (e.g. *Faríd*, obl. *Faríd-a* 'Farid') and "a small number of common nouns (e.g. *apaj*, obl. *apaj-a* 'father-in-law')." The suffix *-i* attaches to "[a]bstract nouns derived with *-wal* and Masdars (verbal nouns) in *-(u)n* (e.g. *jaru-wal*, obl. *jarú-wil-i* 'redness'; *k'él-un*, obl. *k'él-un-i* 'learning')." It also attaches to "all plural suffixes except *-bur* (e.g. *balk'an-ar*, obl. *balk'án-r-i* 'horses')." The suffix *-u* attaches to plurals in *-bur* (e.g. *jaru-bur*, obl. *jarú-bur-u* 'red ones'). The suffix *-Adi* is used with "nouns that denote a non-discrete mass (e.g. *nek*, obl. *nek'-édi* 'milk')." The suffix "*-rA* is used with most native monosyllabic nouns that denote animals." The distribution of the suffixes *-Uni*, *-A*, *-U*, and *-ci/-c'i/-či/-č'i/-ži* is unpredictable.

used or used in functions different from those in (1). For example, the adelative case "originally expresses movement away from the location 'near, by', but it is now mostly used in a more abstract sense" (Haspelmath 1993, p. 90). See (3).

(3) *I* *Müškür* *xalu.di-z* *ča-waj* *wuč* *k'an-zawa-t'a?*
this Müškür uncle-DAT we-ADEL what:ABS want-IMPF-CND
'I wonder what this Müškür-xalu wants from us?' (Haspelmath 1993, p. 91)

We still observe semantic transparency in the superessive 'on', superelative 'from on', inessive 'in', and inelative 'from in.'

The generalizations about case forms also apply to plurals. Consider the paradigm in (4).[4] The root is *hül* 'sea'. Let us first look at the singulars. The ergative form *hüli* 'sea-ERG' has the oblique suffix *-i*, which appears everywhere except in the absolutive. The distribution of the oblique suffix *-i* is unpredictable (it combines with a few non-derived monosyllabic nouns). The inessive form *hüle* is derived by lowering the vowel [i] of the oblique suffix. The inessive form underlies the in and super localizations.

Next, let us look at the plurals. The plural marker is *-er*.[5] The ergative plural form *hüleri* contains the oblique suffix *-i*. The inessive plural form *hülera* is derived by lowering the vowel [i] of the oblique suffix that attaches to plurals. The inessive plural form underlies the in localizations and the superessive and superdirective forms.[6] Notice that the distribution of *-i* in plural forms is predictable in that it attaches to "all plural suffixes except *-bur*" (Haspelmath 1993, p. 75).

(4) Lezgian nominal paradigm (*hül* 'sea') (Haspelmath 1993, p. 4)

	Singular	Plural
Absolutive	*hül*	*hül-er*
Ergative	*hül-i*	*hül-er-i*
Genitive	*hül-i-n*	*hül-er-i-n*
Dative	*hül-i-z*	*hül-er-i-z*
Adessive	*hül-i-w*	*hül-er-i-w*
Adelative	*hül-i-w-aj*	*hül-er-i-w-aj*
Addirective	*hül-i-w-di*	*hül-er-i-w-di*
Subessive	*hül-i-k*	*hül-er-i-k*
Subelative	*hül-i-k-aj*	*hül-er-i-k-aj*
Subdirective	*hül-i-k-di*	*hül-er-i-k-di*

[4] We put aside issues concerning stress.

[5] According to Haspelmath (1993, p. 71), "[g]enerally, the plural suffix is the stress-attracting suffix *-Ar* or its stress-neutral variant *-ar*. The default plural suffix is stress-neutral *-ar*. Almost all polysyllabic nouns form their plural in *-ar*" E.g. *muhmán-ar* 'guests'. Nouns ending in a vowel form their plural in *-jar* (e.g. *didé-jar* 'mothers'). Most monosyllabic nouns that end in a consonant form their plural in *-Ar*; e.g., *tar-ár* 'trees', *ğül-ér* 'husbands'. The capitalized *A* stands for either /a/ or /e/.

[6] According to Haspelmath (1993, pp. 78–79), the formation of the "in" and "super" localization is more complicated. See his discussion. Nothing there, however, contradicts our point.

Postessive	*hül-i-q^h*	*hül-er-i-q^h*
Postelative	*hül-i-q^h-aj*	*hül-er-i-q^h-aj*
Postdirective	*hül-i-q^h-di*	*hül-er-i-q^h-di*
Superessive	*hül-e-l*	*hül-er-a-l*
Superelative	*hül-e-l-aj*	*hül-er-i-l-aj*
Superdirective	*hül-e-l-di*	*hül-er-a-l-di*
Inessive	*hül-e*	*hül-er-a*
Inelative	*hül-äj*	*hül-er-aj*

As we can see from the paradigm in (4), all case markers are farther away from the nominal stem *hül-* than the plural marker *-er*. The order of the locative and localization markers is consistent in both singulars and plurals, i.e., the locative markers are farther away from the nominal stem than the localization markers.

2.2 Verbal inflection

We find the following patterns in Lezgian verb inflection, with a focus on affix order.

- The past tense marker *-j/-ir* is farther away from a verbal stem than tense-aspectual markers.
- The past tense marker *-ir*, which is used in a negative context, follows the negative suffix *-č*.
- The participle marker *-j* expresses relative clauses, scopes over temporal-aspectual forms, and occurs farther away from a verbal stem.
- The suffix *-č* negates indicative forms.
- The prefix *t(A)-* negates non-indicative forms and is used by a limited number of strong verbs.
- The default negative marker for non-indicative forms is the periphrastic prefixal negative form, which consists of a negated auxiliary and a periphrasis form.

Consider the paradigm in (5).[7] The verb *fin* 'go' is a strong verb. Its inflected forms are placed in three categories based on the three verbal stems of a strong verb. Lezgian has strong and weak (regular) verbs. Strong verbs always take stressed thematic vowels when inflected while weak verbs do not combine with thematic vowels. The citation form of a verb is the masdar (verbal noun). Each strong verb has three stems: the masdar stem; the imperfective stem underlying the infinitive, imperfective, future, etc.; and the aorist stem underlying the aorist, perfect, aorist participle, etc. The distribution of thematic vowels across stems of strong verbs is unpredictable.[8] A weak verb only has one verbal stem.

[7] Stress is not indicated in (5).

[8] It is unpredictable that, for example, the verbal root *ac'-* 'be filled' combines with the thematic vowel [a] in its aorist stem while the verbal root *q̃ač-* 'take' combines with the thematic vowel [u] in its aorist stem, although both roots take the thematic vowel [u] in their masdar and infinitive stems. (The symbol *q̃* stands for [q], an unaspirated and non-labialized uvular.)

(5) Primary verb forms (*fin* 'go') (adapted from Haspelmath 1993, p. 127)

	Affirmative	Negative	Affirmative participle	Negative participle
Masdar	*fi-n*	*te-fi-n*		
Infinitive	*fi-z*	*te-fi-z*		
Imperfective	*fi-zwa*	*fi-zwa-č*	*fi-zwa-j*	*te-fi-zwa-j*
Past Imperfective	*fi-zwa-j*	*fi-zwa-č-ir*		
Continuative Imperfective	*fi-zma*	*fi-zma-č*	*fi-zma-j*	*te-fi-zma-j*
Past Cont. Imperfective	*fi-zma-j*	*fi-zma-č-ir*		
Future	*fi-da*	*fi-da-č*	*fi-da-j*	*te-fi-da-j*
Past Future	*fi-da-j*	*fi-da-č-ir*		
Hortative	*fi-n*	*te-fi-n*		
Aorist	*fe-na*	*fe-na-č*	*fe-ji*	*te-fe-j*
Past Aorist	*fe-na-j*	*fe-na-č-ir*		
Perfect	*fe-nwa*	*fe-nwa-č*	*fe-nwa-j*	*te-fe-nwa-j*
Past Perfect	*fe-nwa-j*	*fe-nwa-č-ir*		
Continuative Perfect	*fe-nma*	*fe-nma-č*	*fe-nma-j*	*te-fe-nma-j*
Past Continuative Perfect	*fe-nma-j*	*fe-nma-č-ir*		

The exponents in (5) are listed in (6).

(6) Inflectional exponents of *fin* 'go'

masdar: *-n*	infinitive: *-z*	imperfective: *-zwa*
cont. imperfective: *-zma*	future: *-da*	past: *-j*/*-ir*
hortative: *-n*	aorist: *-na*	perfect: *-nwa*
cont. perfect: *-nma*	negative: *-č*/*tA-*[9]	participle: *-j*
aorist participle: *-ji*[10]		

There are three types of negative markers in Lezgian, the suffix *-č*, the prefix *t(A)-*, and periphrastic prefixal negative forms. According to Haspelmath (1993, p. 127), the participles, the infinitive, the masdar, and the periphrastic forms are non-finite, and the remaining verb forms in (5) are finite. Within the group of finite verb forms in (5), the Hortative is non-indicative and the others (all underscored in the second column of (5)) are indicative. The suffix *-č* negates indicatives only (as shown in the third column). If *-č* co-occurs with past tense forms, it needs to precede the past tense marker *-ir*. The prefix *t(A)-* is used in some strong verbs to negate

[9] The capitalized *A* stands for either /a/ or /e/: /a/ appears in the environment of /a, u/; /e/ appears in the environment of /e, i, y, æ/.

[10] The aorist participle is realized by "*-aj* for weak verbs (or rarely and archaically *-ur*) and *-r*/*-j*/*-ji* for strong verbs. The form *-r* is used after a high thematic vowel (u, ü), and *-j*/*-ji* is used after a low thematic vowel (a, e). The form *-j* is used after polysyllabic stems, *-jí* is used after monosyllabic stems" (Haspelmath 1993, p. 131).

non-indicatives (e.g. *awun* (masdar) 'do', *t-awun* (negated masdar); *q'un* (masdar) 'hold', *ta-q'un* (negated masdar)).[11]

Most verbs take periphrastic prefixal negative forms, which only apply to non-indicatives and "are formed with the auxiliary *t-awun* 'not do' and the Periphrasis form. The Periphrasis form is always identical to the base in weak verbs, and in strong verbs it is most commonly identical to the Masdar" (Haspelmath 1993, p. 133).

As we can see from (5), the past tense markers *-j*, *-ir* are farther away from the verbal stem than the tense-aspect markers *-zwa* (imperfective), *-zma* (continuative imperfective), *-da* (future), *-na* (aorist), *-nwa* (perfect), and *-nma* (continuative perfect). This order also applies to weak verbs, which take the imperfective marker *-zawa*, the continuative imperfective marker *-zama*, the perfect marker *-nawa*, and the continuative perfect marker *-nama*.

Let us briefly go through the tense-aspect forms in (5).[12] The imperfective typically refers to progressive situations. Despite its name, the future not only refers to future situations, but also to habitual situations.[13] The future can be considered an aspect when it expresses habitual situations (cf. Bybee 1985). The past is only compatible with the habitual meaning of the future, not with the future meaning. The aorist refers to perfective events in the past. The past aorist refers to situations in the remote past, situations that took place before the main story line, situations that do not obtain anymore, and situations whose effect has been cancelled. The perfect refers to past events with current relevance. The past perfect expresses temporal precedence (anteriority) to another past situation. The continuative, combined either with the imperfective or with the perfect, adds the semantic element 'still'.

Participles express relative clauses in Lezgian. "The various tense-aspect forms of the participles generally have the same temporal-aspectual meaning as the corresponding finite forms." (Haspelmath 1993, p. 155) The participle is a relative clause marker just like English *which*, *that*, *who*, etc. and scopes over temporal-aspectual markers within a relative clause, which corresponds to the participle marker being farther away from a verbal stem than temporal-aspectual markers.

3 A Realization Optimality-Theoretic approach to affix order in Lezgian

We present a Realization Optimality-Theoretic account of the data and generalizations on Lezgian affix order that was outlined in Sect. 2. Realization OT is an inferential-realizational model of morphology (Matthews 1972; Zwicky 1985; Anderson 1992; Aronoff 1994; Stump 1993, 2001) within the framework of Optimality Theory. Following Russell (1995), Kager (1996), Yip (1998), MacBride (2004), we assume that the phonological information of inflectional affixes is

[11] According to Haspelmath (1993), Moor (1985) lists 18 such strong verbs and Uslar (1896) lists about sixty verbs with inflectional prefixal negation. The verb *t'ün* 'eat' combines with the negative marker *tü-* (i.e. *tü-t'ün*).

[12] Our discussion is based on Haspelmath (1993, pp. 140–145).

[13] "[The future] used to be a very general non-past form. After the Imperfective took over first the progressive and later the general present meanings, all that was left for this form was the future and habitual meanings" (Haspelmath 1993, p. 130).

introduced through realization constraints that associate abstract morphosyntactic feature values with phonological forms. For example, the constraint {plural}: *-z* requires the feature value {plural} to be realized by the suffix *-z*. We assume that the input to realization consists of stems and unrealized morphosyntactic feature values. Following Grimshaw (1997a), we assume that morphosyntactic feature values remain unchanged from the input to the output.

The crucial constraint governing affix order is the scope constraint, which associates semantic scope with linear order. Following Spencer (2003), we define the scope constraint as follows:

(7) SCOPE: Given two scope-bearing features f_1 and f_2, if f_1 scopes over f_2, then I_2, an exponent of f_2 cannot be farther away from the same stem than I_1, an exponent of f_1.

Within Paradigm Function Morphology (Stump 2001), Spencer (2003) defines the scope constraint as follows:

(8) The scope constraint (Spencer 2003, p. 643): Given a paradigm function evaluated for scope-bearing features f_i, f_j, if f_j scopes over f_i then $I_i > I_j$, where I_i, I_j are affix indexes associated respectively with f_i, f_j.

Notice that we define the scope constraint in a negative way, i.e. an exponent in the scope of another exponent **should not be farther away** from the same stem than the exponent taking scope. By contrast, Spencer defines the scope constraint in a positive way, i.e. an exponent in the scope of another exponent **should be closer** to a stem ($I_i > I_j$). The negatively defined scope constraint has technical advantages over a positive constraint.[14] Consider the example in (9) in which *him* and *like* are each entirely fusional. The pronoun *him* realizes person, number, gender, and case features and is completely undecomposable. It is difficult to tell whether it violates the scope constraint if it is defined positively or (if it does) how many times it violates it, because all features are realized within a single root. The verb *like* raises the same question. It realizes tense and aspect features but it is not clear whether it violates the scope constraint defined positively. The words *him* and *like* in (9), however, clearly do not violate the scope constraint defined negatively (an exponent in the scope of another exponent should not be farther away from the same stem than the exponent taking scope).[15]

[14] Lakämper and Wunderlich (1998) formulate affix ordering constraints in a fashion similar to ours, but they do not justify their formulation.

[15] Both the words *him* and *like* violate the constraint *FEATURE FUSION, which bans an exponent realizing more than one feature value (Xu 2007b). Similar to *FEATURE SPLIT (Xu 2007b; Xu and Aronoff 2008), which is a markedness constraint banning a feature value realized by more than one form, *FEATURE FUSION favors a one-to-one correspondence between a meaning and a form, which is assumed to be universally unmarked (see Wurzel 1989; Embick and Marantz 2008). No feature fusion can also mean no cumulation of morphosyntactic features in an exponent (what Matthews 1974, 1991 termed "cumulation"). The term "fusion" goes back at least to Sapir (1921), in which the degree of fusion refers to the strength of a juncture. If an exponent realizes more than one morphosyntactic feature, there will be no obvious boundary between the features.

(9) *They like him.*

Moreover, it is difficult for the positively defined scope constraint to deal with cases in which one morphosyntactic feature is realized by a prefix while the other one by a suffix. For example, in languages like Turkana (Dimmendaal 1983; Trommer 2001) a tense marker precedes a verbal stem while an aspect marker follows it. The negatively defined scope constraint allows for such cases because there is no way to tell the difference in distance between the affix and a stem while the positively defined constraint does not.

The general scope constraint may be decomposed into more specific constraints between two operators such as SCOPE (case, number), SCOPE (tense, aspect), etc. For example, SCOPE (case, number) can be defined as follows:

(10) SCOPE (case, number): A number exponent cannot be farther away from a nominal stem than a case exponent; case scopes over number because case expresses the relation of an entity or a number of entities to other elements in a clause.

Baker (1985) proposes the "Mirror Principle" to associate syntactic operations with morphological structures. He discusses orders of passive and agreement affixes, orders of causative and reflexive-reciprocal affixes, orders of passive and applicative affixes with respect to orders of syntactic operations. It is hard to test the Mirror Principle in Lezgian based on the types of data discussed in Baker (1985). Lezgian has no passive or reflexive or reciprocal affixes. There is no agreement between adjective and noun or between verb and noun in Lezgian. Though the Mirror Principle or Constraint (Hyman 2003) can be easily incorporated into a Realization OT model, semantic scope-based ordering (Rice 2000) seems to be a more appropriate concept to use since the order of syntactic operations discussed by Baker is not obvious in the Lezgian data (cf. Paster 2005).

3.1 Lezgian nominal inflection

We return to the generalizations about affix order in Lezgian nominal inflection. Case markers are farther away from a nominal stem than number markers. The locatives scope over the localizations, which corresponds to the order in which the locative markers are farther away from a nominal stem than the localization markers. Consider (11).

(11) Partial Lezgian nominal paradigm (*hül* 'sea')

	Plural
Absolutive	*hül-er*
Ergative	*hül-er-i*
Dative	*hül-er-i-z*
Superelative	*hül-er-i-l-aj*
Superdirective	*hül-er-a-l-di*

To account for the data in (11), we propose the constraint SCOPE (case, number). This constraint is a universal markedness constraint built on the generalization by Greenberg that "the expression of number almost always comes between the noun base and the expression of case" (Greenberg 1963, p. 112, cited in Bybee 1985, p. 34). We can understand that case scopes over number because case expresses the relation of an entity or a number of entities to other elements in a clause.[16] Additionally, we propose the following relevant realization constraints:[17]

(12) a. {ergative, plural}: *-i*: The suffix *-i* realizes both the ergative and plural.[18]
b. {dative}: *-z*: The dative case is realized by the suffix *-z*.
c. {super}: *-l*: The super localization is realized by the suffix *-l*.
d. {elative}: *-aj*: The elative is realized by the suffix *-aj*.
e. {directive}: *-di*: The directive is realized by the suffix *-di*.
f. {plural}: *-Ar*: The plural is realized by the suffix *-Ar* (either *-ar* or *-er*).
g. SCOPE (locative, localization): A localization exponent cannot be farther away from a nominal stem than a locative exponent because locative scopes over localization.

In conventional OT, constraints are assumed to have universal status. Realization constraints, however, are language-specific by their very nature in that they realize arbitrary Saussurean signs. It is important to emphasize that the target of conventional OT is phonology while our theory mainly deals with morphology, which, since at least Saussure, has emphasized arbitrary associations of meaning and form. In other words, morphological realization is necessarily language-particular, in any

[16] Bybee (1985) hypothesizes that "[a] meaning element is *relevant* to another meaning element *if the semantic content of the first directly affects or modifies the semantic content of the second*" (p. 13). She further remarks that "the expression of number occurs closer to the noun base because it is more relevant to the meaning of the noun. Number has a direct effect on the entity or entities referred to by the noun. Case, on the other hand, has no effect on what entity is being referred to, but rather only changes the relation of that same entity to the other elements in the clause" (p. 34).

[17] For simplicity of presentation we ignore vowel alternation in deriving case forms.

[18] The Lezgian nominal inflection schema, noun + plural + ergative case can be found in related languages. We are grateful to Alice C. Harris for providing us with the following data.

(i) Tabasaran: *š:aw* 'nail' (Magometov 1965, pp. 112–113)

	Singular	Plural
Absolutive	*š:aw*	*š:aw-ar*
Ergative	*š:aw-di*	***š:aw-ar-i***
Genitive	*š:aw-di-n*	*š:aw-ar-i-n*
Dative	*š:aw-di-s*	*š:aw-ar-i-s*

(ii) Aghul: *k'ar* 'palka, drova' (Magometov 1970, p. 73)

	Singular	Plural
Absolutive	*k'ar*	*k'ur-ar*
Ergative	*k'ar-u*	***k'ur-ar-i***
Genitive	*k'ar-u-n*	*k'ur-ar-i-n*
Dative	*k'ar-u-s*	*k'ur-ar-i-s*

It is also possible to treat the ergative plural marker *-i* as a meaningless oblique suffix. We leave open the question of whether it is better to treat the suffix *-i* as an ergative case marker or meaningless oblique suffix.

framework. Our work is concerned with morphological realization, not with phonology and language-particular realization constraints are crucial in dealing with morphological phenomena, by definition. Whether language-particular constraints are necessary for purely phonological aspects of language is completely outside the scope of our work.[19] Mohanan and Mohanan (2003) propose a model in which a universal constraint matrix generates language-particular constraints. The effects of the OCP constraint, for example, are universally observed while each instantiation of this constraint is language-particular (cf. Yip 1998; Mohanan and Mohanan 2003). Similarly, we assume that each realization constraint is a language-particular instantiation of a universal constraint that associates meaning with form. In Sect. 4, we will continue to argue that realization constraints are indispensable in the morphological component of the whole grammatical architecture.

The ergative plural form *hül-er-i* 'seas' is derived through the constraints {ergative, plural}: *-i*, {plural}: *-Ar*, and SCOPE (case, number). See (13). Assume an input consists of the lexeme HÜL 'sea' with its nominal stem *hül-* and phonologically unrealized feature values plural and ergative. Candidate (b) **hül-i-er* is ruled out by SCOPE (case, number) because the plural marker *-er* is farther away from the nominal stem *hül-*than the case marker *-i*.

(13) *hül-er-i* 'seas' {erg, pl}

HÜL 'sea', pl, erg | *hül-*	{ergative, plural}: *-i*	{plural}: *-Ar*	SCOPE (case, number)
☞a. HÜL 'sea', pl, erg | ⟍ *hül* *-er -i*			
b. HÜL 'sea', pl, erg | ⟋⟍ *hül* *-i -er*			*!

It might be possible to rule out **hül-i-er* by a phonological constraint banning vowel hiatus (*VV) instead. "In general, all non-initial syllables begin with exactly one consonant [in Lezgian]" (Haspelmath 1993, p. 41). We use *VV as a shorthand for the constraint banning vowel hiatus.[20] The constraint *VV, however, cannot rule out other candidates that violate the scope constraint. Consider the superdirective example *hül-er-a-l-di* 'onto the seas'. The super localization is realized by the suffix *-l* and the directive case is realized by the suffix *-di*. The phonological constraint *VV cannot rule out **hül-er-a-di-l* which is phonologically well-formed, while the constraint SCOPE (locative, localization) can.

The dative form *hül-er-i-z* 'seas' {dat, pl} and the superelative form *hül-er-i-l-aj* 'from on the seas' are built on the ergative plural form *hül-er-i* 'seas' {erg, pl}.

[19] Wunderlich (2006) remarks that it remains a question of whether all constraints must belong to a universal set, or whether there can be language- or even construction-specific constraints. Our paper addresses this question. See also McCarthy (to appear), which argues for the significance of morpheme-specific constraints.

[20] See Rosenthall (1997) for a comprehensive discussion of constraints against prevocalic vowels.

To capture this observation, we propose output-to-output (OO) correspondence constraints (Benua 1995; McCarthy and Prince 1995; Kenstowicz 1997; Kager 1999) to make the ergative plural form *hül-er-i* copied by the superelative plural form *hül-er-i-l-aj*. We give a definition of the relevant OO constraint in (14).[21]

(14) MAX (erg (base), non-abs & non-erg): Every segment in a base ergative form, either singular or plural, has a correspondent in a non-absolutive and non-ergative form. (MAX (erg, non-abs & non-erg))[22]

Consider the tableau in (15). Candidate (b) is ruled out because it does not spell out all the phonological information in the base. Candidate (c) is ruled out by SCOPE (locative, localization) because the super exponent *-l* which is in the scope of the elative exponent *-aj* is farther away from the stem than *-aj*.

(15) *hül-er-i-l-aj*

HÜL 'sea', pl, superelative *hül-* Base: HÜL, erg pl: *hül-er-i*	MAX (erg, non-abs & non-erg)	{super}: *-l*	{elative}: *-aj*	SCOPE (locative, localization)
☞ a. HÜL 'sea', pl, super elative *hül-er-i* *-l* *-aj*				
b. HÜL 'sea', pl, super elative *hül* *-l* *-aj*	*-e*!*r-i*			
c. HÜL 'sea', pl, super elative *hül-er-i* *-aj* *-l*				*!

To briefly summarize, the proposed Realization OT model, which incorporates the constraints SCOPE (case, number) and SCOPE (locative, localization), captures the generalizations about affix order in Lezgian nominal inflection.

[21] See Xu (2007a, b), which account for inflectional syncretism based on paradigmatic output-to-output correspondence constraints.

[22] The absolutive and ergative may be placed in a (natural) class, though Wunderlich (1997) and Stiebels (2000), for example, assume that absolutive is unspecified with respect to a structural role (i.e. [ ]) while ergative bears a structural role (i.e. [+l(ower) r(ole)]). It is also possible to account for this stem syncretism with a markedness hierarchy of features (Comrie 1975; 1976; Aissen 1999; Woolford 2001). If the degree of markedness increases from absolutive to ergative to other cases, we may refer to the idea that syncretism moves towards an unmarked state (cf. Noyer 1998) so that more marked case forms refer to the less marked ergative form in Lezgian. There are at least two problems with this idea. First, there is no universal markedness relation between ergative and dative (Woolford 2001), which weakens the markedness motivation for having a dative stem refer to an ergative form. Second, under divergent bidirectional syncretism (DBS) Baerman (2004) has shown that the realizations of unmarked features sometimes need to refer to the phonological form of marked ones, which shows that the markedness hierarchy of features is sometimes unreliable in predicting syncretic directions. See Xu (2007a, b), which provide a Realization OT account of DBS based on paradigmatic output-to-output correspondence constraints.

3.2 Lezgian verbal inflection

Recall the generalizations about affix order in Lezgian verbal inflection. The past tense marker *-j/-ir* is farther away from a verbal stem than tense-aspect markers. The past tense marker *-ir*, which occurs in a negative context, follows the negative suffix *-č*. The participle marker *-j* expresses relative clauses, scopes over temporal-aspectual forms, and occurs farther away from a verbal stem. The suffix *-č* negates indicative forms. The prefix *t(A)-* negates non-indicative forms and co-occurs with a limited number of strong verbs. The default structure to negate non-indicative forms is the periphrastic prefixal negative form, which consists of a negated auxiliary and a periphrasis form. Consider (16).

(16) Partial Lezgian verbal paradigm (*fin* 'go')

	Affirmative	Negative	Affirmative participle	Negative participle
Masdar	*fi-n*	*te-fi-n*		
Infinitive	*fi-z*	*te-fi-z*		
Future	*fi-da*	*fi-da-č*	*fi-da-j*	*te-fi-da-j*
Past Future	*fi-da-j*	*fi-da-č-ir*		
Perfect	*fe-nwa*	*fe-nwa-č*	*fe-nwa-j*	*te-fe-nwa-j*
Past Perfect	*fe-nwa-j*	*fe-nwa-č-ir*		

To account for the partial paradigm in (16), we first propose the following constraints:

(17) a. {masdar}: *-n*: The masdar is realized by the suffix *-n*.
b. {infinitive}: *-z*: The infinitive is realized by the suffix *-z*.
c. {future (habitual)}: *-da*: The habitual aspect is realized by the suffix *-da*.
d. {perfect}: *-nwa*: The perfect is realized by the suffix *-nwa*.[23]
e. {past}: *-ir*: The past tense is realized by the suffix *-ir*.
f. {past}: *-j*: The past tense is realized by the suffix *-j*.
g. {participle}: *-j*: The participle is realized by the suffix *-j*.
h. {negative, [+indicative]}: *-č*: *-č* realizes both negative and [+indicative] features.
i. {negative, FIN-class}: *tA-*: *tA-* realizes both a negative feature and a feature of the inflectional class under which *tA-* is the negation marker and attaches to a main verb.
j. SCOPE (tense, aspect): An aspectual exponent cannot be farther away from a verbal stem than a temporal exponent because tense scopes over aspect.

[23] We put aside post-tonic vowel syncope, through which inflectional suffixes such as *-nwa* may be derived from inflectional suffixes such as *-nawa*.

k. SCOPE (participle, tense & aspect): Exponents of tense and aspect cannot be farther away from a verbal stem than an exponent of participle (relative clause marker) because participle (relative clause marker) scopes over tense and aspect.

Constraints (17a–i) are realization constraints that associate morphosyntactic or semantic feature values with phonological forms.

Constraints (17j–k) are scope constraints. The constraint SCOPE (tense, aspect) is a universal markedness constraint on the order of tense and aspect markers. Aspect markers are closer to a verbal stem than tense markers (Bybee 1985). Tense scopes over aspect because "[t]ense places the situation [(habitual, progressive, perfect, etc.)] in time with respect to an established point in time, either the moment of speech, or some other point in time" (Bybee 1985, p. 28). The meaning of aspect is therefore first added to a verb and the meaning of tense is added to that of the combination of both the verb and aspect.

Notice that some Lezgian inflectional affixes may combine tense and aspect. The aorist marker *-na*, for example, realizes both tense and aspect because the aorist usually refers to perfective events in the past. The future exponent *-da* expresses either future or habitual situations and the past is only compatible with the habitual meaning of the future, not with the future meaning. The imperfective marker *-z(a)wa* may express progressive situations, habitual situations, etc. In the past imperfective example Haspelmath (1993) gives, the imperfective refers to progressive situations. The order in which the past tense marker *-j*/*-ir* follows these tense-aspect markers satisfies SCOPE (tense, aspect) because the aspect exponent is not farther away from a verbal stem than the tense exponent.

The relative clause marker (e.g. *the one* ***that*** + clause) should scope over temporal-aspectual markers within a clause, which is reflected in the scope constraint SCOPE (participle, tense & aspect).

Let us see how the constraints in (17) account for the data in (16). Consider the tableau in (18). Candidate (18b) **fi-j-da* is ruled out by SCOPE (tense, aspect) because *-da* which expresses habitual situations in this case is farther away from the verbal stem *fi* than the tense marker *-j*.

(18) *fi-da-j* (past habitual)

fi-, habitual, past	{future (habitual)}: *-da*	{past}: *-j*	SCOPE (tense, aspect)
☞ a. habitual, past *fi -da -j*			
b. habitual, past *fi -j -da*			*!

A similar analysis can be made of past perfect forms like *fe-nwa-j*, future participle forms like *fi-da-j*, and perfect participle forms like *fe-nwa-j* in (16) by using the relevant realization and scope constraints in (17).

Let us look at the order of tense and aspect markers and the suffix *-č*, which is assumed to realize both negation and indicative mood (e.g. *fe-nwa-č-ir* 'go-perf-neg.ind-past' in (16)). To account for this order, which runs counter to scope, we must rank phonotactic constraints higher than any scope constraint involving either mood or negation. Bybee (1985) found that tense and aspect markers are universally closer to a stem than mood markers, for "mood necessarily has the whole proposition in its scope, while tense places the event described by the *verb* in time relative to the speech event" (p. 184).[24] Semantic scope therefore predicts that a tense marker first combines with a verbal stem as a unit, which further combines with a mood marker. Accordingly, we can propose the following scope constraint to capture this empirical generalization.

(19) SCOPE (mood, tense & aspect): Exponents of tense and aspect cannot be farther away from a verbal stem than a mood exponent because mood scopes over tense and aspect.

Additionally, Bybee (1985) notices that "in some uses negation can resemble what we are calling mood, in that it can have the whole proposition in scope [(e.g. *it is* ***not*** *the case* that + clause)]" (p. 176). See also the examples in Chichewa and Imbabura (20–21), which show that negation scopes over other affixes.

(20) Multiple prefixation in Chichewa (Hyman 2003, p. 247)

	NEG-	SUBJ-	TNS-	ASP-	OBJ-	stem	
Main root clause:	***si-***	*ti-*	*dzá-*	*ngo-*	*mú-*	*ményá*	'we will not just hit him'
						-dzá-	'future', *-ngo-* 'just'

(21) Imbabura negation (Cole 1982, p. 164, cited in Palmer 2001, p. 53)
*shuwa-shka-ni-**chu***
steal-PERF-2SG-**NEG**

We can propose a scope constraint in which negation scopes over tense and aspect (22).

(22) SCOPE (negation, tense & aspect): Exponents of tense and aspect cannot be farther away from a verbal stem than an exponent of negation because negation scopes over tense and aspect.

The constraints in (19) and (22) are formulated in a simplified way and can be decomposed into constraints such as SCOPE (mood, tense), SCOPE (mood, aspect), etc. Either of the two constraints can explain why the negated indicative future (habitual) form of the verb *fin* 'to go' is *fi-da-č* instead of **fi-č-da*, which violates both. See (23).

[24] In Bybee's 50-language database, Ojibwa presents the only exception to the order that mood markers are farther away from the verb than tense and aspect markers. In Ojibwa "the Dubitative suffix precedes the Preterite suffix" (Bybee 1985, p. 196).

(23) *fi-da-č* (negative habitual)

fi-, habitual, ind, neg	{future (habitual)}: *-da*	{negative, [+indicative]}: *-č*	SCOPE (mood, tense & aspect)	SCOPE (negation, tense & aspect)
☞ a. habitual, ind, neg *fi -da -č*				
b. habitual, ind, neg *fi -č -da*			*!	*

The negative past future (habitual) form *fi-da-č-ir* violates the scope constraint that requires the tense marker *-ir* not to be farther away from a verbal stem than the negative and indicative marker *-č*. The negative and indicative marker *-č* precedes the past tense marker *-ir* because otherwise the ungrammatical form **fi-da-ir-č* would have a vowel hiatus, which is generally banned in Lezgian. In other words, what appears to govern the order of these two suffixes is not scope, but phonology. Consider the tableau in (24). Candidate (b) is ruled out by *VV though it satisfies the scope constraint. The ungrammatical form **fi-da-j-ir-č*, which contains an epenthesized segment [j] to avoid vowel hiatus, is ruled out by the constraint DEP, which outranks SCOPE and bans segment insertion.

(24) *fi-da-č-ir* (negative past habitual)

fi-, habitual, past, neg, ind	neg, [+ind]: *-č*	past: *-ir*	habitual: *-da*	*VV	DEP	SCOPE (mood, tense & aspect)
☞ a. habitual, past, neg, ind *fi -da -č -ir*						*
b. habitual, past, neg, ind *fi -da -ir -č*				*!		
c. habitual, past, neg, ind *fi -da -j -ir -č*					*-j*!	

Additionally, we need to explain why *fi-da-č-ir* (negative past habitual), which violates the scope constraint, is better than **fi-da-j-č*, which satisfies it because the past tense suffix *-j* is closer to the verb stem *fi* than the negative and indicative suffix *-č*. One solution is to rank *COMPLEXCODA higher than the scope constraint so that *COMPLEX-CODA can rule out **fi-da-j-č*, although complex codas are common in Lezgian (e.g. /-jd/ *q̃ejd* 'remark', /-w∫/ *benewš* 'violet', /-fs/ *nefs* 'thirst, desire', /-χ∫/ *baxš*

'dedication'). This can be considered a case of the emergence of the unmarked (McCarthy and Prince 1994) and explains why the past tense marker *-j* does not co-occur with the negative and indicative suffix *-č*. See the tableau in (25). Notice that the illicit form **fi-č-da-j* more seriously violates the scope constraint than *fi-da-č-ir* because **fi-č-da-j* violates not only SCOPE (mood, tense) but also SCOPE (mood, aspect) while *fi-da-č-ir* only violates SCOPE (mood, tense).

(25) *fi-da-č-ir* (negative past habitual)

fi-, habitual, past, neg, ind	neg, [+ind]: *-č*	past: *-ir*	past: *-j*	*COMPLEX CODA	SCOPE (mood, tense & aspect)
☞ a. habitual past neg, ind *fi -da -č -ir*			*		*
b. habitual past neg, ind *fi -da -j -č*		*		*!	
c. habitual past neg, ind *fi -č -da -j*		*			**!

The reason why the past tense marker *-ir* does not follow tense-aspect markers is clear (e.g. *fe-nwa-j* (past perfect), **fe-nwa-ir*). If the past tense suffix *-ir* follows a tense-aspect marker which always ends in a vowel, the consequent form (e.g. **fe-nwa-ir*) will lead to vowel hiatus which is generally banned in Lezgian.

The constraint {negative, [+indicative]}: *-č* bears no subset relation to the constraint {negative, FIN-class}: *tA-*, but the former needs to outrank the latter. Consider the tableau in (26). Candidate (b) **te-fe-nwa* is ruled out by {negative, [+indicative]}: *-č*. To rule out the illicit form **te-fe-nwa-č* which bears two negation markers, we refer to the markedness constraint *FEATURE SPLIT (Xu 2007b), which favors simple exponence and bans a morphosyntactic feature value realized by more than one form.[25] Both {negative, [+indicative]}: *-č* and {negative, FIN-class}: *tA-* that introduce synthetic negation markers should

[25] One reviewer points out that to derive the ergative plural form *hül-er-i* 'sea-pl-erg.pl' both the constraints realizing *-er* and *-i* need to outrank *FEATURE SPLIT, which leads to a case of extended exponence of plurality. See Xu (2007b) and Xu and Aronoff (2008), which provide a unified account of blocking and extended exponence. If two constraints that realize the same morphosyntactic feature value outrank *FEATURE SPLIT, we will observe extended exponence. Otherwise, blocking of exponents will take place. By comparison, Aissen (1999, 2003a, b) presents alternative OT mechanisms under which more marked meanings or features are realized by more marked forms and less marked meanings or features by less marked forms. However, the markedness relation between verbal negation and substantive plurality is not clear. In addition, cross-linguistically feature values, either marked or unmarked, can be multiply realized. (See Xu 2007b for a survey of languages with extended exponence.)

outrank the less specific constraint introducing a periphrastic negative form, which is the default negative structure in Lezgian.[26]

(26) *fe-nwa-č* (negative indicative perfect)

fe-, perfect, neg, ind	{neg, [+ind]}: *-č*	*FEATURE SPLIT	{neg, FIN-class}: *tA-*
☞ a. perfect neg ind *fe -nwa -č*			*
b. neg perfect ind *te- fe -nwa*	*!		
c. neg perfect ind *te- fe -nwa -č*		*!	

An alternative approach to placing the negation and indicative marker *-č* is to refer to language-particular morphotactic constraints, which is much less interesting because it is purely stipulative. This approach needs to stipulate the position of *-č* with respect to tense and aspect markers. We might propose in such an approach the following language-particular constraints for Lezgian.

(27) a. Negation > Tense: An exponent of negation cannot be farther away from a stem than an exponent of tense.
b. Aspect > Negation: An exponent of aspect cannot be farther away from a stem than an exponent of negation.

The two constraints in (27) put the negation marker *-č* between a (tense-) aspectual marker and a tense marker. The constraint Aspect > Negation needs to outrank Negation > Tense because in Lezgian, tense-aspect markers such as *-na* {aorist} which realizes both tense and aspect precede the negative marker *-č* (*fe-na-č*, **fe-č-na*). Consider (28). Notice that compared to *fi-da-č-ir*, the illicit candidate **fi-da-č-j* which has the past tense marker *-j* violates not only *COMPLEXCODA but also the Sonority Sequencing Principle (Kenstowicz 1994) which requires a coda cluster to have a contour with falling sonority. Additionally, the coda cluster *[-*čj*] is illicit in Lezgian.

[26] See Kiparsky (2005) for a review of various approaches to the blocking of periphrastic structures by synthetic forms.

(28) *fi-da-č-ir* (negative past habitual)

fi-, habitual, neg, past, ind	hab: *-da*	{neg, [+ind]}: *-č*	past: *-ir/-j*	Asp > Neg	Neg > Tense	*CPLEX CODA
☞ a. habitual neg past ind *fi -da -č -ir*						
b. habitual neg past ind *fi -č -da -ir*				*!		
c. habitual neg past ind *fi -da -ir -č*					*!	*
d. habitual neg past ind *fi -da -č -j*						*!

This type of approach is advocated in Paster (2006), which argues that there is no phonologically conditioned affix ordering and that affix order is solely determined by scope and templates. It would stipulate not only the past tense allomorph that can co-occur with the negative and indicative suffix *-č* in Lezgian, but also their order, both of which could otherwise be explained under phonotactics. Putting aside the counterargument that phonotactics determines affix order (e.g. Rice 2008), it is hard to imagine how to falsify Paster's claim, since all affix orderings, even if phonotactics is clearly involved, can be ascribed to morphological templates. A template is essentially a concatenation of numbers of rule blocks (e.g. I–II–III) in the sense of Stump (2001).[27] An affix can always be placed in a rule block. Additionally, for Paster's approach to work there should be a clear-cut boundary between morphology and phonology, as pointed out in Paster (2009). However, the morphological component very often overlaps with the phonological one. That is, phonological constraints show effects in morphology and morphological information can be a determining factor in the phonological component. For example, Bonet (2004) and Mascaró (2007) show the emergence of phonotactic effects in allomorph selection, which is otherwise lexically determined. See also Wolf (2008) for discussion of the interaction of morphology and phonology.

To briefly summarize, in Realization OT we can describe the patterns about affix order in Lezgian verbal inflection via universal scopal, phonotactic and morphological constraints and language-particular realization constraints.

[27] Stump (2009) presents template-like "rules of composition".

4 Alternative approaches

In this section, we argue for the advantages of Realization OT over other approaches to affix order. These include Paradigm Function Morphology (Stump 1993, 2001), Distributed Morphology (Halle and Marantz 1993), Constructional Morphology (Blevins 2006; Booij 2005, 2007, 2008, 2009), Minimalist Morphology (Wunderlich and Fabri 1996; Lakämper and Wunderlich 1998), OT approaches based on the generation of morphosyntactic feature values (Grimshaw 1997b, 2001; Wunderlich 2001), the ranking schema "templatic constraints >> the Mirror Constraint" (Hyman 2003), conventional OT (e.g., McCarthy and Prince 1993b, Paster 2005), hybrid approaches that include both constraint ranking and rule ordering (Trommer 2001, 2003), and a diachronic approach to affix ordering.

In Paradigm Function Morphology (PFM) (Stump 1993, 2001), Stump implements affixation in rule blocks. An affix that is closer to a stem is placed in a rule block that precedes another rule block containing an affix that is farther away from the same stem. This approach is similar to that in Anderson (1992), which implements affixation cyclically. Consider the Finnish example in (29) described within the framework of PFM. "The Finnish noun form *talo-i-ssa-ni* 'in my houses' consists of the root *talo*, followed by Plural, Inessive Case and 1Sg Possessor affixes" (Spencer 2003, p. 630). An output from Rule Block I (X*i*) becomes an input to Rule Block II (X).

(29) *talo-i-ssa-ni* 'in my houses' (Finnish)
(a) Block I, [NUM: Pl], [CLASS: Noun] (X) = X*i*
(b) Block II, [CASE: Iness], [CLASS: Noun] (X) = X*ssa*
(c) Block III, [POSSESSOR: 1sg], [CLASS: Noun] (X) = X*ni*

One of the shortcomings of this approach is that by simply labeling each rule block with a number we miss universal scope generalizations such as "case scopes over number", which entails that a case exponent should not be closer to a stem than a number exponent. Spencer (2003) notices this problem and proposes the general scope condition imposed on rule blocks. See (8) (repeated in (30)).

(30) The scope constraint (Spencer 2003, p. 643): Given a paradigm function evaluated for scope-bearing features f_i, f_j, if f_j scopes over f_i then $I_i > I_j$, where I_i, I_j are affix indexes associated respectively with f_i, f_j.

The scope constraint proposed by Spencer is a redundant strategy for PFM, however, given that the order of rule blocks is determined by the distance between a stem and an affix on a language-particular basis. PFM might consider the scope constraint a factor in determining the order of rule blocks, to avoid analytical redundancy, but it is not clear how the scope constraint interacts with a language-particular templatic constraint in PFM, which is encoded in the order of rule blocks and overrides the scope constraint. It is therefore not clear how PFM solves this paradoxical situation: on the one hand, the scope constraint determines the

order of rule blocks, while on the other hand it needs to be overridden by the order of rule blocks in some cases. By contrast, the violable scope constraint points toward our Realization OT approach, which encodes language universals in constraint rankings.

Additionally, based on the ranking of phonotactic and scope constraints Realization OT provides a more reasonable explanation of several issues in Lezgian, such as the order of the past tense marker *-ir* and the negative and indicative suffix *-č*, the selection of the past tense allomorph after *-č*, which would otherwise be stipulated under PFM.

It is also possible to account for affix order in Lezgian via syntactic approaches. For example, in Distributed Morphology (DM) (Halle and Marantz 1993; Embick and Noyer 2001) which is designed specifically to handle syntax–morphology interpenetration, the scope generalization will be automatically implemented in syntactic structures with the elements that take scope c-commanding the elements within their scope. Under a DM approach, a morphological structure is derived from a syntactic structure that encodes scope directly, though it may subsequently undergo processes such as lowering of morphosyntactic elements in a syntactic tree or head-to-head movement, followed by Vocabulary Insertion that realizes morphosyntactic feature values and places affixes in linear orders.

The mechanism to derive a morphological structure in Distributed Morphology embodies the claim in Baker (1985), i.e. morphology and syntax interact in one component, i.e. the *syntax proper*.[28] Hyman (2003) argues that at least some affix-orderings in Bantu should be explained in the *morphology proper* and concludes that the Mirror Principle is a violable OT constraint. Hyman, however, does not incorporate this observation into a larger framework.

We now turn to Minimalist Morphology (Wunderlich and Fabri 1996; Lakämper and Wunderlich 1998), an incremental morphological model. Lakämper and Wunderlich (1998) discuss the verb morphology of Quechua dialects and provide a descriptive analysis of the asymmetry of markings of person features. They propose some affix ordering constraints, although they do not justify their formulation. Under an incremental morphological model, meanings or morphosyntactic features are introduced by morphophonological forms. That is, a morphophonological form is a starting point of derivation while a meaning is an outcome. Since markedness constraints are output-oriented, in an incremental morphological model they should restrict meanings or possible semantic interpretations instead of

[28] Grimshaw (1986) argues that Baker's (1985) Mirror Principle does not necessarily show that morphology and syntax interact in one grammatical component. Instead, she suggests that morphology and syntax belong to two different grammatical components.

morphophonological forms.[29] It is therefore hard to imagine how constraints on affix order that regulate the sequence of morphophonological forms work in an incremental morphological model.

By contrast, in our realizational model, morphophonological forms are introduced through morphosyntactic features and markedness constraints target morphophonological forms. The affix ordering constraint, which targets a linear order of forms instead of semantic interpretation, is therefore correctly implemented in our model but not in Wunderlich's Minimalist Morphology.

Realization OT captures affix ordering, allomorph selection, blocking and extended exponence more readily than a framework based on the generation of morphosyntactic feature values (Grimshaw 1997b, 2001; Wunderlich 2001), which lacks a mechanism to spell out abstract feature values. Even if we introduce extra machinery such as Vocabulary Insertion (as in Distributed Morphology), it is hard to imagine how constraints on morphophonological forms (e.g. the scope constraint) operate in this framework given that both an input and output consist of abstract features only.

Let us turn to Hyman's (2003) ranking schema "templatic constraints >> the Mirror Constraint". Hyman (2003) argues that the Mirror Principle (Baker 1985) is a violable constraint, which can be outranked by language-particular templatic constraints.[30] He says little, though about the morphological framework under which this ranking schema works, but it is hard to imagine how an output sequence of affixes, restricted by semantic scope, could be derived without specific realization constraints or exponents whose order can be determined by the scope constraint.[31] Additionally, templatic constraints cannot explain the Lezgian data which we have analyzed. A template is an object that, by definition, cannot be derived via universal principles. Templatic constraints for Lezgian would simply stipulate the order of past tense and negative indicative markers, the selection of past tense allomorphs, and extended exponence in Lezgian, all of which can be explained via the interaction of realization constraints and universal semantic, phonotactic, and morphological constraints.

[29] Lakämper and Wunderlich (1998) proposes the Object-Subject Constraint (OSC), which says that if an object is marked separately from the subject, it refers to a person that is higher on the hierarchy of person than the person to which the subject refers (Hierarchy of person: 1 > 2 > 3). This constraint restricts the semantic interpretation of the following examples:

i.	1/2	*qam-ta* *rika-r-ni-(y)ki*	'when I see you'
		you-acc see-SS-ni-2	
ii	3/2	*rika-shu-r-ni-(y)ki*	'when he/she sees you'
		see-obj-SS-ni-2	

"[A] person affix that follows the [same-subject] (SS)-marker *-r* can never relate to the subject, so both forms [i & ii] relate to two objects, although *-yki* itself is not an object but a possessive affix. If the object is separately marked by *-shu*, this affix must refer to a person that is higher on the hierarchy of person than the subject person. Thus, one subject is excluded and speakers have to use the form without *-shu* in order to license the 1/2 combination, even if the dependent verb itself says nothing about the subject explicitly" (p. 128).

[30] See also Good (2003) for discussion of the properties of templates.

[31] See also Stiebels (2003), which shows that affixes are ordered based on semantic scope.

In conventional OT (McCarthy and Prince 1993a, b, 1995), whose target is phonology, information such as "affix", "root", and "stem" constitutes enough morphological information for the grammar to process. No reference is permitted to morphosyntactic information. It is thus hard to see how to incorporate into this model anything like the scope constraint, which crucially relies on morphosyntactic feature values.[32] Paster (2005), for example, uses the scope constraint to account for affix order in Pulaar, a West Atlantic language spoken across a wide area of West Africa. She needs to assume that morphosyntactic feature values are present in both an input and output in order for the scope constraint to work, though her tableaux do not contain feature values.

Even if morphosyntactic feature values are introduced into both an input and output of conventional OT, the fixed model is incapable of handling semantic scope. An overwhelming majority of current morphological theories simply assume that linearization takes place when phonological exponents are inserted to realize morphosyntactic features. Additionally, almost all conventional OT works assume that an input specifies the lexical information of whether an affix is a prefix or suffix. It is therefore natural to linearize exponents in an input that are drawn from the lexicon in conventional OT. The scope constraint is expected to take effect when affixes are introduced into an input of conventional OT, because this is the moment when linearization of affixes takes place. Since conventional OT does not have a mechanism of realizing morphosyntactic feature values, it is incapable of using the scope constraint that takes effect at the moment of morphological realization. By contrast, Realization OT readily captures the range of interactions between scope and affix order in natural languages, including violations of strict correspondence between the two. No other current model can do this.

Trommer (2001, 2003) proposes a hybrid account of affix order that includes both parallel constraint ranking and serial rule ordering. Trommer (2001), for example, remarks that person markers generally occur to the left of number markers though the reverse order is sometimes observed. He therefore proposes two universal alignment constraints to place a person marker to the left of a stem and a number marker to the right. However, Kager (1999) points out that "any exclusively typology-based definition of universality runs the risk of circularity: certain properties are posited as 'unmarked' simply because they occur in [linguistic] systems with greater frequency than other 'marked' properties" (p. 11). Putting aside the problem of circularity, it is necessary to introduce realization constraints or exponents in order for these alignment constraints to work, which Trommer does not explore. Trommer's alignment constraints cannot explain the Lezgian affix order, which involves the interaction of scope and phonotactics; they cannot account for closely related issues in Lezgian inflection, such as the selection of allomorphs after the negative and indicative marker, blocking, and extended exponence, because these issues are better explained via realization constraints and universal

[32] Within a conventional OT model, Russell (1997) proposes that Bybee's (1985) generalizations about affix order can be expressed as a set of violable generalized alignment constraints that form part of Universal Grammar. However, it is hard to see how alignment constraints (McCarthy and Prince 1993a) account for the generalization of semantic scope defined in a negative way, i.e. an exponent in the scope of another exponent cannot be farther away from a stem than the one taking scope.

phonotactic and morphological constraints. Trommer's alignment constraints can also be easily incorporated into Realization OT, because the realization constraints we have presented can be easily decomposed into realization and alignment constraints. For example, the constraint realizing the English plural suffix *-z* can be easily decomposed into a realization constraint {plural}: *z*, which does not specify the position of the exponent, and an alignment constraint, either language-particular or universal, which places the exponent after a stem. Therefore, Trommer's account of the position of person and number markers can be easily accounted for in Realization OT via the ranking schema "language-particular alignment constraints >> universal alignment constraints", which also captures the reverse order of person and number markers that does not obey Trommer's general alignment constraints. Language-particular realization constraints must be introduced not only for this ranking to work but also to cover other issues related to affix order.

On the other hand, Trommer adopts a rule-based serial approach to the order of tense and aspect markers. Based on the discoveries of Julien (2000), Trommer claims that the order "aspect-verb-tense" is "virtually non-existent" because syntactic movements do not derive that order. Trommer's hybrid approach therefore brings about a serious and undesirable problem, i.e., human beings are assumed to possess two fundamentally different linguistic computational systems rather than a consistent one. As far as we can see, the order of tense and aspect markers can be captured by both the scope constraint we have presented in Sect. 3 and alignment constraints that Trommer proposes to account for the order of person and number markers. Trommer's data basically show that tense markers generally occur to the left of aspect markers, so we can propose an alignment constraint TENSE LEFT that places tense markers to the left of aspect markers. The ranking "SCOPE (tense, aspect) >> TENSE LEFT", which can be easily incorporated into Realization OT, accounts for almost all of Trommer's data. Trommer's (2001) generalizations about the order of tense and aspect markers are presented as follows.

(31) Order of tense and aspect markers (Trommer 2001)

	Both prefixes	Mixed	Both suffixes
Tense > Aspect	Tense Aspect Verb	Tense Verb Aspect	*Verb Tense Aspect
Aspect > Tense	*Aspect Tense Verb	*Aspect Verb Tense	Verb Aspect Tense

If both tense and aspect markers are prefixes in a language, the ranking "SCOPE (tense, aspect) >> TENSE LEFT" will rule out *Aspect Tense Verb, which violates the scope constraint. See (32).

(32) Both prefixes

	SCOPE (tense, aspect)	TENSE LEFT
☞ Tense Aspect Verb		
Aspect Tense Verb	*!	*

If both tense and aspect markers are suffixes in a language, the ranking schema will rule out *Verb Tense Aspect. See (33).

(33) Both suffixes

	SCOPE (tense, aspect)	TENSE LEFT
Verb Tense Aspect	*!	
☞ Verb Aspect Tense		*

If tense and aspect markers occur on both sides of a stem, the ranking will rule out *Aspect Verb Tense, which violates TENSE LEFT. See (34).

(34) Mixed

	SCOPE (tense, aspect)	TENSE LEFT
☞ Tense Verb Aspect		
Aspect Verb Tense		*!

To briefly summarize, Realization OT readily extends to Trommer's (2001, 2003) account of affix order.

Notice that all of the above-mentioned approaches are synchronic in nature. One reader points out a diachronic approach to affix order under which scope-based ordering in inflection follows from grammaticalization of syntactic patterns, and scope-based ordering in syntax follows from rules of syntax–semantics mapping. S/he mentions that realizationalists also adopt this approach (e.g. Anderson 2004).

But what are the semantic rules that determine word order and where do these rules come from? They must be scope constraints of some sort. As far as we can see, there is no discrepancy between a diachronic approach and ours as to the contention that semantic scope determines affix order. The difference between our proposals concerns whether we should tackle affix ordering (or maybe morphology in general) synchronically or diachronically, but that does not necessarily involve a contradiction. It may well be the case that both a diachronic and synchronic approach to the ordering of linguistic objects conform to the same mechanism, though grammaticalization of individual forms might be involved. Additionally, under a diachronic approach, several issues closely related to affix order in Lezgian that can find reasonable synchronic explanations will be considered historical leftovers or even aberrations and simply listed in the lexicon, which are highly undesirable for theoretical linguists. Our account focuses on morphological theories, which are expected to efficiently explain synchronic data. It follows the tradition of doing theoretical linguistics, i.e., a linguistic theory should be simple and able to capture universal generalizations.

Anderson (2004) does not discuss affix ordering. He argues that certain irregular morphological patterns such as split ergativity, morphological metathesis, and multiple exponence, arise because of historical innovations instead of a limitation of the innate cognitive system. He does not ascribe central morphological issues like blocking to historical innovations. The debate about whether a synchronic or

diachronic approach is better in analyzing morphological data (from what perspectives) is beyond the scope of our analysis.

Lastly, under constructional approaches to morphology (Blevins 2006; Booij 2005, 2007, 2008, 2009), a fully inflected word is a starting point of analysis and smaller elements are abstracted from a word. A construction is like a template, which is stipulative in nature. Most generalizations about word structure become epiphenomenal in constructing a morphological grammar under this approach. Cases of affix order, phononologically driven allomorph selection, blocking and extended exponence, which involves scope, phonotactics, and universal morphological restrictions, would be left to diachrony. We leave to future research whether synchronic or diachronic approaches provide a real explanation of these issues.

5 Conclusion

In this paper we analyzed Lezgian inflectional morphology with a focus on affix order. We found that case markers are outside number markers. Locative markers which scope over localization markers are farther away from a nominal stem. The past tense marker is outside tense-aspect markers. Participles which express relative clauses are outside temporal-aspectual affixes. A negation marker in indicative mood occurs between past-tense and tense-aspect markers. The past tense suffix *-ir* does not appear in an affirmative context or follow tense-aspect markers, which always end in a vowel. Additionally, extended exponence occurs in Lezgian nominal inflection while blocking of exponents takes place in Lezgian verbal inflection. We show that these generalizations are captured under Realization OT by scopal, phonological, and universal morphological constraints, as well as language-particular realization constraints, which are necessary in morphological analysis.

Remaining issues include, for example, a question of how morphology interacts with phonology. Our analysis shows that the morphological component intersects with the phonological one, i.e. phonological effects occur in morphology and morphological information can be a determining factor in phonology as in Prosodic Morphology. But there remains the question of how to formalize the interaction of the two components. Whatever a solution is, it must recognize an autonomous morphological component that handles morphological realization, which may analytically precede phonology; it should also be able to capture the mutual effects of the two components.

Other questions include whether serialism is necessary in morphological analysis and how Realization OT extends to derivational morphology. Though our work focuses on inflectional morphology, Realization OT has potential to extend to derivational morphology. Derivational affixes or word-formation rules (Aronoff 1976; Anderson 1992) can be encoded in realization constraints that associate meaning with form. For example, the suffix *-ness* can denote the meaning of "the quality or state of being *X*" (Aronoff 1976, p. 38). The *ness*-suffixation can be implemented in a realization constraint {the quality or state of being *X*}: *-ness*. The symbol ":" is read as "realized by". The adjectival suffix *-ous* can denote the meaning of "having the properties of *X*". It can also be encoded in a realization

constraint in a similar fashion. In the word *poisonousness* 'the state of having the properties of poison', the order of *-ous* and *-ness* can be governed by the semantic scope constraint. That is, *poison* first combines with *-ous* as a unit, which further combines with *-ness*. The semantics of *-ness* is added to that of *poison* and *-ous* as a unit. There remain issues of, for example, how the scope constraint would formally apply in a model that serially builds up a word (cf. Kiparsky 1982) and whether such an application would be better than one in a parallel model.

We have shown that Realization OT is superior to several alternative approaches to affix order and morphology in general. It remains to be seen how widely Realization OT applies, either crosslinguistically or within the whole grammatical architecture. In the past few decades, phonologists have tried to analyze everything related to morphology in the phonological component, we hope to have shown that an autonomous morphological component is indispensable and to have provided linguists with a useful and promising tool for doing morphology.

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