RUSSIAN VERBAL AFFIXES IN THE PROJECTION ARCHITECTURE

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Abstract

Russian perfectivity paradigms raise a complex network of formal issues for the projection architecture of LFG, including the structure of morphological representation and its relationship to the c-, f- and a-structures, with some consequences that appear to favor description-by-analysis over co-description for semantic interpretation. This paper presents the data and navigates its formal implications, suggesting in the end that Paradigm Function Morphology allows a clear description of the Russian facts that is equally compatible with both co-description and description-by-analysis, while permitting the elimination of m-structure.

1 Introduction

A foundational idea of Lexical-Functional Grammar is that different types of grammatical information may belong in different, related structures. Originally, Kaplan and Bresnan (1982) endowed the framework with the familiar c(onstituent)-structure and f(unctional)-structure, with the c-structure containing information necessary for stating generalizations about constituency, syntactic category, and linear order, and the f-structure containing information necessary for stating generalizations about grammatical function, agreement, control and raising, and so on. The architecture of the grammar assumed was as sketched in Figure 1, where ϕ is the correspondence function mapping from pieces of c-structure to pieces of f-structure.

$$\text{c-structure} \xrightarrow{\phi} \text{f-structure}$$

Figure 1: The original LFG architecture

Kaplan (1987) generalized the notion of correspondence function, arguing that the fundamental grammatical mapping between form and meaning, conceptualized as the function Γ, can be decomposed in an arbitrary number of component correspondence functions, each between a domain structure and its range structure projection. The array of structures is to be motivated "descriptively or linguistically", on the basis of "sound theoretical argumentation" (Kaplan 1987: 363), and the correspondence functions between these structures can be composed to recover Γ.

Since this work, LFG grammars have been understood as being stated within this projection architecture. The approach explicitly requires engagement with issues like: the kinds of linguistic generalizations that need to be stated, the kinds of structures that should be assumed in order for these generalizations to be formulated perspicuously, and how these structures are to be projected one from another.

This last issue can be reframed as an issue of interface: a correspondence function between two structures is a direct interface between them. Since some linguistic generalizations are interface generalizations, it stands to reason that the set of correspondence functions assumed should reflect the linguistic generalizations that need to be stated. Furthermore, the type of any particular correspondence function should be primarily driven by the properties of the structures between which it interfaces.

We argue that a close look at Russian perfectivity paradigms can help shed light on these formal issues. These complex datasets have properties that place them at the intersection of several different proposed structure types: though we will mention in passing their interaction with argument structure, semantic structure, and information structure, we focus here on their morphological and morphosyntactic properties. In particular, we show that a simple sublexical-rule and m-structure treatment of these properties imposes constraints on the syntax–semantics interface; but a treatment within Paradigm Function Morphology (PFM; Stump 2001) does not. Since the syntax–semantic interface is generally viewed as the correspondence function σ between f- and s(emantic)-structure, a morphological treatment orthogonal to this interface is preferable. Our PFM morphology, unlike that of Sadler and Nordlinger (2004), also obviates the need for m-structure altogether.

We review some theoretical prerequisites in Section 2, present the Russian data in Section 3, and in Section 4 illustrate some constraints imposed on the syntax–semantics interface by a sublexical rules and m-structure analysis. In Section 5 we provide an alternative PFM account, which allows us to dispose of m-structure in Section 6.

2 Structures and correspondences: Theoretical overview

It is now generally accepted that there is a correspondence function σ from f-structure to s-structure (Dalrymple 1999), and that the original correspondence function ϕ from c- to f-structure is best understood as the composition of α from c- to a(rgument)-structure, and λ from a-structure to f-structure (Butt et al. 1997). Some recent work has also addressed i(nformation)-structure (Butt and King 2000; O'Connor 2006) and p(honological/prosodic)-structure (Butt and King 1998; Mycock 2006).[1] But there is little agreement as to how these structures project relative to one another: the architecture of LFG grammars is an issue that remains unresolved.

One manifestation of this is the debate over m(orphosyntactic)-structure, concerning among other things its formal type, its placement within the projection architecture, and the type of correspondence function that links it to the rest of the grammar. These issues are addressed separately below.

Placement of m-structure Miriam Butt originally conceived of the m-structure as a "junk structure" (p.c.), in which were placed attribute–value pairs necessary

[1]P-structure is envisioned by Butt and King (1998) as the syntax–phonology interface and intended to contain prosodic information "which feeds into a further phonological component". Their p-structure attribute P-FORM has a phonemic form as its value. Projection to p-structure for us is limited to this attribute and involves no prosodic information.

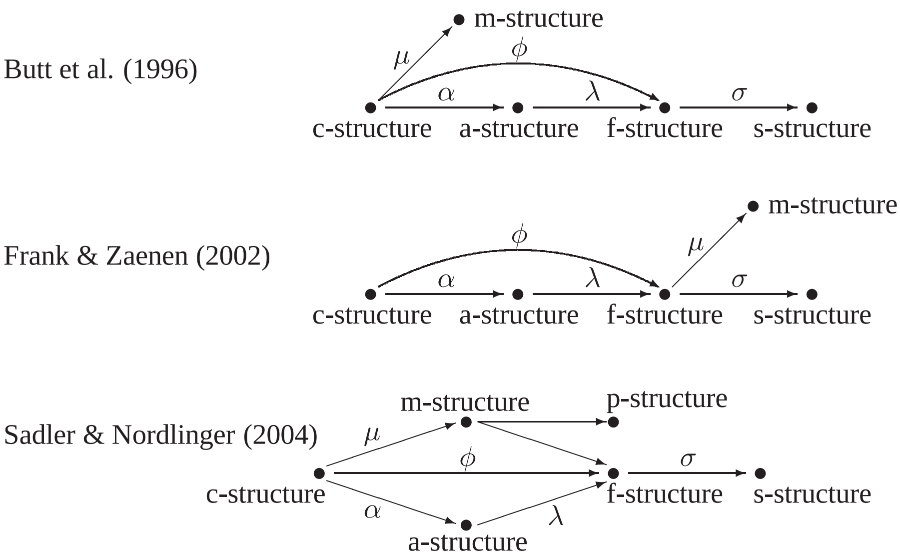

Figure 2: Proposals for placement of m-structure in the projection architecture

to an analysis of auxiliary constructions (Butt et al. 1996) but deemed to clutter the f-structure. In this conception, m-structure is a projection of the c-structure, as at the top of Figure 2, though it does not itself project another structure. In contrast, Frank and Zaenen (2002) argue that the m-structure is better thought of as a projection of the f-structure; this is shown in the middle of Figure 2. Finally, though it is implicit in their presentation, Sadler and Nordlinger (2004) envision m-structure as a projection of the c-structure, and as projecting to both the f-structure and the p-structure — see the bottom of Figure 2.

Formal type of m-structure These treatments of the m-structure also differ in the type of structure assumed. Both Butt et al. (1996) and Frank and Zaenen (2002) assume that m-structures have the same formal type as f-structures: they are functions from attributes to values, where values can be other such functions. In contrast, Sadler and Nordlinger (2004), working within a Paradigm Function Morphology framework (Stump 2001), assume that m-structures are sets of morphosyntactic properties, where such a property can also be a set.

Correspondence function type For Butt et al. (1996), the m-structure is projected from the c-structure; relevant grammatical statements are found as annotations on c-structure nodes, nonterminal and terminal (i.e. lexical entries), alongside f-structure annotations. These m-structure annotations, like f-structure ones, make direct reference to c-structure nodes. As such, the m-structure is a description-by-analysis of the c-structure, and c-structure elements co-describe the f- and the m-structure. This is also true of the c- to m-structure correspondence of Sadler and Nordlinger (2004).

For Frank and Zaenen (2002), the m-structure is projected from the f-structure; m-structure annotations make direct reference to f-structures and, like f-structure annotations, are found on c-structure nodes. Thus the m-structure is a description-by-analysis of the f-structure, and c-structure elements co-describe the f- and the m-structure.

In the case of Sadler and Nordlinger (2004), there are two more correspondence functions to consider: one from m- to p-structure, and another from m- to f-structure. In the former case, the correspondence function is the paradigm function: it specifies how the m-structure, a set of morphosyntactic features, is to be realized phonologically. In the latter case, transfer rules convert morphosyntactic feature sets to f-descriptions, providing a description-by-analysis of the f-structure. Though both the p- and the f-structure are projected from the m-structure, they are not co-described.

On the basis of evidence to be presented below pertaining to the perfectivity of verb forms in Russian, we take exception to most of the above: there is no need to assume a separate level of m-structure, and thus no need for it to have a formal type. Though our PFM approach to morphology is in line with Sadler and Nordlinger (2004), we have need of only a paradigm function as a correspondence function projecting a p-structure from the c-structure.

3 Russian perfectivity paradigms

Every verb stem in Russian is classified as either imperfective or perfective.[2] Verb roots have an inherent perfectivity value, for example imperfective for *chita-* in (1a), and more complex stems can be augmented with affixes which alter the perfectivity of their base, as with *pro–* in (1b).[3]

(1) a. *Petya chita–l knig–u*
Peter read.[IMPF]–MASC.SG.PST book–ACC
'Peter read/was reading a book.'

b. *Petya pro–chita–l knig–u*
Peter [PRF]–read.~~IMPF~~–MASC.SG.PAST book–ACC
'Peter has read the book.'

Prefixed stems are usually perfective (2a). Imperfective stems are either bare roots (2b), or have a *secondary imperfective* suffix, realized as *–yva* in (2c):

[2] This is true of other Slavic languages as well; however we focus exclusively on Russian.

[3] We notate the perfectivity of verb forms with a box around the relevant value, and strikethroughs for any other perfectivity values. Abbreviations in glosses are as follows: ACC = accusative; CML = cumulative; DAT = dative; DISTR = distributive; GEN = genitive; IMPF = imperfective; INCEP = inceptive; INF = infinitive; MASC = masculine; PL = plural; PRDR = perdurative; PREP = prepositional; PRF = perfective; PST = past; SG = singular.

(2) a. *s–pisa–tj* 'copy' (PRF)

b. *pisa–tj* 'write' (IMPF)

c. *s–pis–yva–tj* 'copy' (IMPF)

Russian verbal prefixes are not a homogeneous class: traditionally they are divided into lexical and superlexical prefixes (Ramchand 2004; Romanova 2004; Svenonius 2004), these two types differ in morphosyntactic properties as outlined below.

Lexical prefixes (LP henceforth) typically have the following properties:

(3) A. Usually attach to telic stems;
B. Allow the secondary imperfective suffix (*–yva/iva*, *–va*, *–a*);
C. Disallow prefix stacking: only one LP can attach to each verb stem;
D. May license argument structure, i.e. turn an intransitive verb into a transitive one;
E. Form an idiosyncratic meaning of the verb.

The following examples from Russian, explained below, illustrate these properties:

(4) *Mne nuzhno s–jezdi–tj v Moskv–u*
I.DAT necessary LP.[PRF]–go.~~IMPF~~–INF to Moscow–ACC
'It is necessary for me to go to Moscow.'

(5) a. *rabota–tj*
work.[IMPF]–INF
'work'

b. *za–rabota–tj*
LP.[PRF]–work.~~IMPF~~–INF
'earn/*work'

c. *za–rabat–yva–tj*
LP.~~PRF~~–work.~~IMPF~~–[IMPF]–INF
'earn/*work'

d. ∗*rabat–yva–tj*
work.~~IMPF~~–[IMPF]–INF
'work'

(6) a. *lozhy–tj*
put.[IMPF]–INF
'put'

b. *po–lozhy–tj*
LP.[PRF]–put.~~IMPF~~–INF
'put down'

c. ∗*na–po–lozhy–tj*
LP.[PRF]–LP.~~PRF~~–put.~~IMPF~~–INF

(7) a. *za–rabota–tj* *piatj dollar–ov*
LP.PRF–work.~~IMPF~~–INF five dollars–GEN.PL
'to earn five dollars'

b. ∗*rabota–tj* *piatj dollar–ov*
work.IMPF–INF five dollars–GEN.PL
'to earn five dollars'

Example (4) shows the LP *s*– perfectivizing the telic imperfective verb of motion *jezdi–tj* 'to go',[4] without otherwise affecting its meaning or argument structure. The examples in (5) show the process of secondary imperfectivization: (5a) shows that the bare verb stem 'work' is imperfective; it can be perfectivized by an LP in (5b), and re-imperfectivized with the secondary imperfective suffix in (5c). However, the secondary imperfective cannot attach to the original imperfective stem: (5d) is ungrammatical. Note also that the LP verbs in (5b,c) obligatorily translate to 'earn', not 'work'. Examples (6a–c) show that attaching more than one LP to the verb stem results in an ungrammatical string. Finally, examples (7a,b) show that the intransitive verb 'work' is not just perfectivized by the LP *za*–, but also transitivized to 'earn': the direct object is not licensed in the absence of the prefix.

Superlexical prefixes (SPs henceforth) are drawn from the same set of forms as LPs but differ in their function. Their typical properties (8A–E) below are directly comparable to (3A–E) above, respectively:

(8) A. Attach to atelic stems;
B. Only allow secondary imperfective if there is also an LP;
C. Allow prefix stacking: SPs can stack on top of each other and on top of LPs;
D. Do not license argument structure;
E. SPs do not change the meaning of lexical root but simply add information about the progress of the event.

These properties are illlustrated by the examples below:

(9) a. *bega–tj*
run.IMPF–INF
'run'

b. *pro–bega–tj*
SP.PRDR.PRF–run.~~IMPF~~–INF
'run' (for some period of time)

c. ∗*pro–beg–iva–tj*
SP.PRDR.~~PRF~~–run.~~IMPF~~–IMPF–INF

[4] Romanova (2004) demonstrates that verbs of directed motion in Russian are telic, whereas verbs of manner of motion are atelic.

(10) a. *kry–tj*
cover.IMPF–INF
'cover'

b. *na–kry–tj*
LP.PRF–cover.~~IMPF–~~INF
'cover'

c. *na–kr–yva–tj*
LP.~~PRF–~~cover.~~IMPF–~~IMPF–INF
'cover'

d. *po–na–kr–yva–tj*
SP.DISTR.PRF–LP.~~PRF–~~cover.~~IMPF–IMPF–~~INF
'cover many objects'

(11) a. *proda–tj*
sell.IMPF–INF
'sell'

b. *ras–proda–tj*
SP.CML.PRF–sell.~~IMPF–~~INF
'sell out'

c. *po–ras–proda–tj*
SP.DISTR.PRF–SP.CML.~~PRF–~~sell.~~IMPF–~~INF
'sell out piece by piece'

(12) a. *dva mesiatsa pro–lezha–tj v bolnitse*
two months.GEN SP.PRDR.PRF–lie.~~IMPF–~~INF in hospital.PREP
'to spend two months in a hospital'.

b. *dva mesiatsa lezha–tj v bolnitse*
two months.GEN lie.IMPF–INF in hospital.PREP
'to be in a hospital for two months'

(13) a. *za–pe–tj pesnju*
SP.INCEP.PRF–sing.~~IMPF–~~INF song
'to start singing a song'

b. *pe–tj pesnju*
Sing.IMPF–INF song
'sing a song'.

Example (9b) shows that SPs can attach to an atelic stem like 'run' in (9a); however the resulting stem cannot take the secondary imperfective; see (9c). The examples in (10) show that SPs can in fact co-occur with the secondary imperfective, if an LP is also part of the same form: (10a–d) show the incremental assembly of such a verb. Examples (11a–c) illustrate the ability of the SPs to stack: compare the single-SP verb in (11b) to the two-SP verb in (11c). In (12a) the SP *pro–* is attached to the imperfective stem *lezha–tj* 'lie', perfectivizing the verb and adding a perdurative meaning, indicating that the stay in the hospital is over. Compare (12b), which lacks the SP, and means that the person may still be in the hospital.

In (13a) the inceptive SP *za*– is illustrated. There is no way to manipulate the argument structure of any of the verbs in (9–13) by adding or taking away an SP.

Perfectivity and tense Russian distinguishes morphologically between past and nonpast tenses (we use ‘preterite’ below): there is one set of agreement suffixes for past tense verbs, and another set for nonpast verbs. Morphologically past tense forms and morphologically imperfective forms are relatively well-behaved semantically, in the sense that they are interpreted as past tense and imperfective, respectively. But complications arise with morphological perfectives in the nonpast tenses: though an imperfective root with only a present tense agreement marker is interpreted as imperfective, that same form with a perfectivizing prefix is interpreted as future tense. The upshot is that no verb forms are interpreted as present perfective. Consequently, though semantically future imperfective forms are morphosyntactically periphrastic, future perfective is not: this function is covered and pre-empted by morphologically present perfective forms (on all this, see Smith and Rappaport in Chapter 10 of Smith 2001).

			build Impf		SP+*build* Perf (Cumul)	SP+*build*+2IMPF Impf (Cumul)	
Preterite	Past	1S		*stroi*-la/l/lo	na-*stroi*-la/l/lo		na-*stra*-yva-la/l/lo
		2S		*stroi*-la/l/lo	na-*stroi*-la/l/lo		na-*stra*-yva-la/l/lo
		3S		*stroi*-la/l/lo	na-*stroi*-la/l/lo		na-*stra*-yva-la/l/lo
		1P		*stroi*-li	na-*stroi*-li		na-*stra*-yva-li
		2P		*stroi*-li	na-*stroi*-li		na-*stra*-yva-li
		3P		*stroi*-li	na-*stroi*-li		na-*stra*-yva-li
Nonpret.	Present	1S		*stroi*-u			na-*stra*-yva-yu
		2S		*stroi*-ish			na-*stra*-yva-yesh
		3S		*stroi*-it			na-*stra*-yva-yet
		1P		*stroi*-im			na-*stra*-yva-yem
		2P		*stroi*-ite			na-*stra*-yva-yete
		3P		*stroi*-at			na-*stra*-yva-yut
	Future	1S	bud-u	*stroi*-tj	na-*stroi*-u	bud-u	na-*stra*-yva-tj
		2S	bud-esh	*stroi*-tj	na-*stroi*-ish	bud-esh	na-*stra*-yva-tj
		3S	bud-et	*stroi*-tj	na-*stroi*-it	bud-et	na-*stra*-yva-tj
		1P	bud-em	*stroi*-tj	na-*stroi*-im	bud-em	na-*stra*-yva-tj
		2P	bud-ete	*stroi*-tj	na-*stroi*-ite	bud-ete	na-*stra*-yva-tj
		3P	bud-ut	*stroi*-tj	na-*stroi*-at	bud-ut	na-*stra*-yva-tj

Table 1: Partial paradigm for *stroi*– ‘build’, including its cumulative forms

This situation is displayed in Table 1, a partial inflectional paradigm for the verb *stroi*– ‘build’, including in the left column the bare imperfective in all three tenses, and in the remaining columns cumulative forms, meaning ‘build (a lot of)’, resulting from the prefixation of the *na*– SP — note the stem change with the secondary imperfective.[5] Omitted are forms with a different single SP, and forms with

[5]This paradigm is an exception to property (8B), in that it combines the superlexical prefix *na*– and the secondary imperfective suffix –*yva* with no lexical prefix, yet remains grammatical. We provide it as a cautionary tale about the complexity of the phenomena we discuss.

stacked SPs; we treat LP forms as part of derivational, not inflectional, paradigms.[6] Notably, the center region of the table is empty: the set of forms belonging there morphologically — namely the ones differing from the imperfective present in just the prefix *na–* and from the cumulative imperfective present in just the suffix *–yva* — are semantically future tense forms. As such they are located in the bottom row of the paradigm, where they differ from the other future forms, which are periphrastic. Periphrastic future perfective forms such as ∗*bud–u na–stroi–tj* are ungrammatical.

Pragmatics and the imperfective An additional complication is that the Russian imperfective can be deployed for pragmatic effect. We note in particular the general-factual imperfective and the annulled-result imperfective. In the former usage, a morphologically imperfective verb (for example, 'I already ate.IMPF') can be used to refer to a completed event, with the effect of backgrounding its time reference and focussing its facthood. In the latter usage, an imperfective sentence can be used if the result achieved by the event denoted has been undone — for example 'I closed.IMPF the window' when the window is no longer closed; reference is actually to the result's undoing. See Smith and Rappaport in Chapter 10 of Smith (2001) for details. We assume that these phenomena are to be analyzed at i-structure, but make no attempt to provide such an analysis.

4 Sketch of an m-structure analysis

In this section we sketch one possible analysis of Russian perfectivity paradigms within the morphological framework of Butt et al. (1996), to illustrate its imposition of constraints on the syntax–semantics interface. Recall that in this approach c-structure nodes, including terminal nodes via lexical entries, co-describe both m- and f-structure. We augment the c-structure devices with sublexical rules, which generate sublexical trees that we will display as part of the c-structure. Please note that we will reject this analysis in favor of the one to be presented in the next section.

Our point of departure is the partial *stroi–* paradigm in Table 1. We restrict ourselves to the 3rd person singular present imperfective cumulative form *na–stra–yva–yet*, as this is sufficient for making our point. Our analysis includes the sublexical c-structure rule in (14a) and the partial lexicon in (14b).

(14) a. Vstem → Af_{Pf} , Vstem

$$\begin{array}{ccc} & \uparrow=\downarrow & \uparrow=\downarrow \\ & \hat{*}_\mu = *_\mu & (\hat{*}_\mu\ \textsc{marg}) = *_\mu \end{array}$$

Furthermore, for the forms listed here as cumulative, there are homophonous non-cumulative forms where *na–* is an LP and which translate to 'tune', as a musical instrument. Some speakers prefer this interpretation to the one we use.

[6] We return to this distinction briefly in Section 5 below.

b. *stra-* Vstem (↑ PRED) = ‘build ⟨(↑ SUBJ)(↑ OBJ)⟩’
($\hat{*}_{\mu}$ VPERF) = impf

na- Af_{Pf} ($\hat{*}_{\mu}$ VPERF) = perf
($\hat{*}_{\mu}$ MARG VPERF) = impf
(↑ CUMUL) = +

-yva Af_{Pf} ($\hat{*}_{\mu}$ VPERF) = impf
($\hat{*}_{\mu}$ MARG VPERF) = perf

-yet Af_{Agr} (↑ SUBJ PERS) = 3
(↑ SUBJ NUM) = sg

The sublexical rule (14a) treats verb stems and perfectivity affixes (Af_{Pf}), in either linear order, as f-structure co-heads (Bresnan 2001). This provides an ↑=↓ path to the arbitrarily deeply embedded PRED of the root. With respect to m-structure, in contrast, perfectivity affixes are heads and stems are their arguments (MARG). This device allows affixes to select for stems with particular morphosyntactic properties. For example, the annotations on the prefix *na–* in (14b) state that its own m-structure has the attribute–value pair [VPERF perf], while its morphological argument MARG is [VPERF impf].

Figure 3 displays the resulting c-, m- and f-structures. Notice that we are assuming an additional sublexical rule that makes f- and m-structure co-heads of verb stems and agreement affixes; furthermore we assume that the top node of this sublexical tree is annotated such that its own f-structure's ASPECT value is equated with its mother's m-structure's VPERF value. This essentially passes the outermost m-structure's perfectivity to the verb's f-structure; perfectivity values more deeply embedded into the m-structure are irrelevant at f-structure.

Perfectivity at the syntax–semantics interface But this cannot be all there is to it: perfectivity is semantically interpreted, and must participate in semantic composition.[7] In the projection architecture this means that perfectivity must be projected via the correspondence function σ from the f-structure to the s-structure. There are two current views of σ: one from the transfer rules tradition (Halvorsen 1983; Crouch and King 2006) and another from the Glue Semantics tradition (Dalrymple 1999).

Transfer rules are a description-by-analysis device whose function is to parse the f-structure and translate its relevant bits into an s-structure. Thus a morphosyntactically imperfective verb in this approach, for example the one in Figure 3, is semantically imperfective because of a transfer rule that converts the f-structure attribute–value pair [ASPECT impf] into the appropriate semantic expression, appropriately composed with the semantics of the clause. There is no need for any individual morpheme to contribute semantic perfectivity to the sentence, since this

[7] The precise semantic contribution of perfectivity is beyond the scope of this paper; we are content to assume it is aspectual definiteness, following Ramchand (2008).

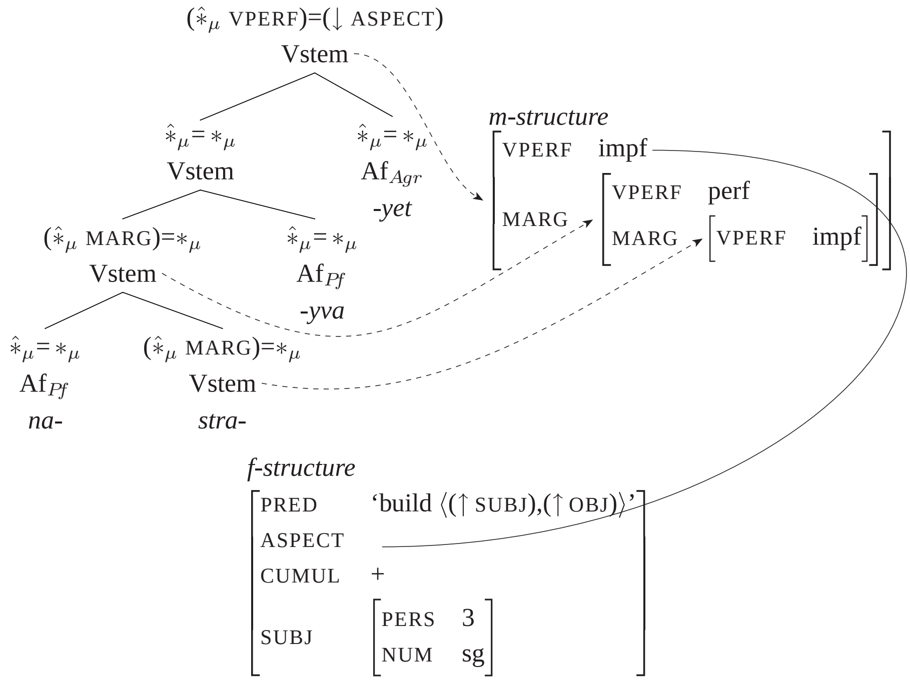

Figure 3: The c-, m- and f-structures of *na–stra–yva–yet*

semantic contribution is made by the transfer rules based on the morpheme's morphosyntactic contribution.

The Glue Semantics approach to σ is co-descriptive: lexical entries include meaning constructors pairing a semantic expression with a formula of linear logic to direct its composition. Using Glue Semantics with our analysis above would require an imperfective verb to carry in its lexical entry a meaning constructor matching (or perhaps replacing) the VPERF value of its m-structure. The complication in Russian is that a single verb form may have multiple morphosyntactic markers of perfectivity; for example the verb in Figure 3 has three such markers, the root and two affixes. These markers contribute perfectivity values which, though co-present at m-structure, do not conflict with each other because of the morphosyntactic embedding implemented by the sublexical rule (14a). But each perfectivity morpheme would have its own meaning constructor, effectively expressing three separate semantic perfectivity values for the single f-structure these morphemes share: a perfective one from *na–* and two imperfective ones from *stra–* and *–yva*. Then either these meaning constructors cannot compose with each other and the structure is ungrammatical, or else they can compose with each other after all but the verb's aspect is re-imperfectivized perfectivized imperfective rather than just imperfective. One apparent way of sidestepping this issue is to make the meaning constructors optional; however this would result in an ambiguous sentence, perfective when the prefix's meaning constructor is chosen, imperfective otherwise. All of these results are wrong.

The conclusion must then be that given an analysis like that in Figure 3, s-structure is projected via transfer rules, at least where perfectivity is concerned: semantic perfectivity is read off of the f-structure, not contributed by morphemes. This does not necessarily mean that there is no role to play for co-description — a hybrid approach combining transfer rules for symbol values with meaning constructors for grammatical functions and scope (for example) seems possible to envision — just that it is not up to the task of dealing with perfectivity, given this analysis of Russian facts.

We do not adopt this analysis. We presented it to illustrate the point that there can be a dependency between choices that are better kept orthogonal. In this case the dependency is between the approach to m-structure we employed above and the choice of syntax–semantics interface type. The m-structure represents a theoretical commitment to the existence of a set of morphosyntactic generalizations distinct from f-structure generalizations, while the correspondence function σ between f- and s-structure represents a theoretical commitment to the existence of a significant relationship between the contents of these structures. Decisions about these theoretical commitments should be interdependent only if the commitments are found to be related.

5 Paradigm Function Morphology analysis

We follow Sadler and Nordlinger (2004, 2006) in proposing Paradigm Function Morphology as the morphological component in LFG grammars. We introduce our analysis in a manner consistent with their architecture (see the bottom of Figure 2), but end up departing from it significantly in the next section.

In Stump (2001), PFM is presented as a framework primarily for inflectional morphology. Since we believe lexical prefixes to be derivational, our analysis will therefore focus on superlexical prefixes and the secondary imperfective. With regards to lexical prefixes, we take the following to suffice at this point: property (3D), according to which LPs are able to license additional arguments, can be modeled by assuming that these prefixes carry annotations such as ($\hat{*}_\alpha$ THEME), effectively projecting an additional argument to the a-structure in its Butt et al. (1997) incarnation. Meanwhile property (3E), according to which LP stems can have idiosyncratic meaning, for example 'work' vs. 'earn' in (5), are accounted for if such stems are memorized as lexical units.

As to our inflectional affix types, the superlexical prefixes and the secondary imperfective suffix, they combine with lexemes to form paradigms of morphological forms. These are defined in PFM by declaring a paradigm space — a set of morphosyntactic feature sets — and stating rules to realize the forms filling that space. We define the paradigm space for verb lexemes by:

(15) a. declaring a set of possible morphosyntactic features: attributes and their possible values:

Attribute	Values
ASPECT	prf, impf
PRETERITE	$+, -$
TENSE	past, present, future
PERS	1, 2, 3
NUM	sg, pl
GEND	fem, masc, neut
SUBJAGR	{PERS:x, NUM:y, GEND:z}
CUMUL	$+, -$
PRDR	$+, -$
⋮	

b. declaring what constitutes a complete feature set; here we assume this means one of each attribute in the table above along with a valid value for this attribute.

c. declaring feature co-occurrence restrictions; in our case there is at least:

> If a morphosyntactic feature set Σ is an extension of {TENSE:present}, then Σ is not an extension of {ASPECT:prf}.

Formally, the paradigm represented diagrammatically in Figure 1 is a set of complete morphosyntactic feature sets including (16a,b), though not (16c) since it violates (15c):[8]

(16) a. Non-cumulative imperfective present:
{ASPECT:impf, PRETERITE:$-$, TENSE:pres, CUMUL:$-$, PRDR:$-$,
SUBJAGR:{PERS:1|2|3, NUM:sg|pl, GEND:fem|masc|neut} . . . }

b. Cumulutative perfective future:
{ASPECT:prf, PRETERITE:$-$, TENSE:fut, CUMUL:$+$, PRDR:$-$,
SUBJAGR:{PERS:1|2|3, NUM:sg|pl, GEND:fem|masc|neut} . . . }

c. Cumulative perfective present:
∗{ASPECT:prf, PRETERITE:$-$, TENSE:pres, CUMUL:$-$, PRDR:$-$,
SUBJAGR:{PERS:1|2|3, NUM:sg|pl, GEND:fem|masc|neut} . . . }

In the projection architecture of LFG, these complete morphosyntactic feature sets constitute the m-structure of the verb. The lexical entry of a verb lexeme thus contains an equation like $(\hat{*}_{\mu})$ = [(16a)|(16b)|. . .] in which the morphosyntactic feature sets constituting the lexeme's paradigm space are enumerated disjunctively.

It is important to notice at this point that each complete feature set contains a single perfectivity value. Each such set also constitutes a unique constellation of features, which can be used to realize a unique form for this constellation.

[8]The conjunctions in the SUBJAGR subsets of features abbreviate the 18 possible combinations of person, number and gender.

Block A (stem choice)
A1. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{cumul}:+\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{Y}', \Sigma\rangle$, where Y is X's 2nd stem
A2. $\mathrm{RR}_{\mathrm{V},\{\,\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{Y}', \Sigma\rangle$, where Y is X's 1st stem
Block B
B1. $\mathrm{RR}_{\mathrm{V},\{\textsc{cumul}:+\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle na\mathrm{X}', \Sigma\rangle$
Block C
C1. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{cumul}:+\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}yva', \Sigma\rangle$
Block D
D1. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:+\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}l', \Sigma\rangle$
D2. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{tense}:\mathrm{pres},\textsc{cumul}:+\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}y', \Sigma\rangle$
Block E
E1. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:+,\textsc{subjagr}:\{\textsc{num}:\mathrm{pl}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}i', \Sigma\rangle$
E2. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:+,\textsc{subjagr}:\{\textsc{num}:\mathrm{sg},\textsc{gend}:\mathrm{fem}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}a', \Sigma\rangle$
E3. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:+,\textsc{subjagr}:\{\textsc{num}:\mathrm{sg},\textsc{gend}:\mathrm{neut}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}o', \Sigma\rangle$
E4. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:1,\textsc{num}:\mathrm{sg}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}u', \Sigma\rangle$
E5. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:2,\textsc{num}:\mathrm{sg}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}esh', \Sigma\rangle$
E6. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:3,\textsc{num}:\mathrm{sg}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}et', \Sigma\rangle$
E7. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:1,\textsc{num}:\mathrm{pl}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}em', \Sigma\rangle$
E8. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:2,\textsc{num}:\mathrm{pl}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}ete', \Sigma\rangle$
E9. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:3,\textsc{num}:\mathrm{pl}\}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}ut', \Sigma\rangle$
E10. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{preterite}:-,\textsc{tense}:\mathrm{fut}\}}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \langle \mathrm{X}tj', \Sigma\rangle$

Figure 4: Realization rule blocks for Russian verb lexemes

Projection to p-structure takes place via blocks of realization rules, among each of which the most specific rule applicable, given the lexeme's morphosyntactic feature set, adds phonological material to the p-structure of the lexeme. When no rule within a block is applicable, the identity function applies to add nothing. We assume the rule blocks in Figure 4 (which abstract away from some morphophonological details), and define the paradigm function for Russian verb lexemes as:

(17) $\mathrm{PF}(\langle \mathrm{X}, \Sigma\rangle) =_{\mathrm{def}} \mathrm{Nar}_{\mathrm{E}}\,(\mathrm{Nar}_{\mathrm{D}}\,(\mathrm{Nar}_{\mathrm{C}}\,(\mathrm{Nar}_{\mathrm{B}}\,(\mathrm{Nar}_{\mathrm{A}}\,(\langle \mathrm{X}, \Sigma\rangle)))))$

Thus a lexeme X with morphosyntactic feature set Σ has its phonological form defined by the successive application of the narrowest rule from each of rule blocks A through E. A complete example follows.

Assume a lexeme *stroitj* 'build' with first stem *stroi*– and second stem *stra*–, and the morphosyntactic feature set in (18), including GEND:fem to be complete per (15b). The narrowest rule from each block is listed in (19) along with its effect. Rule A1 is narrowest in block A because its conditions of application match more of the lexeme's features than the alternative; thus the lexeme's second stem is selected. Rules B1 and C1 are narrowest in their blocks because their conditions of application match the lexeme's features; if there was no such match, the identity function would apply and nothing would be added to the lexeme's phonological form. In block D, rule D2 is narrowest because the other rule's conditions of application do not match the lexeme's features. Finally in block E rule E7 applies, as no other rules match the lexeme's features. The output is the form *na–stra–yva–y–em*. The meaning associated with this form is determined by the m-structure's projection to the f-structure and then via σ to the s-structure.

(18) $\langle$*stroitj*,{ASPECT:impf,
PRETERITE:$-$,
TENSE:pres,
CUMUL:$+$,
REPET:$-$,
SUBJAGR:{PERS:1, NUM:pl, GEND:fem} } $\rangle$

(19) $\langle$*stroitj*,$\Sigma\rangle$

A1. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{cumul}:+\}}(\langle \textit{stroitj}, \Sigma\rangle) = \langle stra, \Sigma\rangle$
B1. $\mathrm{RR}_{\mathrm{V},\{\textsc{cumul}:+\}}(\langle stra, \Sigma\rangle) = \langle nastra, \Sigma\rangle$
C1. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{cumul}:+\}}(\langle nastra, \Sigma\rangle) = \langle nastrayva, \Sigma\rangle$
D2. $\mathrm{RR}_{\mathrm{V},\{\textsc{aspect}:\mathrm{impf},\textsc{tense}:\mathrm{pres},\textsc{cumul}:+\}}(\langle nastrayva, \Sigma\rangle) = \langle nastrayvay, \Sigma\rangle$
E7. $\mathrm{RR}_{\mathrm{V},\{\textsc{preterite}:-,\textsc{subjagr}:\{\textsc{pers}:1,\textsc{num}:\mathrm{pl}\}\}}(\langle nastrayvay, \Sigma\rangle) = \langle nastrayvayem, \Sigma\rangle$

Projection to the f-structure takes place via transfer rules, which can be summarized as in Table 2, taking f to the f-structure of the lexeme.

Morphosynatctic feature	$\Rightarrow$	f-description
ASPECT:impf		(f ASPECT) = impf
TENSE:pres		(f TENSE) = pres
CUMUL:+		(f CUMUL) = $+$
SUBJAGR:{PERS:1}		(f SUBJ PERS) = 1
SUBJAGR:{NUM:pl}		(f SUBJ NUM) = pl
SUBJAGR:{GEND:fem}		(f SUBJ GEND) = fem
	⋮	

Table 2: Transfer rules projection from m- to f-structure

It follows that the lexeme in (18) corresponds to the form *nastrayvayem* at p-structure, and to the f-structure in (20):

(20)
$$f\begin{bmatrix} \textsc{pred} & \text{‘build } \langle(\uparrow \textsc{subj}),(\uparrow \textsc{obj})\rangle\text{’} \\ \textsc{aspect} & \text{impf} \\ \textsc{tense} & \text{pres} \\ \textsc{cumul} & + \\ \textsc{repet} & - \\ \textsc{subj} & \begin{bmatrix} \textsc{pers} & 1 \\ \textsc{num} & \text{pl} \\ \textsc{gend} & \text{fem} \end{bmatrix} \end{bmatrix}$$

Sadler and Nordlinger (2004) need an additional, intermediary tree representation to complete the f-description: the recursive case stacking phenomenon they analyze allows single forms to specify not just attributes of their own f-structure, but also attributes of other f-structures in which they are embedded, via inside-out function application. We accept the argument in Andrews (2005) that this intermediary representation can be eliminated by complexifying the transfer rules.

Semantic perfectivity One advantage of this analysis over the one presented in Section 4 is that it is compatible with both a co-description and a transfer rule (or some other kind of description-by-analysis) treatment of the syntax–semantics interface. The compatibility of a transfer rule treatment can be straightforwardly observed: the f-structure contains a single perfectivity value, which will be translated to a semantic expression of perfectivity. A co-description treatment would place perfectivity meaning constructors in the lexical entries of lexemes, matching the single morphosyntactic perfectivity value they project to m-structure. There is no issue of conflicting perfectivity values arising from morpheme concatenation, because the verb's features are not calculated from the sum of its morphemes' features; rather the verb's form is calculated based on the lexeme's features.

6 PFM without m-structure

While the Paradigm Function Morphology presented in the previous section solves the issue of morphology constraining the choice of syntax–semantics interface type, its architecture seems unnecessarily complicated to us. In particular, we believe that the m-structure can be completely eliminated with no detriment to the analysis.

Consider again Table 2, and notice what little value is added by having both a set of morphosyntactic features and a set of f-structure features when they are essentially identical. Suppose that we replace (15), where paradigm space is defined with respect to morphosyntactic features, with the following:

(21)
a. a declaration of a set of possible f-structure features: attributes and their possible values — note that this is a required feature of XLE grammars (Butt et al. 1999; Crouch et al. 2008);
b. a declaration of what constitutes a complete f-description for lexemes;
c. a declaration of feature co-occurrence restrictions, at potentially arbitrary outside-in and inside-out depths, to cover phenomena like case stacking.

Paradigm functions, projecting to p-structure, can then be defined to apply to the f-descriptions of lexemes. The recursive morphosyntactic feature sets that Sadler and Nordlinger (2006) use to account for case stacking find their analogue in the recursiveness of f-structure descriptions. Since in this view lexemes already have f-descriptions and already project to the f-structure, there is no need for transfer rules to do this. We therefore argue that the architecture in Figure 5 is appropriate for LFGs with a PFM morphological component:

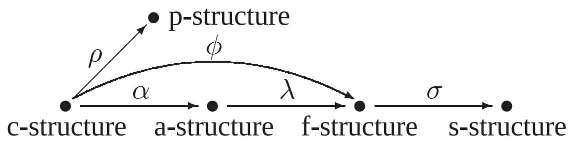

Figure 5: The projection architecture without m-structure

There is an implied theoretical innovation in this approach: though a lexeme is standardly understood as having a lexical entry containing its own f-description, in a c-structure that lexeme merely contributes to the f-description of the sentence, within which the provenance of functional equations is effaced. We assume that it is possible to revise this conception such that the f-descriptions of different terminal nodes can be differentiated. Paradigm functions then apply to terminal nodes based on their f-descriptions.

One possible objection to the elimination of morphosyntactic features in favor of f-structure features, which was raised in the question period of our presentation, is that there is a need for such things as conjugation classes, and possibly other kinds of purely morphological categories that have no business in f-structure. But the conjugation class issue is already taken care of in the PFM framework: the application conditions of realization rules include not just morphosyntactic features, but also category features (Stump 2001). In Figure 4, our rules apply to lexemes of category V, but we could decompose V into features and have rules apply to Vs with only some of these features.[9] A formalization of this might recruit some of the same tools that Bresnan (2001) uses in her theory of structure–function mapping.

As for the issue of other features that do not belong in the f-structure, we suggest that PFM work should proceed by eliminating them from analyses: by hypothesis, only meaningful features will be used to cross-classify the forms in a well-specified paradigm. As long as the cross-classification is total, the end result will be that each cell in the paradigm formally constitutes a unique constellation of functional schemata: an f-description unique within the paradigm, which a well-designed paradigm function can spell out as a unique form. We only appear to violate this methodological principle with our use of PRETERITE among morphosyntactic features, but not in f-structures, to differentiate past from nonpast tenses — compare (18) with its f-structure in (20). If paradigm functions apply based on the f-descriptions of lexemes, then this feature can be eliminated because the f-description language allows negative expressions like $(f\ \text{TENSE}) \neq \text{past}$.

Finally, we note that Saléschus and Hautli (2008) generate correct verb forms by using finite-state tools to state long-distance dependencies between morphemes.

[9] In fact we do need to do this since Russian has conjugation classes.

While we do not believe that their analysis has the scope of ours, it does raise the question of whether assuming Paradigm Function Morphology is necessary.

7 Conclusion

The expression of perfectivity in Russian lies at a busy intersection: morphosyntactically it arises from nontrivial patterns of affixation, which do not interact straightforwardly with tense interpretations and are sensitive to telicity; it seems to have a foot in both inflectional and derivational paradigms; it affects argument structure and interacts with information structure. This makes it a privileged vantage point from which to view issues concerning the projection architecture.

We focussed on a particular problem arising from some of these Russian facts: the analysis type indicated by an m-structure approach like that of Butt et al. (1996) in not compatible with a purely co-descriptive approach to the syntax–semantics interface, and requires at least some admixture of description-by-analysis. In contrast, a Paradigm Function Morphology treatment of the Russian data is trivially compatible with either form of syntax–semantics interface.

We do not purport to have resolved the issue of morphology in the projection architecture, nor to have a complete analysis of Russian perfectivity paradigms. However we do believe that we have demonstrated the practicality of the general course we advocate, of freeing theoretical choices from orthogonal constraints. In frameworks like LFG where grammars are highly modular by design, and deciding on the architecture of the grammar is part of object of research, compartmentalizing theoretical choices is a sound methodological strategy that need not interfere with detailed grammatical description.

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