The formal and functional architecture of inflectional morphology[1]

Gregory Stump
University of Kentucky
gstump@uky.edu

> It is the pervading law of all things organic and inorganic, of all things physical and metaphysical, of all things human and all things superhuman, of all true manifestations of the head, of the heart, of the soul, that the life is recognizable in its expression, that form ever follows function. This is the law.
> Architect Louis Sullivan,
> in "The tall office building artistically considered," *Lippincott's Magazine* (March 1896)

1. Introduction

In thinking about the architectural theme of the Eighth Mediterranean Morphology Meeting, I was drawn to the epigraph from Louis Sullivan, one of the pioneers of modernist architecture. Seen from a distance, the architecture of inflectional morphology conforms to Sullivan's law: the function of inflectional morphology is to relate content to form at the level of words, and the overall architecture of the component fits this function. But once we examine the architecture of inflection more closely, it is less clear that form invariably follows function in inflectional morphology. There are mismatches between form and function. In particular, if form straightforwardly followed function, we might expect words that are functionally alike to be expressed in formally identical ways, but this expectation is sometimes disconfirmed: the relation between content and form can be much more complicated. Two words can be alike in their morphosyntactic content but differ in the manner of their formal definition.

Sullivan's law does, however, raise the possibility of distinguishing morphological phenomena according to how closely they adhere to an ideal of optimal functionality. I assume that the most functional inflection is what Corbett (2009) has called canonical inflection. Canonical inflection is a kind of typological extreme relative to which actual inflectional systems can be calibrated. It encompasses both the notion of a canonical inflectional paradigm and the more general notion of a canonical system of inflectional paradigms (for some syntactic category). The characteristics of canonical inflection are paraphrased in (1).

(1)   Canonical inflection (paraphrased from Corbett 2009)

   a. Properties of a canonical inflectional paradigm

   - **Exhaustivity**:   Every compatible combination of the relevant morphosyntactic properties defines a cell.
   - **Completeness**: Every cell has a realization.
   - **Unambiguousness**: All realizations are distinct.
   - **Freedom from stem alternation**: Every realization is based on the same stem.

- **Morphotactic uniformity**: the same morphotactic pattern (e.g. stem+suffix) is used in every realization.

b. Properties of a canonical system of paradigms (for some syntactic category)

- **Parallelism**: All individual paradigms realize the same morphosyntactic property sets and all are canonical.
- **Distinctness**: Distinct paradigms are based on distinct stems and therefore have distinct realizations.
- **Uniformity of exponence**: Across paradigms, the same morphosyntactic property set is expressed by the same exponence.

The paradigm of the Breton inflecting preposition HERVEZ 'according to' in (2a) might be seen as nearly canonical: although it only shows a gender distinction in the 3sg and therefore fails the test of exhaustivity, it passes the tests of completeness, unambiguousness, freedom from stem alternation and morphotactic uniformity. The system of prepositional paradigms in which HERVEZ is embedded is somewhat less canonical; as a class, prepositional paradigms aren't parallel (some involve stem alternation, e.g. those of 'of' and 'against' in (2b)) and there is no uniformity of exponence (for example, 'according to' and 'against' belong to distinct conjugation classes).

(2) The paradigms of four inflecting prepositions in Breton

a.	HERVEZ 'according to'	b.	E 'in'	A 'of'	OUZH 'against'
1sg	*hervez-on*	1sg	*enn-on*	*ac'han-on*	*ouzh-in*
2sg	*hervez-out*	2sg	*enn-out*	*ac'han-out*	*ouzh-it*
3sgm	*hervez-añ*	3sgm	*enn-añ*	*anezh-añ*	*out-añ*
3sgf	*hervez-i*	3sgf	*enn-i*	*anezh-i*	*out-i*
1pl	*hervez-omp*	1pl	*enn-omp*	*ac'han-omp*	*ouzh-imp*
2pl	*hervez-oc'h*	2pl	*enn-oc'h*	*ac'han-oc'h*	*ouzh-oc'h*
3pl	*hervez-o*	3pl	*enn-o*	*anezh-o*	*out-o*

As this example suggests, purely canonical inflection isn't common; most inflectional phenomena are in some manner or other noncanonical, failing to exhibit one or more of the properties in (1).

Here, I wish to discuss an architecture for inflectional morphology that elucidates the ways in which noncanonical inflection deviates from canonical patterns. I begin with a general discussion of the assumed architecture of inflection and how it relates to canonical inflection. I then examine how the various noncanonical inflectional phenomena in (3) are situated with respect to this architecture.

(3) Noncanonical inflectional phenomena
   a. Defectiveness
   b. Syncretism
   c. Deponency
   d. Functor-argument reversal
   e. Suppletion

2. The architecture of content paradigms, form paradigms and paradigm linkage

I begin with the assumption that the purpose of inflectional morphology is to give **phonological** expression to lexeme + property set pairings supplied by the **syntax**. It is

therefore inherently an interface component, and this fact partially determines its formal architecture. But two additional facts are relevant to the details of this architecture. First, words possess grammatical properties to which rules of syntax and semantics are insensitive; these include membership in inflection classes and other morphomic categories. The architecture of inflectional morphology should entail this fact. Second, the same word may have (or may appear to have) distinct morphosyntactic properties for different purposes. Generally, morphosyntactic property sets serve the three purposes in (4):

(4) A word's morphosyntactic property set
    a. constrains its lexical insertion
    b. determines its semantic interpretation
   c. induces the introduction of its inflectional exponents

Yet, some words behave as if the property set serving purpose (4c) is different from the set serving purposes (4a) and (4b); for instance, the Latin deponent verb *hortātur* 's/he urges' has the property set in (5a) for purposes of lexical insertion and semantic interpretation, yet its inflectional exponence instead presumes the property set in (5b).

(5) *hortātur* 's/he urges'
    a. {3sg present indicative active}
    b. {3sg present indicative passive}

The architecture of inflectional morphology should account for this lack of parallelism.

      In view of these considerations, I have argued in recent work (Stump 2002, 2006, 2007; Stewart and Stump 2007) that the architecture of inflection involves two levels of paradigmatic representation, one with syntacticosemantic relevance, the other with morphophonological relevance. On this view, the job of the inflectional rule system is to relate the two sorts of paradigms and to determine their realization. In particular, I assume that the architecture of inflectional morphology has the form in (6); that is, there are three kinds of representations (content cells, form cells, realizations) whose relation to one another is mediated by rules of paradigm linkage and realization rules.

(6) The architecture of inflectional morphology

Cells in content paradigms	← *Rules of paradigm linkage* →	**Cells in form paradigms**	← *Realization rules* →	**Realizations**
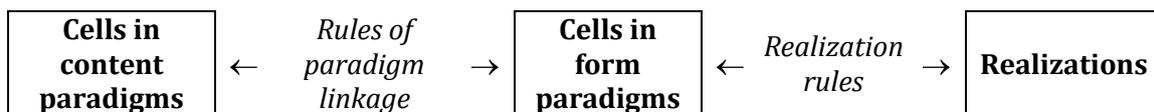
On one hand, lexemes have content paradigms:

(7) a. A lexeme's **content paradigm** is its full inventory of content cells.
      b. A **content cell** for a lexeme L is a pairing ⟨L, σ⟩ of L with a morphosyntactic property set σ with which L may be associated in syntax; thus, the cells in the content paradigm of lexeme L specify the range of syntactic contexts in which L appears.
      c. The content paradigm of the Breton prepositional lexeme HERVEZ 'according to':
            ⟨HERVEZ, {1sg}⟩
            ⟨HERVEZ, {2sg}⟩
            ⟨HERVEZ, {3sgm}⟩
            ⟨HERVEZ, {3sgf}⟩
            ⟨HERVEZ, {1pl}⟩
            ⟨HERVEZ, {2pl}⟩

⟨HERVEZ, {3pl}⟩
d.   Semantic interpretation of ⟨HERVEZ, {3pl}⟩:
$\lambda p \forall x[x \in X_i \rightarrow p \in$ **according-to**$'(x)]$ 'according to them$_i$' (a set of propositions)

A lexeme's content cells determine lexical insertion and semantic interpretation; in particular, the realization of a content cell ⟨L, σ⟩ is insertable in a node specified for the morphosyntactic property set σ, and the content cell determines the semantic interpretation of the resulting structure. For instance, the realization *hervezo* of the content cell ⟨HERVEZ, {3pl}⟩ is insertable in a prepositional node specified as third-person plural, and the content cell entails that the resulting structure will have a semantic interpretation something like (7d).

While lexemes have content paradigms, stems, on the other hand, have form paradigms:

(8)   a.   A stem's **form paradigm** is its full inventory of form cells.
b.   A **form cell** for a stem X is a pairing ⟨X, σ⟩ of X with a set σ of morphosyntactic properties for which X may be inflected; thus, the cells in the form paradigm of stem X specify the range of property sets for which X is inflectable.
c.   **Inflection classes** are seen as properties of stems rather than of lexemes; it is therefore at the level of form paradigms (rather than that of content paradigms) that inflection-class distinctions are made.
d.   The form paradigm of the Breton prepositional stem *hervez*$_{[Cl.1]}$ 'according to' (a member of prepositional inflection class 1):
⟨*hervez*$_{[Cl.1]}$, {1sg}⟩
⟨*hervez*$_{[Cl.1]}$, {2sg}⟩
⟨*hervez*$_{[Cl.1]}$, {3sgm}⟩
⟨*hervez*$_{[Cl.1]}$, {3sgf}⟩
⟨*hervez*$_{[Cl.1]}$, {1pl}⟩
⟨*hervez*$_{[Cl.1]}$, {2pl}⟩
⟨*hervez*$_{[Cl.1]}$, {3pl}⟩

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A stem's form paradigm determines its realization; in particular, realization rules apply to each of a stem's form cells to determine its morphophonological expression. Thus, we might postulate the realization rules in (9) to account for the realization of the form cells in (8d); the resulting realizations are as in (2).

(9)	Realization rules for Breton prepositions (Class 1)		Form cell		Realization
		a.	⟨X$_{[Cl.1]}$, {1sg}⟩	→	X*on*
		b.	⟨X$_{[Cl.1]}$, {2sg}⟩	→	X*out*
		c.	⟨X, {3sgm}⟩	→	X*añ*
		d.	⟨X, {3sgf}⟩	→	X*i*
		e.	⟨X$_{[Cl.1]}$, {1pl}⟩	→	X*omp*
		f.	⟨X, {2pl}⟩	→	X*oc'h*
		g.	⟨X, {3pl}⟩	→	X*o*

Content cells also have realizations; a content cell acquires its realization not directly (by means of realization rules), but indirectly—by association with a form cell and hence with its realization. The form cell with which a content cell is associated is its **form correspondent**. Thus, each of the cells in the content paradigm of the lexeme HERVEZ has, as its form correspondent, a cell in the form paradigm of the stem *hervez*$_{[Cl.1]}$, as in (10); each content cell shares the realization of its form correspondent.

(10) Correspondences between the content paradigm of HERVEZ and the form paradigm of *hervez*[Cl.1]

Content cell	Form correspondent	Shared realization
⟨HERVEZ, {1sg}⟩	⟨*hervez*[Cl.1], {1sg}⟩	*hervezon*
⟨HERVEZ, {2sg}⟩	⟨*hervez*[Cl.1], {2sg}⟩	*hervezout*
⟨HERVEZ, {3sgm}⟩	⟨*hervez*[Cl.1], {3sgm}⟩	*hervezañ*
⟨HERVEZ, {3sgf}⟩	⟨*hervez*[Cl.1], {3sgf}⟩	*hervezi*
⟨HERVEZ, {1pl}⟩	⟨*hervez*[Cl.1], {1pl}⟩	*hervezomp*
⟨HERVEZ, {2pl}⟩	⟨*hervez*[Cl.1], {2pl}⟩	*hervezoc'h*
⟨HERVEZ, {3pl}⟩	⟨*hervez*[Cl.1], {3pl}⟩	*hervezo*

The association of a content cell with its form correspondent is in general specified by a **rule of paradigm linkage**. Such associations are ordinarily effected by means of the universal default rule of paradigm linkage in (11).

(11) The universal default rule of paradigm linkage
Given a lexeme L having X as its σ-stem, the content cell ⟨L, σ⟩ has the form cell ⟨X, σ⟩ as its form correspondent.

Thus, given that the lexeme HERVEZ has *hervez*[Cl.1] as its sole stem (as in (12)), (11) entails that all of the correspondences in (10) will hold by default.

(12) Stem specification for Breton HERVEZ 'according to'
Given any relevant morphosyntactic property set σ, the lexeme HERVEZ has *hervez*[Cl.1] as its σ-stem.

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In the definition of canonical paradigms, the default rule in (11) induces instances of paradigm linkage possessing the four characteristics in (13); extending Corbett's typology, I propose that these be regarded as the properties of canonical paradigm linkage.

(13) Canonical paradigm linkage
    a. The relation between a lexeme's content cells and their form correspondents is a total function, i.e. every content cell has a form correspondent.
    b. All of a lexeme's form correspondents share the same stem, i.e. all are drawn from the same form paradigm.
    c. The relation between content cells and their form correspondents is one-to-one rather than many-to-one, i.e. there is no sharing of form correspondents.
    d. A content cell's form correspondent is morphosyntactically faithful to it, i.e. it carries the same morphosyntactic property set.

Together, these properties characterize the canonical pattern of paradigm linkage schematized in (14).

(14) Canonical paradigm linkage

Content cell	Form correspondent
⟨L, σ⟩	⟨X, σ⟩
⟨L, τ⟩	⟨X, τ⟩

If all inflection were purely canonical, the assumption that inflection involves both content paradigms and form paradigms might seem unnecessarily complicated; one

might, for example, propose to eliminate any need for form paradigms (and hence any need for the rule of paradigm linkage in (11)) by formulating the realization rules in (9) directly in terms of content cells rather than in terms of form cells. But once one begins looking at a wider array of inflectional phenomena, the need to distinguish between content paradigms and form paradigms becomes apparent. In particular, there is a range of noncanonical inflectional phenomena involving overrides of the canonical pattern of paradigm linkage in (14).

Instances of paradigm linkage in noncanonical inflection lack one or more of the characteristics in (13), either because the default rule of paradigm linkage cannot apply, or because the application of the default rule of paradigm linkage is overridden by that of a language-specific rule of paradigm linkage, or because the default rule of paradigm linkage itself draws a lexeme's form correspondents from more than one form paradigm. I examine these various deviations from the canonical ideal in the inflectional morphology of the five phenomena in (3) (repeated here as (15)), each of which defines its own pattern of paradigm linkage.

(15) Inflectional phenomena with noncanonical paradigm linkage
    a.   Defectiveness
    b.   Syncretism
    c.   Deponency
    d.   Functor-argument reversal
    e.   Suppletion

3. Deviations from canonical paradigm linkage

3.1. Defectiveness: lack of a form correspondent

One sort of noncanonical inflection is defectiveness. In the architecture proposed here, a defective lexeme has a content paradigm some of whose cells lack form correspondents (and hence realizations); this pattern of paradigm linkage is schematized in (16). An example is the Latin verb COEPISSE 'begin', which has perfect-system forms (perfect, pluperfect and future perfect) but no present-system forms (present, imperfect and future); the partial paradigm in (17) illustrates. This inflectional peculiarity can be attributed to the absence of a present-system stem in the stem specifications for COEPISSE, as in (18). If there is no present-system stem, then the default rule of paradigm linkage cannot apply to the present-system cells in COEPISSE's content paradigm, leaving these cells without form correspondents and therefore without realizations, as in (19).

(16)   Defective paradigm linkage   Cf. Canonical paradigm linkage

Content cell	Form correspondent		Content cell	Form correspondent
$\langle L, \sigma \rangle$	$\langle X, \sigma \rangle$		$\langle L, \sigma \rangle$	$\langle X, \sigma \rangle$
$\langle L, \tau \rangle$	—		$\langle L, \tau \rangle$	$\langle X, \tau \rangle$

(17)   The defective inflection of Latin COEPISSE 'begin'

	Present	Perfect
1sg	—	*coepī*
2sg	—	*coepistī*
3sg	—	*coepit*
1pl	—	*coepimus*
2pl	—	*coepistis*
3pl	—	*coepērunt*

(18)   Stem specifications for the Latin verb COEPISSE 'begin'

Given any perfect-system (i.e. perfect, pluperfect or future perfect) property set σ, the lexeme COEPISSE has *coep* as its σ-stem.

Given any present-system (i.e. present, imperfect or future) property set σ, COEPISSE lacks a σ-stem.

(19)   The content paradigm and form correspondents of Latin COEPISSE 'begin'

Content paradigm	Form correspondents	Shared realization
⟨COEPISSE, {1sg pres indic act}⟩	—	—
⟨COEPISSE, {2sg pres indic act}⟩	—	—
⟨COEPISSE, {3sg pres indic act}⟩	—	—
⟨COEPISSE, {1pl pres indic act}⟩	—	—
⟨COEPISSE, {2pl pres indic act}⟩	—	—
⟨COEPISSE, {3pl pres indic act}⟩	—	—
⟨COEPISSE, {1sg perf indic act}⟩	⟨*coep*, {1sg perf indic act}⟩	*coepī*
⟨COEPISSE, {2sg perf indic act}⟩	⟨*coep*, {2sg perf indic act}⟩	*coepistī*
⟨COEPISSE, {3sg perf indic act}⟩	⟨*coep*, {3sg perf indic act}⟩	*coepit*
⟨COEPISSE, {1pl perf indic act}⟩	⟨*coep*, {1pl perf indic act}⟩	*coepimus*
⟨COEPISSE, {2pl perf indic act}⟩	⟨*coep*, {2pl perf indic act}⟩	*coepistis*
⟨COEPISSE, {3pl perf indic act}⟩	⟨*coep*, {3pl perf indic act}⟩	*coepērunt*
etc.	etc.	etc.

Thus, one sort of noncanonical inflection involves lexemes whose stem specifications are incomplete; the relation between such a lexeme's content cells and their form correspondents is merely a partial function.

3.2. Syncretism: shared form correspondents

In other instances of noncanonical inflection, the default rule of paradigm linkage is applicable, but its application is overridden by a language-specific rule of paradigm linkage. Instances of syncretism involve overrides of this sort. In syncretism, distinct cells in the same content paradigm are realized by the same form cell; this pattern of paradigm linkage is schematized in (20) and (21). Consider, for example, the forms of the Latin noun BELLUM 'war', given in (22); these forms are all based on the stem *bell* specified in (23). There are two instances of syncretism among these forms. BELLUM is a neuter noun, and therefore participates in a general pattern in Latin, in which a neuter noun's nominative forms are always identical to their accusative counterparts; this is a directional syncretism, in the sense that the nominative seems to pattern after the accusative, at least in the singular. In addition, the forms of BELLUM reflect a default pattern of syncretism between the dative and the ablative; this is a nondirectional syncretism. In the proposed architecture of inflectional morphology, these instances of syncretism are accounted for by the special rules of paradigm linkage in (24) and (25), which cause certain content cells to have the same form correspondent and hence the same realization, as in (26).

(20)   Syncretic paradigm linkage (directional)

Content cell	Form correspondent
⟨L, σ⟩	⟨X, σ⟩
⟨L, τ⟩	

(21)   Syncretic paradigm linkage (nondirectional)   Cf. Canonical paradigm linkage

Content cell	Form correspondent
⟨L, σ⟩	⟨X, σ/τ⟩
⟨L, τ⟩	

Content cell	Form correspondent
⟨L, σ⟩	⟨X, σ⟩
⟨L, τ⟩	⟨X, τ⟩

(22)   The inflection of Latin BELLUM (neut.) 'war'

	Singular	Plural
Nom	*bellum*	*bella*
Gen	*bellī*	*bellōrum*
Dat	*bellō*	*bellīs*
Acc	*bellum*	*bella*
Abl	*bellō*	*bellīs*

(23)   Stem specification for Latin BELLUM 'war'
        For any case/number property set σ, the lexeme BELLUM has *bell* as its σ-stem.

(24)   Special rule of paradigm linkage for neuter nouns
        Where σ = {acc Y} and L is a neuter noun with σ-stem X,
        the content cell ⟨L, {nom Y}⟩ has ⟨X, σ⟩ as its form correspondent.

(25)   Special default rule of paradigm linkage for dative/ablative forms
        Where σ = {dat Y} or {abl Y} and L is a noun with σ-stem X, the content cell ⟨L, σ⟩
        has ⟨X, {dat/abl Y}⟩ as its form correspondent.

(26)   The content paradigm and form correspondents of Latin BELLUM 'war' (neut.)

Content paradigm	Form correspondents	Shared realization
⟨BELLUM, {nom sg}⟩ ⟨BELLUM, {acc sg}⟩	⟨*bell*, {acc sg}⟩	*bellum*
⟨BELLUM, {gen sg}⟩	⟨*bell*, {gen sg}⟩	*bellī*
⟨BELLUM, {dat sg}⟩ ⟨BELLUM, {abl sg}⟩	⟨*bell*, {dat/abl sg}⟩	*bellō*
⟨BELLUM, {nom pl}⟩ ⟨BELLUM, {acc pl}⟩	⟨*bell*, {acc pl}⟩	*bella*
⟨BELLUM, {gen pl}⟩	⟨*bell*, {gen pl}⟩	*bellōrum*
⟨BELLUM, {dat pl}⟩ ⟨BELLUM, {abl pl}⟩	⟨*bell*, {dat/abl pl}⟩	*bellīs*

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3.3. Other morphosyntactically unfaithful form correspondents

3.3.1. Deponency

Another sort of override of the default rule of paradigm linkage is that of deponency, in which form correspondents have seemingly set aside their association with the expected content cells. This pattern of paradigm linkage is schematized in (27). In Latin, for example, many verbs have both active and passive forms, e.g. LAUDĀRE 'praise', *laudat* 's/he praises', *laudātur* 's/he is praised'. Deponent verbs, however, are different: in finite contexts, they are only used in the active voice; yet, they have the form of passives.[2] Thus, only the active cells in the finite content paradigm of the deponent verb HORTĀRĪ 'urge' have form correspondents, yet these form correspondents are specified for passive rather than active morphology. The examples in (28) illustrate.

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[2] The participial forms of a deponent verb add an extra dimension of complexity: as with nondeponent verbs, a deponent verb's present and future participles are active in both form and meaning, and its gerundive, passive in both form and meaning. The properties of these participial forms are not at issue here.

(27) Deponent paradigm linkage

Content cell	Form correspondent
$\langle L, \sigma \rangle$	$\langle X, \tau \rangle$
$\langle L, \tau \rangle$	—

Cf. Canonical paradigm linkage

Content cell	Form correspondent
$\langle L, \sigma \rangle$	$\langle X, \sigma \rangle$
$\langle L, \tau \rangle$	$\langle X, \tau \rangle$

(28)   The present indicative inflection of Latin LAUDĀRE 'praise' and HORTĀRĪ 'urge'

LAUDARE 'praise'		HORTARI 'urge'	
Active	Passive	Active	Passive
laudō	*laudor*	*hortor*	—
laudās	*laudāris*	*hortāris*	—
laudat	*laudātur*	*hortātur*	—
laudāmus	*laudāmur*	*hortāmur*	—
laudātis	*laudāminī*	*hortāminī*	—
laudant	*laudantur*	*hortantur*	—

These peculiarities of deponent verbs are accounted for by the special rule of paradigm linkage in (29) together with stem specifications such as those in (30a): the rule of paradigm linkage in (29) causes a deponent verb's active content cells to have passive form correspondents; stem specifications such as (30a) cause a deponent verb's passive content cells to lack form correspondents. Thus, assuming the additional stem specification in (30b), (29) and (30) together induce the patterns of paradigm linkage exemplified in (31).[3]

(29) Special rule of paradigm linkage for deponents
      Where σ is a finite active property set with τ as its passive counterpart and L is a deponent verb with τ-stem X, the content cell $\langle L, \sigma \rangle$ has $\langle X, \tau \rangle$ as its form correspondent.

(30) Stem specifications for Latin HORTĀRĪ 'urge' and LAUDĀRE 'praise'
      a.   Given any finite passive property set σ, the lexeme HORTĀRĪ has *hortā* as its σ-stem.
            Given any finite active property set σ, the lexeme HORTĀRĪ lacks a σ-stem.
      b.   Given any property set σ, the lexeme LAUDĀRE has *laudā* as its σ-stem.

(31) The content paradigms and form correspondents of Latin LAUDĀRE 'praise' and HORTĀRĪ 'urge'

Content paradigm	Form correspondents	Shared realization
$\langle$LAUDĀRE, {1sg pres indic act}$\rangle$	$\langle$*laudā*, {1sg pres indic act}$\rangle$	*laudō*
$\langle$LAUDĀRE, {2sg pres indic act}$\rangle$	$\langle$*laudā*, {2sg pres indic act}$\rangle$	*laudās*

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[3] In Latin, the finite perfect passive forms of a nondeponent verbal lexeme L are periphrastic, consisting of an active present-system form of the auxiliary verb ESSE 'be' and a nominative form of L's perfect passive participle. Adopting the approach to inflectional periphrasis proposed by Bonami & Webelhuth (2010), I assume that in Latin, a nondeponent verbal lexeme L's finite perfect passive realizations are forms of ESSE that require a perfect passive participial form of L as a complement. In formal terms: where τ_1 is a passive perfect-system property set with τ_2 as its active present-system counterpart and X is the τ_1-stem of a verbal lexeme L, a rule of referral causes the realization of the form cell $\langle X, \tau_1 \rangle$ to be that of $\langle es, \tau_2 \rangle$, and this realization takes L's perfect passive participle as a complement. This analysis correctly entails that the perfect active cells in a deponent verb's content paradigm will have the same periphrastic expression as the perfect passive cells of a nondeponent verb's content paradigm.

⟨LAUDĀRE, {3sg pres indic act}⟩	⟨*laudā*, {3sg pres indic act}⟩	*laudat*
⟨LAUDĀRE, {1sg pres indic pass}⟩	⟨*laudā*, {1sg pres indic pass}⟩	*laudor*
⟨LAUDĀRE, {2sg pres indic pass}⟩	⟨*laudā*, {2sg pres indic pass}⟩	*laudāris*
⟨LAUDĀRE, {3sg pres indic pass}⟩	⟨*laudā*, {3sg pres indic pass}⟩	*laudātur*
etc.	etc.	etc.
⟨HORTĀRĪ, {1sg pres indic act}⟩	⟨*hortā*, {1sg pres indic pass}⟩	*hortor*
⟨HORTĀRĪ, {2sg pres indic act}⟩	⟨*hortā*, {2sg pres indic pass}⟩	*hortāris*
⟨HORTĀRĪ, {3sg pres indic act}⟩	⟨*hortā*, {3sg pres indic pass}⟩	*hortātur*
⟨HORTĀRĪ, {1sg pres indic pass}⟩	—	—
⟨HORTĀRĪ, {2sg pres indic pass}⟩	—	—
⟨HORTĀRĪ, {3sg pres indic pass}⟩	—	—
etc.	etc.	etc.

3.3.3. Functor-argument reversal

A final kind of override of the default rule of paradigm linkage arises in instances of what Spencer & Stump 2011 call functor-argument reversal. This phenomenon, schematized in (32), is dramatically exemplified by Hungarian pronominal case forms. In Hungarian, nouns exhibit possessor marking, as in (33).

(32) Paradigm linkage with functor-argument reversal

Content cell	Form correspondent
⟨L, σ⟩	⟨*f*(σ), *g*(L)⟩

(33) Possessor marking on two Hungarian nouns (in the nominative)

Possessor	KÖNYV 'book' Possessee		HAZ 'house' Possessee	
	Singular	Plural	Singular	Plural
1sg	*könyv-e-m*	*könyv-e-i-m*	*ház-a-m*	*ház-a-i-m*
2sg	*könyv-e-d*	*könyv-e-i-d*	*ház-a-d*	*ház-a-i-d*
3sg	*könyv-e*	*könyv-e-i*	*ház-a*	*ház-a-i*
1pl	*könyv-ünk*	*könyv-e-i-nk*	*ház-unk*	*ház-a-i-nk*
2pl	*könyv-e-tek*	*könyv-e-i-tek*	*ház-a-tok*	*ház-a-i-tok*
3pl	*könyv-ük*	*könyv-e-i-k*	*ház-uk*	*ház-a-i-k*

This same morphology is used to express pronominal objects of postpositions, as in (34).

(34) Object-agreement paradigm of the Hungarian postposition MÖGÖTT 'behind'

mögött-e-m	'behind me'
mögött-e-d	'behind you (sg.)'
mögött-e	'behind her/him'
mögött-ünk	'behind us'
mögött-e-tek	'behind you (pl.)'
mögött-ük	'behind them'

In the Hungarian case system, case is marked suffixally on nouns, with the nominative case being unmarked; the nouns in (35) illustrate.

(35) Case forms of two Hungarian nouns

Case	KÖNYV 'book'		HAZ 'house'		Gloss
	Singular	Plural	Singular	Plural	
Nominative	*könyv*	*könyv-e-k*	*ház*	*ház-a-k*	(subject)
Accusative	*könyv-e-t*	*könyv-e-k-e-t*	*ház-a-t*	*ház-a-k-a-t*	(direct object)

Dative	*könyv-nek*	*könyv-e-k-nek*	*ház-nak*	*ház-a-k-nak*	(indirect object)
Inessive	*könyv-ben*	*könyv-ek-ben*	*ház-ban*	*ház-ak-ban*	'in a book …'
Illative	*könyv-be*	*könyv-ek-be*	*ház-ba*	*ház-ak-ba*	'into a book …'
Elative	*könyv-ből*	*könyv-ek-ből*	*ház-ból*	*ház-ak-ból*	'from inside of a book …'
Superessive	*könyv-ön*	*könyv-ek-en*	*ház-on*	*ház-ak-on*	'on a book …'
Sublative	*könyv-re*	*könyv-ek-re*	*ház-ra*	*ház-ak-ra*	'onto a book …'
Delative	*könyv-ről*	*könyv-ek-ről*	*ház-ról*	*ház-ak-ról*	'from the surface of a book …'
Adessive	*könyv-nél*	*könyv-ek-nél*	*ház-nál*	*ház-ak-nál*	'at a book …'
Allative	*könyv-höz*	*könyv-ek-hez*	*ház-hoz*	*ház-ak-hoz*	'towards a book …'
Ablative	*könyv-től*	*könyv-ek-től*	*ház-tól*	*ház-ak-tól*	'from (near) a book …'
Instrumental	*könyv-vel*	*könyv-ek-kel*	*ház-zal*	*ház-ak-kal*	'with a book …'
Causal-final	*könyv-ért*	*könyv-ek-ért*	*ház-ért*	*ház-ak-ért*	'as a book …'
Translative	*könyv-vé*	*könyv-ek-ké*	*ház-zá*	*ház-ak-ká*	'(change) into a book …'
Terminative	*könyv-ig*	*könyv-ek-ig*	*ház-ig*	*ház-ak-ig*	'up to a book …'
Essive-formal	*könyv-ként*	*könyv-ek-ként*	*ház-ként*	*ház-ak-ként*	'in the capacity of a book …'
Essive	*könyv-ül*	—	*ház-ul*	—	'in the capacity of a book …'

In the direct cases, pronouns exhibit a similar sort of inflection. In the oblique cases, however, pronominal case is expressed by case postpositions inflected for person and number, as in (36).

(36)   Case forms of Hungarian personal pronouns

		First person	Second person	Third person
Singular	nominative	*én*	*te*	*ő*
	accusative	*engem(et)*	*téged(et)*	*őt*
	dative	*nek-e-m*	*nek-e-d*	*nek-i*
	inessive	*benn-e-m*	*benn-e-d*	*benn-e*
	illative	*bel-é-m*	*bel-é-d*	*bel-e, bel-é(-je)*
	elative	*belől-e-m*	*belől-e-d*	*belől-e*
	superessive	*rajt-a-m*	*rajt-a-d*	*rajt-a*
	sublative	*rá-m*	*rá-d*	*rá(-ja)*
	delative	*ról-a-m*	*ról-a-d*	*ról-a*
	adessive	*nál-a-m*	*nál-a-d*	*nál-a*
	allative	*hozz-á-m*	*hozz-á-d*	*hozz-á(-ja)*
	ablative	*től-e-m*	*től-e-d*	*től-e*
	instrumental	*vel-e-m*	*vel-e-d*	*vel-e*
	causal-final	*ért-e-m*	*ért-e-d*	*ért-e*
Plural	nominative	*mi*	*ti*	*ők*
	accusative	*minket ~ bennünket*	*titeket ~ benneteket*	*őket*
	dative	*nek-ünk*	*nek-tek*	*nek-i-k*
	inessive	*benn-ünk*	*benn-e-tek*	*benn-ük*
	illative	*bel-é-nk*	*bel-é-tek*	*bel-é-jük*
	elative	*belől-ünk*	*belől-e-tek*	*belől-ük*
	superessive	*rajt-unk*	*rajt-a-tok*	*rajt-uk*
	sublative	*rá-nk*	*rá-tok*	*rá-juk*
	delative	*ról-unk*	*ról-a-tok*	*ról-uk*
	adessive	*nál-unk*	*nál-a-tok*	*nál-uk*
	allative	*hozz-á-nk*	*hozz-á-tok*	*hozz-á-juk*
	ablative	*től-ünk*	*től-e-tek*	*től-ük*
	instrumental	*vel-ünk*	*vel-e-tek*	*vel-ük*
	causal-final	*ért-ünk*	*ért-e-tek*	*ért-ük*

Thus, the inflection of pronominal case in Hungarian involves a kind of functor-argument reversal. This pattern of paradigm linkage is accounted for by the special rule in (37). To a content cell consisting of a pronominal lexeme paired with an oblique case property,

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rule (37) assigns a form correspondent consisting of the appropriate case stem paired with the appropriate set of pronominal properties; in this way, rule (37) defines instances of paradigm linkage such as those in (38). In (38), the inessive case of the first-person singular lexeme ÉN is inflected as the first-person singular form of the inessive stem *benn*; similarly, the superessive case of the first-person singular lexeme ÉN is inflected as the first-person singular form of the superessive stem *rajt*; and so on.

(37) Rule of paradigm linkage for oblique pronominal case forms
If L is a pronominal lexeme expressing person a and number b and X is a postpositional stem expressing oblique case c, the content cell ⟨L, {c}⟩ has ⟨X, {a b}⟩ as its form correspondent.

(38) The content paradigm and form correspondents of the Hungarian 1sg pronoun ÉN

Content paradigm	Form correspondents	Shared realization
⟨EN, {nominative}⟩	⟨*én*, {nominative}⟩	*én*
⟨EN, {accusative}⟩	⟨*én*, {accusative}⟩	*engem(et)*
⟨EN, {dative}⟩	⟨*nek*, {1sg}⟩	*nekem*
⟨EN, {inessive}⟩	⟨*benn*, {1sg}⟩	*bennem*
⟨EN, {illative}⟩	⟨*bel*, {1sg}⟩	*belém*
⟨EN, {elative}⟩	⟨*belől*, {1sg}⟩	*belőlem*
⟨EN, {superessive}⟩	⟨*rajt*, {1sg}⟩	*rajtam*
⟨EN, {sublative}⟩	⟨*rá*, {1sg}⟩	*rám*
⟨EN, {delative}⟩	⟨*ról*, {1sg}⟩	*rólam*
⟨EN, {adessive}⟩	⟨*nál*, {1sg}⟩	*nálam*
⟨EN, {allative}⟩	⟨*hozz*, {1sg}⟩	*hozzám*
⟨EN, {ablative}⟩	⟨*től*, {1sg}⟩	*tőlem*
⟨EN, {instrumental}⟩	⟨*vel*, {1sg}⟩	*velem*
⟨EN, {causal-final}⟩	⟨*ért*, {1sg}⟩	*értem*

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Summarizing, the default rule of paradigm linkage may be overridden in instances of syncretism, deponency, and functor-argument reversal; each of these defines its own particular pattern of override, as in (39).

(39) Overrides of the default rule of paradigm linkage

Where L is a lexeme with stem X and σ, σ′ are distinct morphosyntactic property sets associated with L,

a.	L's inflection exhibits SYNCRETISM:	⟨L, σ⟩ and ⟨L, σ′⟩ have the same form correspondent.
b.	L's inflection is DEPONENT:	⟨X, σ′⟩ is the form correspondent of ⟨L, σ⟩ rather than of ⟨L, σ′⟩.
c.	L's inflection exhibits FUNCTOR-ARGUMENT REVERSAL:	the form correspondent of ⟨L, σ⟩ is ⟨*f*(σ), *g*(L)⟩.

3.4. Suppletion: form correspondents drawn from distinct form paradigms

A final noncanonical pattern of paradigm linkage arises in the inflection of lexemes exhibiting stem suppletion. In instances of suppletion, the cells in a lexeme's content paradigm have form correspondents based on two (or more) arbitrarily different stems; this pattern of paradigm linkage is schematized in (40). In Latin, for example, present-system cells in the content paradigm of the lexeme FERRE 'carry' have form

correspondents based on the stem *fer*; but the perfect-system cells in this content paradigm have form correspondents based on the stem *tul*. The examples in (41) illustrate.

(40) Suppletive paradigm linkage   Cf. Canonical paradigm linkage

Content cell	Form correspondent
$\langle L, \sigma \rangle$	$\langle X_1, \sigma \rangle$
$\langle L, \tau \rangle$	$\langle X_2, \tau \rangle$

Content cell	Form correspondent
$\langle L, \sigma \rangle$	$\langle X, \sigma \rangle$
$\langle L, \tau \rangle$	$\langle X, \tau \rangle$

(41) The suppletive inflection of Latin FERRE 'carry'

	Present	Perfect
1sg	*ferō*	*tulī*
2sg	*fers*	*tulistī*
3sg	*fert*	*tulit*
1pl	*ferimus*	*tulimus*
2pl	*fertis*	*tulistis*
3pl	*ferunt*	*tulērunt*

In the proposed architecture for inflectional morphology, this suppletive pattern of paradigm linkage arises not because of any override of the default rule of paradigm linkage, but simply because the stem specifications for FERRE give two suppletive stems in complementary distribution, as in (42). Given these specifications, the default rule of paradigm linkage produces the patterns of correspondence exemplified in (43).

(42) Stem specifications for Latin FERRE 'carry'
Given any present-system (i.e. present, imperfect or future) property set σ, the lexeme FERRE has *fer*[Third conjugation] as its σ-stem.
Given any perfect-system (i.e. perfect, pluperfect or future perfect) property set σ, the lexeme FERRE has *tul* as its σ-stem.

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(43) The content paradigm and form correspondents of Latin FERRE 'carry'

Content paradigm	Form correspondents	Shared realization
$\langle$FERRE, {1sg pres indic act}$\rangle$	$\langle$*fer*, {1sg pres indic act}$\rangle$	*ferō*
$\langle$FERRE, {2sg pres indic act}$\rangle$	$\langle$*fer*, {2sg pres indic act}$\rangle$	*fers*
$\langle$FERRE, {3sg pres indic act}$\rangle$	$\langle$*fer*, {3sg pres indic act}$\rangle$	*fert*
$\langle$FERRE, {1pl pres indic act}$\rangle$	$\langle$*fer*, {1pl pres indic act}$\rangle$	*ferimus*
$\langle$FERRE, {2pl pres indic act}$\rangle$	$\langle$*fer*, {2pl pres indic act}$\rangle$	*fertis*
$\langle$FERRE, {3pl pres indic act}$\rangle$	$\langle$*fer*, {3pl pres indic act}$\rangle$	*ferunt*
$\langle$FERRE, {1sg perf indic act}$\rangle$	$\langle$*tul*, {1sg perf indic act}$\rangle$	*tulī*
$\langle$FERRE, {2sg perf indic act}$\rangle$	$\langle$*tul*, {2sg perf indic act}$\rangle$	*tulistī*
$\langle$FERRE, {3sg perf indic act}$\rangle$	$\langle$*tul*, {3sg perf indic act}$\rangle$	*tulit*
$\langle$FERRE, {1pl perf indic act}$\rangle$	$\langle$*tul*, {1pl perf indic act}$\rangle$	*tulimus*
$\langle$FERRE, {2pl perf indic act}$\rangle$	$\langle$*tul*, {2pl perf indic act}$\rangle$	*tulistis*
$\langle$FERRE, {3pl perf indic act}$\rangle$	$\langle$*tul*, {3pl perf indic act}$\rangle$	*tulērunt*
etc.	etc.	etc.

The various noncanonical patterns of paradigm linkage are not mutually exclusive; complex noncanonical patterns may arise. For example, suppletion and deponency coincide in the inflection of Old Icelandic preterite-present verbs. They are deponent in that they form their present tense as a strong verb ordinarily forms its past tense; they are suppletive in that they form their past tense with a separate, weak stem. The examples of ÞURFA 'need' in (44) illustrate. These forms imply the pattern of paradigm linkage schematized in (45) and exemplified in (46).

(44)   Indicative and subjunctive paradigms of three Old Icelandic verbs
(Shaded forms of ÞURFA inflect like shaded forms of BRENNA;
heavy-bordered boxes enclose forms of ÞURFA and DUGA that inflect alike.)

				Strong BRENNA 'burn'	Preterite-Present ÞURFA 'need'	Weak DUGA 'help'
Indicative	Pres.	Sg.	1	*brenn*	*þarf*	*dug-i*
			2	*brenn-r*	*þarf-t*	*dug-ir*
			3	*brenn-r*	*þarf*	*dug-ir*
		Pl.	1	*brenn-um*	*þurf-um*	*dug-um*
			2	*brenn-ið*	*þurf-uð*	*dug-ið*
			3	*brenn-a*	*þurf-u*	*dug-a*
	Past	Sg.	1	*brann*	*þurf-ta*	*dug-ða*
			2	*brann-t*	*þurf-tir*	*dug-ðir*
			3	*brann*	*þurf-ti*	*dug-ði*
		Pl.	1	*brunn-um*	*þurf-tum*	*dug-ðum*
			2	*brunn-uð*	*þurf-tuð*	*dug-ðuð*
			3	*brunn-u*	*þurf-tu*	*dug-ðu*
Subjunctive	Pres.	Sg.	1	*brenn-a*	*þurf-a*	*dug-a*
			2	*brenn-ir*	*þurf-ir*	*dug-ir*
			3	*brenn-i*	*þurf-i*	*dug-i*
		Pl.	1	*brenn-im*	*þurf-im*	*dug-im*
			2	*brenn-ið*	*þurf-ið*	*dug-ið*
			3	*brenn-i*	*þurf-i*	*dug-i*
	Past	Sg.	1	*brynn-a*	*þyrf-ta*	*dyg-ða*
			2	*brynn-ir*	*þyrf-tir*	*dyg-ðir*
			3	*brynn-i*	*þyrf-ti*	*dyg-ði*
		Pl.	1	*brynn-im*	*þyrf-tim*	*dyg-ðim*
			2	*brynn-ið*	*þyrf-tið*	*dyg-ðið*
			3	*brynn-i*	*þyrf-ti*	*dyg-ði*

Source: Zoëga 1910.

(45)   Paradigm linkage with deponency plus suppletion

Content cell	Form correspondent
⟨L, σ⟩	⟨X₁, τ⟩
⟨L, τ⟩	⟨X₂, τ⟩

Cf. Canonical paradigm linkage

Content cell	Form correspondent
⟨L, σ⟩	⟨X, σ⟩
⟨L, τ⟩	⟨X, τ⟩

(46)   The content paradigm and form correspondents of the Old Icelandic preterite-present verb ÞURFA 'need'

Content paradigm	Form correspondents	Shared realization
⟨ÞURFA, {1sg pres indic}⟩	⟨*þarf*[Strong], {1sg past indic}⟩	*þarf*
⟨ÞURFA, {2sg pres indic}⟩	⟨*þarf*[Strong], {2sg past indic}⟩	*þarft*
⟨ÞURFA, {3sg pres indic}⟩	⟨*þarf*[Strong], {3sg past indic}⟩	*þarf*
etc.	etc.	etc.
⟨ÞURFA, {1sg past indic}⟩	⟨*þurf*[Weak], {1sg past indic}⟩	*þurfta*
⟨ÞURFA, {2sg past indic}⟩	⟨*þurf*[Weak], {2sg past indic}⟩	*þurftir*
⟨ÞURFA, {3sg past indic}⟩	⟨*þurf*[Weak], {3sg past indic}⟩	*þurfti*
etc.	etc.	etc.

4. Discussion

The proposed architecture of inflection has several important consequences. It clarifies the difference between morphological properties that have syntactic relevance (e.g. properties of case, tense, etc.) and purely morphological properties (e.g. properties of inflection-class membership): while the former are represented in both content paradigms and form paradigms, the latter are restricted to form paradigms. This means that because content cells are the interface of inflectional morphology with syntax and semantics, a word's syntax and semantics are invariably insensitive to its inflection-class membership.

Because the proposed architecture allows a content cell to have a different morphosyntactic property set from its form correspondent, it correctly entails that a word can have different morphosyntactic property sets for different purposes; specifically, it allows the morphosyntactic property set that determines exponence to differ from the set that determines lexical insertion and semantic interpretation.

The proposed architecture provides an explicit account of how canonical and noncanonical inflection differ: the former conforms to the canonical pattern of paradigm linkage in (14), while the latter invariably deviates from this pattern. The details of this distinction can be articulated in terms of the relation between content cells and form cells, as in (47).

(47) Relations between content cells and form cells

	Canonical inflection	Noncanonical inflection
The relation of a lexeme's content cells to their form correspondents	is a total function [every content cell has a form correspondent]	may be a partial function (as in cases of defectiveness)
	has a single form paradigm as its range	may have many form paradigms in its range (as in cases of suppletion)
	is one-to-one [each content cell has a form correspondent entirely to itself]	may be many-to-one (as in cases of syncretism) [sharing]
A content cell's form correspondent	is morphosyntactically faithful	may not be faithful (as in cases of deponency, functor-argument reversal and directional syncretism)

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Finally, the proposed architecture implies the existence of virtual cells—that is, form cells that aren't form correspondents. The realization rules define virtual realizations for these cells. These virtual realizations may emerge as "exploratory expressions" (cf. (48)) in language change. Consider, for example, the case of the Latin deponent verb HORTĀRĪ 'urge'. In Classical Latin, the active form cells in (49) are merely virtual; even so, they serve as the basis for the active realizations in (50). These too are merely virtual, since they don't serve as the realization of any content cell. In late Latin, active forms of this verb begin to appear, as in (51) and (52) (Hippisley 2010). Assuming the present architecture, such forms existed "all along" as virtual realizations of form cells that didn't serve as form correspondents for any content cell. Their emergence is not the result of adding any new rules nor of changing any existing rules; rather, it is the inevitable effect of simply suppressing an override of the default rule of paradigm linkage.

(48) By **exploratory expressions** we mean expressions which are introduced through the ordinary operation of the grammar and which "catch on" and become fixed expressions and eventually are grammaticalized. [...] It appears that most initial exploratory expressions are made by applying the rules of grammar in a regular way, but it may be that some perhaps also involve ignoring (breaking) existing rules of grammar. (Harris & Campbell 1995: 73)

(49)   Imperfect indicative form paradigm of *hortā*

Active (virtual)	Passive
⟨*hortā*, {1sg impf indic act}⟩	⟨*hortā*, {1sg impf indic pass}⟩
⟨*hortā*, {2sg impf indic act}⟩	⟨*hortā*, {2sg impf indic pass}⟩
⟨*hortā*, {3sg impf indic act}⟩	⟨*hortā*, {3sg impf indic pass}⟩
⟨*hortā*, {1pl impf indic act}⟩	⟨*hortā*, {1pl impf indic pass}⟩
⟨*hortā*, {2pl impf indic act}⟩	⟨*hortā*, {2pl impf indic pass}⟩
⟨*hortā*, {3pl impf indic act}⟩	⟨*hortā*, {3pl impf indic pass}⟩

(50)   Imperfect indicative realizations of *hortā*

	Active (virtual)	Passive
1sg	*hortābam*	*hortābar*
2sg	*hortābās*	*hortābāris*
3sg	*hortābat*	*hortābātur*
1pl	*hortābāmus*	*hortābāmur*
2pl	*hortābātis*	*hortābāminī*
3pl	*hortābant*	*hortābantur*

(51)   *Hortabat   caeteros   Apostolus*
        urge.3PL.IMPF.ACT other.ACC.PL   Apostle.NOM.SG
        "The Apostle exhorted the others…" Luculentius, *Commentary on Romans XII 6*; 5-6 c. AD

(52)   *Petrus   hortabat   eos   de   cruce*
        Peter.NOM.SG   exhort.3SG.IMPF.ACT PRON.3PL.ACC from cross.ABL.SG
        'Peter exhorted them [speaking down] from the cross.' [Gregorian chant, 10th c. AD]

The ultimate conclusion of the ideas developed here is in a sense unsurprising: just as words can be seen as concrete units of morphological form or as abstract units of grammatical analysis, so paradigms exhibit a similar dichotomy. Content paradigms specify the range of syntactic contexts in which a lexeme may appear; both the lexical insertion and the semantic interpretation of a given realization are sensitive to the content cell that it realizes. Form paradigms specify the distinctions to which rules of inflectional exponence are sensitive; they determine a lexeme's inventory of inflected forms. In canonical inflection, the two sorts of paradigm are parallel, but in noncanonical inflection, they exhibit a variety of mismatches.

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