

Valency patterns across Slavic: insights from a token-based cross-linguistic perspective

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Abstract

A token-based typological perspective sheds new light on the comparative study of valency class systems in ten modern Slavic languages. Using Universal Dependencies (UD) treebanks, the analysis addresses two issues: cross-linguistic differences in valency class system complexity and the relationship between type and token frequencies of argument-coding devices such as cases and adpositions. Quantitative measures based on transitivity prominence and entropy reveal systematic intra-Slavic variation. Languages of the northern Slavic area (Russian, Ukrainian, Polish, Czech) show higher valency class complexity than South Slavic languages, despite their close genealogical relationship. Complexity metrics based on UD treebanks largely converge with questionnaire-based results from the BivalTyp database, supporting the methodological validity of the approach. Type and token frequencies of individual argument-coding devices are shown to diverge in systematic ways. Cases and case-preposition combinations associated with semantically more homogeneous verb sets and more tangible semantic roles tend to display higher token frequencies relative to their type frequencies. These findings highlight the added value of token-based evidence for understanding the structure and variation of valency class systems.¹

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1. Introduction

This paper is situated at the intersection of three research domains: (i) verb valency classes, (ii) microtypological approaches to Slavic languages, and (iii) token-based typological research. While each of these areas has produced substantial results, and their pairwise combinations are well represented in the literature, their joint integration remains underexplored. The present study addresses this gap by outlining directions in which the use of token-based data can provide new insights into the organization of valency class systems in Slavic, including both shared properties and internal variation.

The paper is structured as follows. Section 2 reviews the relevant state of the art and introduces the working definitions adopted in the study. Sections 3 and 4 describe the data and methods, largely building on previous research. Section 5 presents the main empirical findings, and Section 6 offers a brief summary.

2. Background and goals

Valency has played a central role in empirical and theoretical linguistics for decades, addressing how verbs and other predicates interact with their arguments, including issues such as alignment, grammatical relations, voice, and semantic roles (Comrie 1981; Dixon 2010: 115–158; Fillmore 1968, Lazard 1994). A particularly challenging issue concerns the relation between argument structure as part of grammatical organization and the (verbal) lexicon. Ongoing debates range from projectionist approaches, in which individual lexical verbs project verb-specific argument patterns (Levin & Rappaport Hovav 2005), to constructional approaches, where argument structure constructions are endowed with their own meaning and accommodate overlapping verb classes on the basis of general principles of semantic compatibility (Goldberg 1995; also see Janda 1993: 25–40 for an insightful overview of possible approaches).

Regardless of theoretical differences, there is broad empirical agreement that languages organize verbs into valency classes, understood as sets of verbs sharing the same argument-structural properties (Levin 1993). This paper adopts a narrow definition of valency class, focusing on argument coding and abstracting away from deeper aspects of argument-related syntax, such as participation in valency alternations or processes like reflexivization. The valency of a verb is thus defined as “the list of its arguments with their coding properties” (Malchukov et al. 2015: 30).

By way of illustration, the examples (1)–(2) below instantiate the same valency pattern, that is, the same combination of argument-coding devices: i) nominative case with verbal indexing for the first argument and ii) the preposition *na* ‘on’ with accusative case for the second argument. Consequently, the Serbian verbs used in these examples

belong to the same valency class, even though the same lexical items may occur with different valency patterns elsewhere.

Serbian

- (1) *Petar* *liči* *na* *Marij-u*
 PN.NOM.SG resemble.PRS.3SG on PN-ACC.SG
 ‘Petar resembles Maria.’ (BivalTyp²)
- (2) *Petar* *se* *ljuti* *na* *Marij-u*
 PN.NOM.SG REFL make_angry.PRS.3SG on PN-ACC.SG
 ‘Petar is angry with Maria.’ (BivalTyp)

Compared to topics such as alignment, valence orientation, or voice, typological research on valency classes remains relatively limited. One likely reason is the absence of a clear *tertium comparationis*: valency classes are identified on the basis of argument-coding devices such as cases, adpositions, and verbal indexes, which cannot be straightforwardly equated across languages (Haspelmath 2009: 510; Haspelmath, Hartmann 2015). As a result, the empirical study of valency classes has largely been confined to language-specific research.

Slavic languages are no exception in this respect. A substantial body of empirically rich work addresses valency classes in individual Slavic languages, including theoretically informed studies with fine-grained semantic analyses, as well as dictionaries and databases of various kinds (see Apresjan, Páll 1982; Apresjan 2014-; Janda, Clancy 2002; Lopatková et al. 2016; Lyashevskaya, Kashkin 2015; Preradovic et al. 2009; Przepiórkowski et al. 2014; Žele 2008; Zolotova 2006).

A recurrent empirical finding in research on valency classes is that they are at least partly semantically motivated: verbs grouped within a given class tend to share aspects of meaning, and conversely, semantic similarity often correlates with shared valency patterns (Apresjan 1965: 51; Clancy 2006; Lazard 1994: 133; Levin 1993: 1–10; Malchukov 2005). In its most general form, this observation aligns with the broader isomorphism hypothesis, according to which recurrent similarities in form correspond to similarities in meaning (Cysouw 2014). However, this relationship does not fully predict the valency behavior of individual verbs. This becomes evident from the fact that languages organize verbs into valency classes in different ways, sometimes even between very closely related languages, such as Slavic languages (Clancy 2006; Janda 1993; 2002).

By way of illustration, the equivalents of (1)–(2) in Czech display distinct valency patterns (*podobat se* ‘resemble’ takes a dative object, whereas *zlobit se* ‘be angry’ requires preposition *na* ‘on’ and the accusative case, as in the Serbian counterpart). Such variation motivates a cross-linguistic perspective on valency class systems and raises questions such as which properties of these systems are cross-linguistically recurrent

² All examples are taken either from the BivalTyp database or from the UD platform and are marked accordingly; see Section 3 for more details on the data.

and which are highly language-specific, and whether observed differences align with genealogical, areal, or structural factors. A growing body of research addresses these issues (Malchukov, Comrie 2015; Bickel et al. 2014; Say 2014), including contrastive studies on Slavic data (Clancy 2006; Janda 2002) and at least two recent studies aimed at the analysis of the whole Slavic genus (Seržant et al. 2022; Say 2025a).

However, this body of work largely adopts a type-based approach, in which the primary datapoints are lexical verbs or constructions treated as abstract types. While such studies have yielded important insights, including systematic cross-linguistic differences, they are necessarily reductionist in that they abstract away from usage-based properties of language, such as variability, contextual effects, and frequency. In response, an emerging strand of research—*token-based typology*—aims to compare languages on the basis of tokens, understood as individual instances of linguistic forms attested in texts, typically analyzed using corpora of various kinds. An emphasis on actual usage, enriched with multi-layered contextual information and frequency distributions, has played a central role in cognitively oriented, corpus-based studies of Russian, most prominently in the work of Tore Nessel (Nessel 2019; Nessel & Janda 2023), including research on case usage (Nessel 2004; Nessel & Kuznetsova 2015).

Recent years have seen substantial advances in token-based typology (Levshina 2022; Schnell et al. 2021), including in the study of Slavic languages (Bauer 2021; Ovsjannikova 2025; von Waldenfels 2012).

Despite these recent developments, valency classes in Slavic languages remain poorly studied from a comparative, token-based perspective. This paper aims to initiate such a research programme by highlighting a few specific questions and complementing existing type-based results reported in, e.g., Seržant et al. (2022) and Say (2025a). More broadly, the goal is to apply quantitative methods to token-based data from Slavic languages and to compare the findings with results obtained from type-based approaches, focusing on both similarities and differences among Slavic languages.

More specifically, this study addresses two empirical questions: (i) Are there systematic differences in the complexity of valency class systems across Slavic languages? (ii) Are there recurrent patterns in the type and token frequencies of individual valency classes, particularly regarding differences between type- and token-based distributions? To answer these questions, data from the UD treebanks are employed and compared with type-based data from BivalTyp (Section 3), and analyzed using quantitative methods (Section 4).

3. Data

The main data source is **Universal Dependencies** (UD), a large cross-linguistic collection of syntactically annotated treebanks (Nivre et al. 2020; Zeman et al. 2023). With coverage of over 150 languages, naturalistic texts, and consistent annotation, UD

is well suited for token-based typological research. However, treebanks vary in size and genre, and the sample is biased toward languages with established literary traditions. This bias is less relevant here, as standard Slavic languages are well represented. This study uses data from ten Slavic languages (see Table A1 in the Appendix) as represented in the UD treebanks in October 2024.³

Data processing proceeded in two steps. First, I extracted all dependents of finite verbs annotated as “obj” (direct object), “iobj” (indirect object), or “obl” (oblique object).⁴ The datasets also included additional grammatical annotations extracted from UD, such as linear position relative to the main verb, part of speech, verb lemma, and morphological case.⁵

Second, because UD does not directly annotate argument-coding devices, I used a semi-automated procedure to identify them. In Slavic languages, these usually involve a morphological case or a morphological case combined with an adposition. For example, the coding devices for the three raw entries from the Russian sentence in (3) were coded as “posleGEN,” “DAT,” and “oLOC.”

- (3) *Posle èt-ogo ljud-i rasskazyva-l-i zal-u o*
 after this-GEN people-NOM.PL tell.IPFV-PST-PL audience-DAT.SG about
rezul'tat-ax
 result-LOC.PL
 ‘After that, people told the audience about the results.’ (UD)

This yielded ten language-specific datasets (see Table A1 in the Appendix for a quantitative overview). A major limitation of UD data is that it does not differentiate between arguments and adjuncts, as already seen in example (3), where *zalu* ‘to the audience’ and *o rezul'tatax* ‘about the results’ are arguments of *rasskazyvat'* ‘tell’, whereas the third dependent, *posle ètogo* ‘after this’, is an adjunct.⁶ However, for studying verb-specific valency patterns in a cross-linguistic perspective, arguments are more relevant than adjuncts.

To separate arguments from adjuncts, I applied an automated argumenthood script developed for Russian (Say & Seržant 2025) and extended it to all ten languages. A dependent is classified as an argument if its coding device occurs significantly more often with a given verb than on average (cf. Korhonen et al. 2000). For example, **DAT**

³ The Macedonian treebank, containing 1,360 tokens, is too small for meaningful analysis of lexical valency patterns.

⁴ The algorithm excludes subjects to avoid inflating datasets, as Slavic nominative subjects show little variation beyond the overt versus zero NP distinction, which could hinder cross-dataset comparison.

⁵ The **extracting algorithm** was implemented in Python. I thank Ivan Seržants for writing the script.

⁶ UD documentation explicitly notes that the argument/adjunct distinction is subtle, often debated, and best omitted, whereas the core-oblique distinction is clearer and more cross-linguistically applicable (<https://universaldependencies.org/u/overview/syntax.html>; retrieved December 20, 2025). The UD distinction between direct objects, indirect objects, and obliques relies on the formal properties of coding devices and is only tangentially related to argumenthood.

and **oLOC** co-occur with *rasskazyvat* ‘tell’ more frequently than expected and are tagged as arguments, whereas **posleGEN** is not and is treated as an adjunct.

For Russian, the algorithm achieves approximately 0.83 precision, based on manual comparison with *The Active Dictionary* (Apresjan, ed., 2014–) as a gold standard. Say and Seržant (2025) discuss its advantages and limitations, distinguishing false positives (dependents identified as arguments but not listed in the dictionary) and false negatives (the reverse).

In the Russian data, false positives are rare and typically arise in special contexts, for example when a coding form can express multiple meanings with the same verb. There is no reason to expect them to be more frequent in other languages. False negatives, however, are more common and usually result from data sparsity: with rarer verbs, combinations with particular coding devices may simply not occur often enough to reach statistical significance. The algorithm’s precision is therefore likely comparable to the Russian benchmark in languages with larger datasets (e.g. Czech), but lower in languages with smaller ones (e.g. Slovak).⁷

Despite these limitations, the algorithmically assigned argumenthood labels were retained in the analysis for three reasons. First, imperfect precision mainly reflects false negatives, meaning that dependents identified as arguments are likely to be genuine arguments even if some argument types remain undetected. Second, no better practical alternative is available: despite its imperfections, the script allows many adjuncts to be filtered out without manual annotation of thousands of examples across ten languages. Third, some calculations rely on the full dataset without distinguishing arguments from adjuncts (see Table 1 and the accompanying footnote).

In addition to UD, parts of the analysis use **BivalTyp** (Say 2020–), a cross-linguistic database of bivalent verbs based on 130 questionnaire sentences, covering 149 languages as of October 2025. See Nikolaev and Say (n.d.) for the general database design and Say (2025a) for a detailed analysis of the Slavic data in BivalTyp. I used the same ten Slavic languages as in UD. BivalTyp’s advantage is that entries are semantically aligned across languages and valency patterns are explicitly coded, unlike in UD. Its limitations include non-naturalistic examples, a focus on bivalent patterns, and a somewhat arbitrary questionnaire design that does not reflect actual usage frequencies. Comparing results from UD and BivalTyp allows assessment of these complementary strengths and weaknesses.

The data used in this study—including the UD-based datasets for the ten languages with argumenthood annotations, as well as spreadsheets representing the latest

⁷ I have not obtained precision estimates for languages other than Russian for practical reasons. Producing such estimates would require (i) a dictionary comparable in coverage and accuracy to *The Active Dictionary* (Apresjan, ed., 2014–) for Russian and (ii) an expert with native or near-native command of the target language willing to check hundreds or thousands of corpus examples against detailed lexicographic descriptions. At the time of writing, these conditions were not met for any other Slavic language. Moreover, direct comparison of precision across languages would be problematic even with such annotations, as language-specific lexicographic practices differ, undermining the idea of a cross-linguistically valid “gold standard”.

development version of the BivalTyp database—are available in a GitHub repository at https://github.com/serjozhka/Slavic_valency_Slovo.

4. Methods

As noted in Section 2, this study addresses two issues: (i) the complexity of valency class systems and (ii) the relationship between type and token frequencies of individual valency classes. These concerns determined the choice of quantitative methods.

Studying complexity at different levels of linguistic systems is a major topic in linguistics, including typology (Miestamo et al. 2008; Shcherbakova et al. 2023). The key idea in analyzing valency class complexity is that more complex systems make finer distinctions between verbs in their valency patterns. I use two metrics to quantify this complexity: **transitivity prominence** and **Shannon’s entropy** (see Say, 2025b, for the same idea applied to type-based data).

Transitive patterns are commonly treated as the default for bivalent verbs. Canonical transitivity involves an action verb with a volitional agent and a highly affected patient (Tsunoda 1985; Malchukov & Comrie 2015; Næss 2007), while many other bivalent verbs (e.g., *like*, *follow*, *kiss*) may appear morphosyntactically transitive or intransitive depending on the language. **Transitivity prominence** is calculated as the ratio of transitive patterns to total patterns in a dataset (Creissels 2018; Haspelmath 2015). In this study, a clause is considered transitive if its two arguments correspond to the ‘killer’ and ‘victim’ micro-roles of the *kill* verb (see Haspelmath 2015: 136 for a similar approach).

In Slavic languages with morphological case, this corresponds to a nominative–accusative pattern. In UD data, transitivity prominence was calculated as the ratio of clauses containing an accusative argument to the total number of clauses.⁸ Although this does not fully reflect corpus frequencies—for example, the extracting script simply ignores clauses without any non-subject arguments—the identical extraction procedure ensures comparability of obtained metrics across language-specific UD-based datasets. In BivalTyp, transitivity prominence is simply the proportion of transitive entries among the 130 entries obtained for each language. Again, while absolute scores are shaped by the questionnaire design, cross-linguistic comparisons remain meaningful.

Transitivity prominence is **inversely** correlated with valency system complexity: lower prominence indicates finer distinctions between verb classes (Drossard 1991: 435–436; Haspelmath 2015; Lazard 1994: 61–63). However, it is a coarse metric, capturing only the contrast between default transitive and other patterns, without distinguishing among non-transitive patterns (e.g., use of multiple adpositions for argument coding). To address this, I employ **Shannon’s entropy** (see Ackerman,

⁸ In Bulgarian—the only language in my Slavic sample without morphological case—the transitive pattern involves a canonical subject and either an unflagged nominal argument, an accusative clitic, or both.

Malouf 2013; Juola 2008; Levshina 2019 for the general idea and Say, 2014; 2025b for its application to valency class systems research), which measures the information content of a discrete variable.

For UD data, the discrete variable is the argument-coding device (e.g. the dative case, annotated as “DAT”, or *na* + accusative, “naACC”); datasets with a more scattered distribution of observations across coding devices have higher entropy. For BivalTyp, the discrete variable is the observed bivalent valency pattern.⁹ UD is token-based, BivalTyp is type-based, and UD considers coding devices associated with individual arguments (e.g., “naACC”) while BivalTyp considers whole valency patterns (e.g. “NOM_naACC”). Despite these differences, entropy captures the degree of complexity in argument-coding distributions in both datasets.

In addition to these holistic metrics, I applied standard frequency analyses to UD data to examine specific coding devices. **Type frequency** measures the number of different verbs using a given coding device (e.g. “naACC”), while **token frequency** counts the number of occurrences of that device in the treebank-based dataset.

5. Results

5.1. Complexity

As discussed in Section 4, valency class system complexity is assessed using two metrics: **transitivity prominence** and **entropy**.

Transitivity prominence calculated from UD data ranges from 0.39 in Polish (lower values indicate higher complexity) to 0.56 in Bulgarian. Scores derived from UD treebanks show a similar distribution, ranging from 0.41 (Polish) to 0.52 (Bulgarian). Results for the ten Slavic languages are presented together with entropy values in Table 1.

As shown in Table 1, transitivity prominence scores in BivalTyp and UD are significantly correlated (Pearson’s $r = 0.66$, $p = 0.040$). These correlations indicate that both UD and BivalTyp capture broadly similar patterns of valency class complexity across Slavic languages. This relationship is additionally visualized in Fig. 1, which also reflects corpus sizes. The potential role of corpus size in the reliability of the results is discussed below.

⁹ In the case of BivalTyp, an additional correction was applied using a random subsampling technique to address the problem of unequal numbers of non-missing data points across languages (see Say, 2025b, for a detailed discussion of this method).

language	transitivity prominence		entropy	
	UD	BivalTyp	UD ¹⁰	BivalTyp
Russian	0.41	0.42	2.68	2.23
Belarusian	0.46	0.43	2.56	2.16
Ukrainian	0.42	0.44	2.7	2.17
Polish	0.39	0.41	2.71	2.17
Czech	0.42	0.45	2.72	2.16
Slovak	0.55	0.48	2.36	2.03
Slovenian	0.45	0.50	2.56	1.94
Croatian	0.45	0.49	2.62	2.04
Serbian	0.43	0.5	2.62	1.97
Bulgarian	0.56	0.52	2.12	1.61

Table 1. Transitivity prominence and entropy in UD and BivalTyp

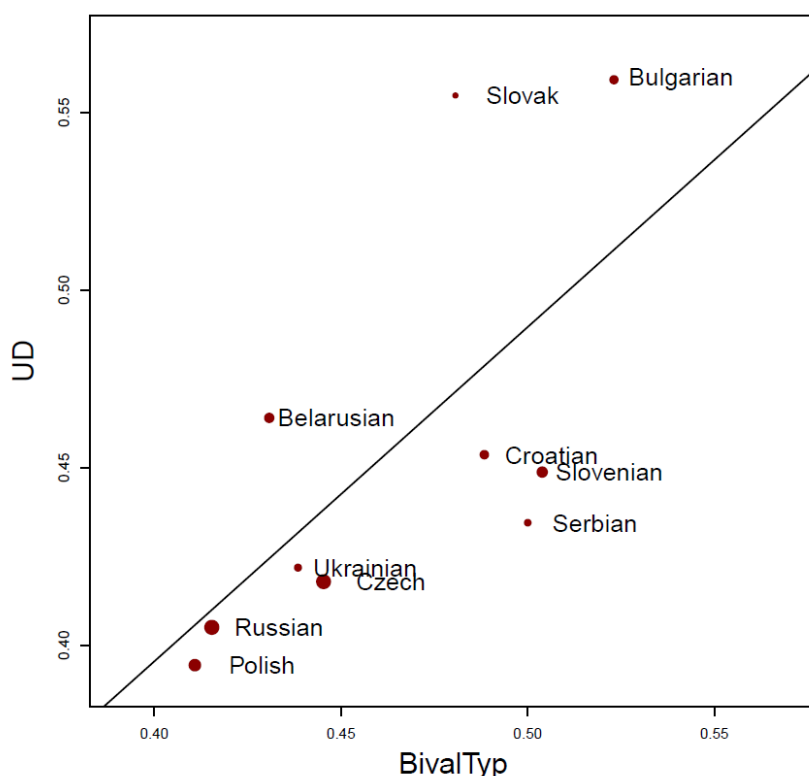


Figure 1. Transitivity prominence in UD and BivalTyp; point size reflects corpus size

Figure 1 visualizes the strong similarity between transitivity prominence values in the two datasets already reported numerically in Table 1, confirming the validity of the observed cross-linguistic differences.

Entropy values show a systematic numerical mismatch across datasets. In UD, entropy ranges from 2.12 (Bulgarian) to 2.72 (Czech), whereas BivalTyp yields substantially lower values, from 1.61 (Bulgarian) to 2.23 (Russian). This discrepancy is expected: BivalTyp is limited to at most 130 observations and necessarily

¹⁰ These scores are based on all non-subject dependents.

underrepresents rarer argument-coding patterns that contribute to overall entropy in UD. Nevertheless, the correlation between entropy scores is even stronger than for transitivity prominence and highly significant (Pearson's $r = 0.86$, $p = 0.0015$).

Methodologically, these strong correlations support the validity of the approach adopted here. While the usefulness of UD treebanks based on large amounts of naturalistic data is well established, the status of BivalTyp is less straightforward, given its reliance on elicited data, its limited size, and its restriction to bivalent verbs. However, cross-validation against UD confirms that BivalTyp captures broadly the same patterns of intragenealogical variation in valency class system complexity within Slavic.

One potential concern is the large variation in the size of UD-based datasets. To assess its impact, I performed a subsampling procedure, creating random subsamples of 4,732 observations for each of the ten languages (the size of the smallest dataset, Slovak). The entropy values calculated from these subsamples were very close to those based on the full datasets: in no case did the difference exceed 0.03. Importantly, the differences were sometimes positive and sometimes negative, suggesting that variation in corpus size is unlikely to systematically bias the entropy estimates. That said, corpus size may still affect some of the results obtained in an indirect way, since smaller datasets can reduce the accuracy of the frequency-based argumenthood algorithm, as discussed in Section 3. Possible calibration techniques addressing this issue remain to be explored.

Empirically, the results shown in Table 1 reinforce a clear north-to-south cline. North Slavic languages (Russian, Ukrainian, Polish, Czech) consistently display higher complexity than South Slavic languages (Slovenian, Croatian, Serbian, and especially Bulgarian), a pattern previously observed in BivalTyp (Say 2025a; see also Seržant et al. 2022 based on an unrelated dataset) and now corroborated by UD data.

Although non-Slavic comparisons are beyond the scope of this paper, two brief observations are in order. First, in a broader typological perspective, all Slavic languages exhibit moderate to high valency class complexity, forming part of a wider Eastern European areal concentration of complexity.¹¹ Second, based on BivalTyp data, the internal Slavic north-to-south gradient mirrors a larger areal trend extending beyond Slavic, from more complex systems in Baltic and Finnic to simpler systems in Southern Europe, including the Balkans (Say 2014: 136–137).

Within Slavic, several finer-grained factors nuance this cline. High complexity in Russian, Ukrainian, Polish, and Czech is largely driven by extensive use of oblique-case objects. While the frequency of dative dependents remains relatively stable across case-

¹¹ This claim was previously made by Bossong (1998), Lazard (1994: 63), and Haspelmath (2015: 139–142), confirmed on the basis of BivalTyp data in Say (2014; 2025b), and is now further supported by UD-based evidence. In UD, Slavic languages show complexity profiles comparable to those of several Central and Eastern European languages (German, Lithuanian, Finnish) and clearly exceed those of languages from other parts of Europe (French, Basque) and beyond (Turkish, Bambara), see Seržant & Say (2024).

marking Slavic languages (7–11% of clauses in UD), prepositionless genitive and instrumental objects are distributed unevenly, as shown in Table 2.

	ACC		DAT		INS		GEN		total clauses
	N	%	N	%	N	%	N	%	
Russian	36374	0.41	7929	0.09	9766	0.11	1677	0.02	89797
Belarusian	7641	0.46	1182	0.07	909	0.06	823	0.05	16467
Ukrainian	3075	0.42	646	0.09	571	0.08	818	0.11	7289
Polish	14616	0.39	3305	0.09	2273	0.06	3804	0.10	37057
Czech	35981	0.42	8042	0.09	6818	0.08	3601	0.04	86094
Slovak	2031	0.55	410	0.11	143	0.04	59	0.02	3661
Slovenian	10534	0.45	2535	0.11	0	0.00	2410	0.10	23473
Croatian	5478	0.45	1202	0.10	680	0.06	1023	0.08	12075
Serbian	2712	0.43	494	0.08	296	0.05	571	0.09	6262

Table 2. Clause counts and ratios for specific case-marked dependents in Slavic UD treebanks

The data in Table 2 highlight similarities in the frequency of prepositionless dative objects and significant differences in the frequency of prepositionless instrumental and genitive objects across Slavic.

Instrumental objects show clear frequency peaks in the North; for example, several North Slavic languages regularly use instrumental objects with verbs meaning ‘smell’, as illustrated for Ukrainian in (4).

- (4) *Vod-a u kyrnyc-i <...> pax-l-a rozmočen-oju trav-oju.*
 water in well-LOC.SG smell-PST-F.SG soaked-F.INS.SG grass-INS.SG
 ‘The water in the well <...> smelled of soaked grass.’ (UD)

Instrumental objects in some North Slavic languages show conceptual overlap with canonical accusative objects, reflected in their passivizability (Fowler 1996; Knjazev 2007: 526) and in alternations between accusative and instrumental marking in some semantic zones, such as verbs of throwing (Nuckols 2007: 163–205).

Genitive objects are likewise unevenly distributed, with peaks in Polish, Ukrainian, and Slovenian, in line with earlier non-corpus-based studies (Pirnat 2015). Genitive marking encroaches on domains typically associated with transitivity, as manifest i) in the genitive of negation, illustrated for Polish in (5), ii) partitive objects (an areal feature of Eastern Circum-Baltic languages, Seržant 2015), iii) the passivizability of certain Russian verbs lexically governing genitive objects (Fowler 1996), and iv) and the genitive-to-accusative drift as attested in e.g. Russian (Neset & Kuznecova 2015).¹²

- (5) *żaden powiew nie porusza-ł*
 none[NOM.SG.M] breath_of_wind[NOM.SG] not stir-PST[M.SG]
szklist-ego powietrz-a
 glassy-M.GEN.SG air-GEN.SG

¹² Caseless Bulgarian and Macedonian lack prepositional patterns analogous to the genitive of negation and related constructions in other Slavic languages.

‘No breath of wind stirred the glassy air above the little meadow.’ (UD)

One particularly unexpected result is that Slovak exhibits lower valency class complexity than Czech, as reflected in lower entropy and higher transitivity prominence in both BivalTyp and UD (Table 1). The accuracy of this generalization and its possible causes require further investigation beyond the scope of this article. One possible factor is the very small size of the Slovak UD treebank, which is roughly half the size of the second smallest treebank in the sample. As discussed in Section 3, smaller datasets may indirectly bias the estimates, because the argumenthood algorithm relies on statistically significant frequency differences. As a result, fewer arguments may be detected in smaller datasets, potentially inflating the proportion of transitive constructions, whose arguments are more easily identified.

Nevertheless, several considerations suggest that the higher complexity values observed in Czech compared to Slovak may reflect a real pattern. First, the same difference is observed not only in UD but also in BivalTyp, where dataset size is not a relevant factor. Second, the difference also appears in the entropy values calculated from the UD data, for which the distinction between arguments and adjuncts was not taken into account (see footnote 10). Subsampling the Czech dataset to the size of the Slovak dataset did not eliminate the large difference in entropy values (2.74 for Czech vs. 2.36 for Slovak). Third, the present observation partly aligns with earlier findings that Slovak shows higher transitivity prominence than other West Slavic languages, partially aligning it with South Slavic languages (Seržant et al. 2022: 311). In any case, the question of whether Czech and Slovak differ systematically in this respect requires more detailed investigation.

Finally, Bulgarian emerges as the Slavic language with the least complex valency class system in both UD and BivalTyp. Although UD data are unavailable for Macedonian, BivalTyp shows that Macedonian also has a relatively simple valency class system (entropy = 1.61). This extreme position of the two East South Slavic languages is plausibly linked to the loss of nominal case morphology. Although many former case functions have been reassigned to specialized devices (e.g. pronominal clitics and prepositions such as *na* for dative and *ot/od* for instrumental functions), the overall number of available argument-coding distinctions has nevertheless decreased. In particular, contrasts based on case alternations with the same preposition (e.g. *na* + ACC vs. *na* + LOC), common elsewhere in Slavic, are no longer available, contributing to the relative simplicity of these systems.

While the detailed interaction between quantitative complexity metrics and specific morphosyntactic developments remains to be explored, the interim methodological conclusion is clear: valency class system complexity is a crucial yet underappreciated dimension of typological variation (Say 2025b), one that reveals substantial differences even among closely related languages within the Slavic group, especially when examined from a token-based perspective.

5.2. Type and token frequencies of flagging devices

This section examines the distributions of **type and token frequencies** of individual argument-coding devices in the UD-based datasets. To illustrate the approach, consider Russian prepositional phrases with *k* ‘to, towards’ plus dative case, exemplified in (6)–(7).

- (6) *Itak, ušl-i roditel-i k djad-e Vas-e.*
 so go.PST-PL parent-NOM.PL to uncle-DAT.SG PN-DAT.SG
 ‘So, the parents went to uncle Vasya’s.’ (UD)
- (7) *Predpolož-im, on gotovitsja k publičn-omu*
 assume-1PL he.NOM prepare.PRS.3SG to public-N.DAT.SG
vystuplenij-u.
 performance-DAT.SG
 ‘Let us assume that he is preparing for a public performance.’ (UD)

This coding device, annotated as kDAT, occurs in 3,364 clauses headed by 781 distinct verb lemmas. Of these, 150 verbs were classified as selecting *k* + DAT dependents as arguments, as with *gotovit’sja* ‘prepare’ in (7), *dobavit’* ‘add’, *napravit’* ‘direct’, *otnosit’sja* ‘refer, belong’, as opposed to adjunct uses such as in (6). As discussed in Section 4, argumenthood annotation is based on co-occurrence frequencies: *gotovit’sja* combines with kDAT significantly more often than the average verb, whereas *ujti* ‘go (away)’, as in (6), does not.

From this point on, only argument uses are considered. The **type frequency** of kDAT as an argument-coding device is therefore 150, and its **token frequency** is 2,417, i.e. the number of clauses in which a kDAT phrase occurs as a dependent of one of these verb lemmas. I also calculated an **argumenthood ratio**, defined as the proportion of clauses in which a given coding device is annotated as an argument; for Russian kDAT, this ratio is 0.72 (= 2,417 / 3,364).

The same procedure was applied to all language-specific coding devices. As expected, token frequency correlates strongly with type frequency: devices used with more verbs tend to account for more corpus tokens. However, the relationship is not fully straightforward, as token frequency is not directly predictable from type frequency alone. To capture this variation, I computed the **token/type ratio** (token frequency divided by type frequency), corresponding to the average number of tokens per verb type. For kDAT, this value is 16.1 (= 2,417 / 150).

Figure 2 plots type frequency against the token/type ratio for Russian argument-coding devices with type frequencies above 50; point size reflects the argumenthood ratio.

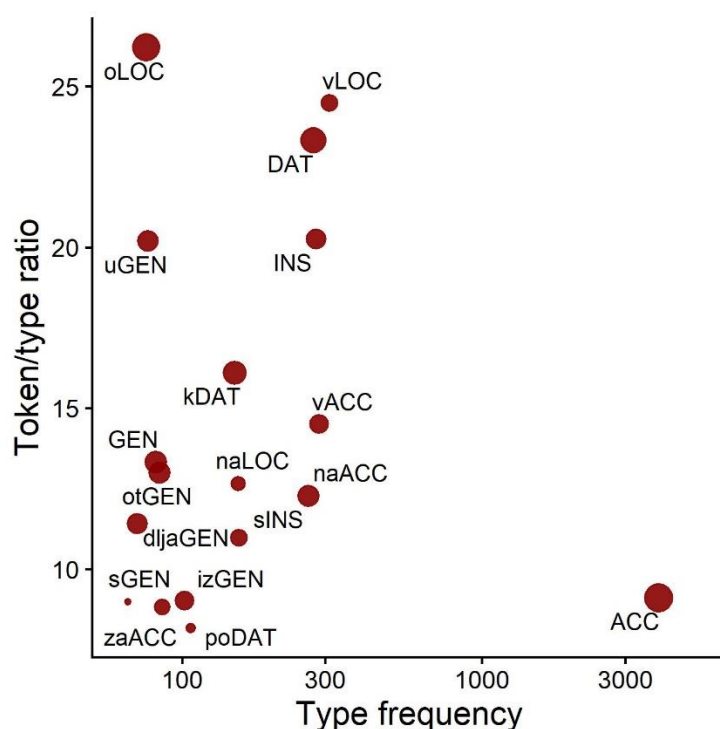


Figure 2. Type frequency and token/type ratio in Russian argument-coding devices

Figure 2 shows that argument-coding devices with comparable type frequency (i.e., the number of different verbs they co-occur with) can vary widely in the number of corpus tokens they cover. One unsurprising pattern in Fig. 2 is the exceptional behavior of the accusative case, which shows by far the highest type frequency (3,870, more than ten times that of the next device, preposition *в* ‘in’ plus locative case, with 310), coupled with a relatively modest token/type ratio. This reflects its role as the default object case, used with a very broad range of verbs and showing little semantic specialization.

Other devices display more complex profiles. Two illustrative cases are oLOC and zaACC. The combination of *о* ‘about’ with the locative (oLOC) has a low type frequency (76 verbs) but accounts for 1,992 tokens, yielding a high token/type ratio of 26 and also a high argumenthood ratio (0.91). These verbs form a semantically coherent class, consisting almost entirely of verbs of thought and speech, including high-frequency items such as *znat’* ‘know’, *zabyt’* ‘forget’, *sprašivat’* ‘ask’, and *govorit’* ‘talk’, illustrated in (8).

- (8) *Poroj oni govornjat o religi-i.*
 sometimes they.NOM talk.PRS.3PL about religion-LOC.SG
 ‘Sometimes they talk about religion.’ (UD)

Semantically, oLOC lacks spatial or temporal meanings and closely corresponds to an aboutness topic role, plausibly representing a case of thematic case assignment (Yip et al. 1987). It combines productively with verbs from a narrow semantic domain and rarely with others, yielding the observed quantitative profile.

A contrasting pattern is found with zaACC. Although its type frequency (86) is comparable to that of oLOC, its token/type ratio is much lower (8.8), and its argumenthood ratio is only 0.46. The verbs involved do not form a coherent semantic class but instead reflect several loosely related or idiosyncratic meanings, as in *bespokoit'sja za bezopasnost* ‘worry about safety’, *golosovat' za Trampa* ‘vote for Trump’, *prodavat' za kopejki* ‘sell for peanuts’, *vypit' za družbu* ‘drink to friendship’, or *perevalit' za sto dollarov* ‘exceed one hundred dollars’. In many cases, the semantic role of the dependent is abstract and difficult to delimit, and the choice of zaACC appears lexically determined.

These two devices thus represent opposite ends of a continuum, with many others—such as kDAT—occupying intermediate positions. Overall, Fig. 2 suggests a tentative generalization: higher token frequency per type tends to be associated with coding devices that encode more homogeneous and semantically tangible roles.

Space limitations preclude a detailed discussion of other Slavic languages, but the overall distributions are strikingly similar.¹³ Figure 3 presents Czech data in the same format as Fig. 2.

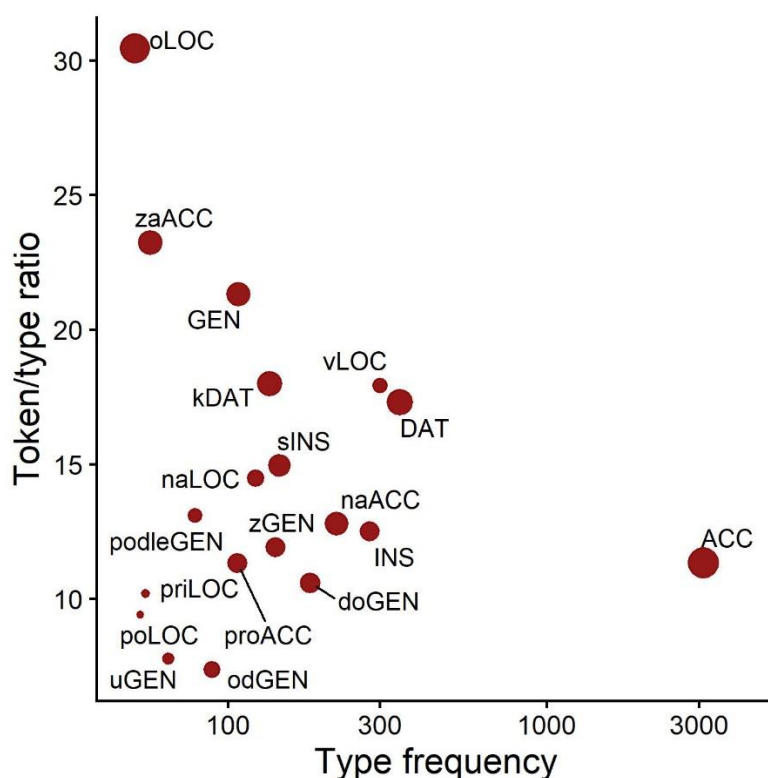


Figure 3. Type frequency and token/type ratio in Czech argument-coding devices

The overall distribution for Czech in Fig. 3 closely resembles that for Russian in Fig. 2. Moreover, many cognate devices show closely aligned quantitative profiles across

¹³ The main limitation concerns smaller treebanks, where data size is sometimes insufficient to draw clear conclusions about the relationship between token and type frequencies of individual argument-coding devices.

Russian and Czech, including ACC, DAT, INS, oLOC, kDAT, naACC, and naLOC (issues of cognacy mismatches aside). Some differences are nevertheless revealing. Notably, Czech zaACC does not pattern like its Russian counterpart: although it can express similar meanings, many verbs that require zaACC in Russian select different constructions in Czech (e.g. *obávat se o bezpečnost* ‘worry about safety’, *hlasovat pro Trumpa* ‘vote for Trump’, *připít si na přátelství* ‘drink to friendship’, *přesáhnout sto dolarů* ‘exceed one hundred dollars’). Instead, Czech zaACC is strongly associated with evaluative constructions, including those involving very frequent verbs, such as *považovat* ‘consider’ in (9), contributing to a high token/type ratio of Czech zaACC.

- (9) *Považuj-te proto tento dopis za pokus*
 consider.IMP-2PL therefore this letter[ACC.SG] for attempt[ACC.SG]
o smír.
 at reconciliation[ACC.SG]
 ‘Therefore, consider this letter an attempt at reconciliation.’ (UD)

Despite such instructive differences, the overall stability of quantitative profiles across Slavic languages suggests that the frequency-based mechanisms underlying argument coding are relatively robust diachronically (see Nessel & Janda 2023 for discussion of the possible role of stasis in Slavic diachrony).

6. Synopsis

This article has presented a proof-of-concept exploration of what a token-based perspective can contribute to the typology of valency class systems, drawing on UD-based data from ten closely related Slavic languages. Methodologically, the main result is that token-based measures capture dimensions of variation that remain opaque in purely type-based approaches, where verb lemmas rather than discourse tokens constitute the basic units of comparison.

Empirically, the study supports earlier claims that Slavic languages differ systematically in the complexity of their valency class systems, despite their close genealogical relationship. Using quantitative metrics such as transitivity prominence and entropy, the data reveal consistent intra-Slavic variation, with higher complexity associated with languages of the northern part of the Slavic area (Russian, Ukrainian, Polish, Czech), a pattern observable in both type- and token-based data.

In addition, the analysis of individual argument-coding devices shows that type and token frequencies, while correlated, do not map onto each other in a fully straightforward way. Across Slavic languages, coding devices associated with semantically more homogeneous verb sets and more tangible semantic roles tend to exhibit higher token frequencies relative to their type frequencies. While this observation remains preliminary, it points to a promising direction for future research on the interaction between lexical semantics, frequency, and argument coding.

Appendix

languages	BivalTyp				UD					
	tr	intr	TP	entropy	size	dependents	entropy	clauses	ACC/DO	TP
Russian	54	76	0.42	2.23	1896	122551	2.68	89797	36374	0.41
Belarusian	56	74	0.43	2.16	305	23047	2.56	16467	7641	0.46
Ukrainian	57	73	0.44	2.17	122	10350	2.7	7289	3075	0.42
Polish	53	76	0.41	2.17	499	50637	2.71	37057	14616	0.39
Czech	57	71	0.45	2.16	2252	115796	2.72	86094	35981	0.42
Slovak	62	67	0.48	2.03	106	4732	2.36	3661	2031	0.55
Slovenian	65	64	0.5	1.94	343	32536	2.56	23473	10534	0.45
Croatian	63	66	0.49	2.04	199	16731	2.62	12075	5478	0.45
Serbian	64	64	0.5	1.97	97	8402	2.62	6262	2721	0.43
Bulgarian	68	62	0.52	1.61	156	14539	2.12	11327	6334	0.56

Table A1. Overview of quantitative characteristics by language. Explanation of columns. BivalTyp data: *tr* and *intr* — number of transitive and intransitive patterns among BivalTyp entries, respectively (the sum is sometimes less than 130 due to missing data); *TP* — transitivity prominence (the number of transitive entries divided by the total number of non-missing data points); *entropy* — entropy of the distribution of entries across valency classes. UD data: *size* — UD treebank size (in thousands of tokens); *dependents* — total number of dependents in the dataset; *entropy* — entropy of the distribution of dependents across coding devices; *clauses* — total number of clauses; *ACC/DO* — number of dependents whose coding aligns with direct objects; *TP* — transitivity prominence.

References

- Ackerman, F., & R. Malouf. 2013. Morphological organization: The low conditional entropy conjecture. *Language* 89(3). 429–464. <https://doi.org/10.1353/lan.2013.0054>
- Apresjan, Ju. D. 1965. Opyt opisanija značenij glagolov po ix sintaksičeskim priznakam (tipam upravljenja). *Voprosy jazykoznanija* 5. 51–66.
- Apresjan, J. D., & E. Páll. 1982. *Russkij glagol – vengerskij glagol. Upravlenie i sočetaemost’*. Vols. 1–2. Budapest: Tankönyvkiado.
- Apresjan, Ju. D. (ed.). 2014–. *Aktivnyj slovar’ russkogo jazyka*. Vol. 1 (2014), Vol. 2 (2014), Vol. 3 (2017), Vol. 4, part 1 (2023), Vol. 4, part 2 (2024). Moscow: Jazyki slavjanskoj kul’tury.
- Bauer, Anastasia. 2021. Impersonalization in Slavic. *Journal of Slavic Linguistics* 29(2). 123–178. <https://doi.org/10.1353/jsl.2021.0012>
- Bickel, Balthasar, Taras Zakharko, Lennart Bierkandt & Alena Witzlack-Makarevich. 2014. Semantic role clustering: An empirical assessment of semantic role types in non-default case assignment. *Studies in language* 38(3). 485–511. <https://doi.org/10.1075/sl.38.3.01bic>
- Bossong, Georg. 1998. Le marquage de l’experient dans les langues d’Europe. In Jacques Feuillet (ed.), *Actance et valence dans les langues de l’Europe*, 259–294. Berlin: Mouton de Gruyter.
- Clancy, Steven J. 2006. The topology of Slavic case: Semantic maps and multidimensional scaling. *Glossos* 7. 1–28.

- Comrie, Bernard. 1981. *Language Universals and Linguistic Typology: Syntax and Morphology*. Chicago: The University of Chicago Press.
- Creissels, Denis. 2018. Transitivity prominence in typological perspective: The case of Basque. *Anuario del Seminario de Filología Vasca Julio de Urquijo* 52(1–2). 175–187. <https://doi.org/10.1387/asju.20215>
- Cysouw, M. 2014. Inducing semantic roles. In S. Luraghi & H. Narrog (eds.), *Perspectives on semantic roles*, 23–68. Amsterdam Philadelphia: John Benjamins.
- Dixon, R.M.W. 2010. *Basic linguistic theory*. Vol. 2: Grammatical topics. Oxford: Oxford University Press.
- Drossard, Werner. 1991. Transitivität (vs. Intransitivität) und Transitivierung (vs. Intransitivierung) unter typologischem Aspekt. In Hansjakob Seiler & Waldfried Premper (eds.), *Partizipation: Das sprachliche Erfassen von Sachverhalten*, 408–445. Tübingen: Narr.
- Fillmore, C. 1968. The case for case. In E. Bach & R. Harms (eds.), *Universals in linguistic theory*, 1–88. New York: Holt, Rinehart and Winston.
- Fowler G. 1996. Oblique passivization in Russian. *The Slavic and East European Journal* 40(3). 519–545. <https://doi.org/10.2307/309447>
- Goldberg, Adele E. 1995. *Constructions: A Construction Grammar Approach to Argument Structure*. Chicago: The University of Chicago Press.
- Haspelmath, Martin. 2009. Terminology of case. In Andrej Malchukov & Andrew Spencer (eds.), *The Oxford Handbook of Case*, 505–517. Oxford: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199206476.013.0024>
- Haspelmath, Martin. 2015. Transitivity prominence. In Andrej Malchukov & Bernard Comrie (eds.), *Valency classes in the world's languages*, vol. 1, 131–147. Berlin & Boston: De Gruyter Mouton.
- Haspelmath, M., & I. Hartmann. 2015. Comparing verbal valency across languages. In Andrej Malchukov & Bernard Comrie (eds.), *Valency classes in the world's languages*, vol. 1, 41–72. De Gruyter.
- Janda, Laura A. 1993. *A Geography of Case Semantics. The Czech Dative and the Russian Instrumental*. Berlin & New York: Mouton de Gruyter.
- Janda, Laura A. 2002. Cases in collision, cases in collusion: The semantic space of case in Czech and Russian. In Laura A. Janda, Steven Franks & Ronald Feldstein (eds.), *Where one's tongue rules well: A Festschrift for Charles E. Townsend*, 43–61. Columbus, OH: Slavica.
- Janda, L. A., & Clancy, S. 2002. *The case book for Russian*. Columbus, OH: Slavica.
- Juola, P. 2008. Assessing linguistic complexity. In M. Miestamo, K. Sinnemäki, & F. Karlsson (eds.), *Language complexity: Typology, contact, change*, 89–108. Amsterdam & Philadelphia: John Benjamins. <https://doi.org/10.1075/tsl.80.07juo>
- Knjazev, Ju. P. 2007. *Grammatičeskaja semantika. Russkij jazyk v tipologičeskoj perspektive*. Moscow: Jazyki slavjanskix kul'tur.
- Korhonen, A., Gorrell, G., & D. McCarthy. 2000. Statistical filtering and subcategorization frame acquisition. In *Proceedings of the Joint SIGDAT Conference on Empirical Methods in Natural Language Processing and Very Large Corpora*, 199–205. Hong Kong, China.
- Lazard, G. 1994. *L'actance*. Paris: Presses Universitaire de France.

- Levin, B. 1993. *English verb classes and alternations: A preliminary investigation*. Chicago: University of Chicago Press.
- Levin, B., & M. Rappaport Hovav. 2005. *Argument realization*. Cambridge: Cambridge University Press.
- Levshina, N. 2019. Token-based typology and word order entropy: A study based on universal dependencies. *Linguistic Typology* 23(3). 533–572. <https://doi.org/10.1515/lingty-2019-0018>
- Lopatková, M., Kettnerová, V., Bejček, E., Vernerová, A., & Z. Žabokrtský. 2016. *Valenční slovník českých sloves VALLEX*. Praha: Karolinum.
- Lyashevskaya, O., & E. Kashkin. 2015. Inducing verb classes from frames in Russian: Morphosyntax and semantic roles. In *Computational linguistics and intellectual technologies: Proceedings of the Annual International Conference "Dialogue"*, Moscow, May 27–30, Vol. 1, 412–425. RSUH Publishers.
- Malchukov, A. 2005. Case pattern splits, verb types and construction competition. In M. Amberber & H. de Hoop (eds.), *Competition and variation in natural languages: The case for Case*, 73–117. Oxford: Elsevier.
- Malchukov, Andrej L. & Bernard Comrie (eds.). 2015. *Valency classes in the world's languages*. Vols. 1–2. Berlin: Mouton de Gruyter.
- Malchukov, Andrej and Leipzig Valency Classes Project team. 2015. Leipzig Questionnaire on valency classes. In Andrej Malchukov & Bernard Comrie (eds.), *Valency classes in the world's languages, Vol. 1: Introducing the framework, and case studies from Africa and Eurasia*, 27–40. Berlin: Mouton de Gruyter.
- Miestamo, M., Sinnemäki, K., & Karlsson, F. (eds.). 2008. *Language complexity: Typology, contact, change*. John Benjamins.
- Næss, Åshild. 2007. *Prototypical transitivity*. Amsterdam & Philadelphia: John Benjamins.
- Nesset, Tore. 2004. Case assignment and image schemas: Russian temporal adverbials. *Studies in Language* 28(2). 285–319. <https://doi.org/10.1075/sl.28.2.03nes>
- Nesset, Tore. 2019. Big data in Russian linguistics? Another look at paucal constructions. *Zeitschrift für Slawistik* 64(2). 157–174. <https://doi.org/10.1515/slav-2019-0009>
- Nesset, Tore and Laura A. Janda. 2023. A network of allostructions: quantified subject constructions in Russian. *Cognitive Linguistics* 34(1). 67–97.
- Nesset, Tore & Julia Kuznetsova. 2015. Constructions and language change. From genitive to accusative objects in Russian. *Diachronica* 32(3). 365–396. <https://doi.org/10.1075/dia.32.3.03nes>
- Nikolaev, Dmitry & Sergey Say. n.d. Studying valency patterns of bivalent verbs with BivalTyp. Under review in *Language Resources and Evaluation*.
- Nivre, Joakim, Marie-Catherine de Marneffe, Filip Ginter, Jan Hajič, Christopher D. Manning, Sampo Pyysalo, Sebastian Schuster, Francis Tyers, & Daniel Zeman. 2020. Universal Dependencies v2: An Evergrowing Multilingual Treebank Collection. In *Proceedings of the 12th Language Resources and Evaluation Conference*, 4034–4043. Marseille: European Language Resources Association.
- Nuckols, Mark E. 2007. *Case variation in Czech and Russian: implications for the transitivity hypothesis*. Ph.D. dissertation. Ohio State University.

- Ovsjannikova, Maria. 2025. What it means to feel in Slavic: An exploration into the semantics of Slavic ‘feel’-verbs. *Prace filologiczne* 80. 231–253.
- Pirnat, Žiga. 2015. Genesis of the Genitive of Negation in Balto-Slavic and Its Evidence in Contemporary Slovenian. *Slovenski jezik – Slovene Linguistic Studies* 10. 3–52.
- Preradovic, N. M., D. Boras & S. Kisicek. 2009. CROVALLEX: Croatian verb valence lexicon. In *Proceedings of the ITI 2009 31st International Conference on Information Technology Interfaces, Cavtat, Croatia*, 533–538. <https://doi.org/10.1109/ITI.2009.5196142>.
- Przepiórkowski, A., Hajnicz, E., Patejuk, A., Woliński, M., Skwarski, F., & M. Świdziński. 2014. Walenty: Towards a comprehensive valence dictionary of Polish. In N. Calzolari, K. Choukri, T. Declerck, H. Loftsson, B. Maegaard, J. Mariani, A. Moreno, J. Odijk, & S. Piperidis (eds.), *Proceedings of the Ninth International Conference on Language Resources and Evaluation, LREC 2014*, 2785–2792. ELRA.
- Say, Sergey. 2014. Bivalent verb classes in the languages of Europe: A quantitative typological study. *Language dynamics and change* 4(1). 116–166. <https://doi.org/10.1163/22105832-00401006>
- Say, Sergey (ed.). 2020-. *BivalTyp: Typological database of bivalent verbs and their encoding frames*. Available online at <https://bivaltyp.info> (accessed 24 December 2025.)
- Say, Sergey. 2025a. Bivalent verb classes across Slavic: areal and genealogical patterns. *Russian Linguistics* 49. Article 13. <https://doi.org/10.1007/s11185-025-09322-w>
- Say, Sergey. 2025b. Degrees of complexity in valency class systems: implications for efficiency. *STUF - Language Typology and Universals* 78(4). <https://doi.org/10.1515/stuf-2025-2022>
- Say, Sergey & Ilja A. Seržant. 2024. Complexity of valency-encoding devices in pre- vs. postverbal positions. *Talk presented at the 57th Annual Meeting of the Societas Linguistica Europaea*. University of Helsinki, 21–24 August 2024.
- Say, Sergey & Ilja A. Seržant. 2025. An Algorithm for Argument Extraction from Russian Treebanks. *Neophilologica* 37. <https://doi.org/10.31261/NEO.2025.37.07>
- Schnell, S., Haig, G., & F. Seifart. 2021. The role of language documentation in corpus-based typology. In G. Haig, S. Schnell, & F. Seifart (eds.), *Doing corpus-based typology with spoken language corpora: State of the art*, 1–28. University of Hawai’i Press.
- Seržant, Ilja A. 2015. Independent partitive as an Eastern Circum-Baltic isogloss. *Journal of Language Contact* 8. 341–418. <https://doi.org/10.1163/19552629-00802003>
- Seržant, I. A., Wiemer, B., Bužarovska, E., Ivanová, M., Makartsev, M., Savić, S., Sitchinava, D., Skwarska, K., & M. Uhlik. 2022. Areal and diachronic trends in argument flagging across Slavic. In E. Dahl (ed.), *Alignment and alignment change in the Indo-European family*, 300–327. Oxford: Oxford University Press. <https://doi.org/10.1093/oso/9780198857907.003.0010>.
- Shcherbakova, O., Gast, V., Blasi, D. E., Skirgård, H., Gray, R. D., & Greenhill, S. J. 2023. A quantitative global test of the complexity trade-off hypothesis: The case

- of nominal and verbal grammatical marking. *Linguistics Vanguard* 9(s1). 155–167. <https://doi.org/10.1515/lingvan-2022-0067>
- Tsunoda, Tasaku. 1985. Remarks on transitivity. *Journal of Linguistics* 21. 385–396. <https://doi.org/10.1017/S0022226700010308>
- von Waldenfels, Ruprecht. 2012. Aspect in the imperative across Slavic — a corpus driven pilot study. In Grønn, Atle and Pazelskaya, Anna (eds.), *The Russian Verb. Oslo Studies in Language* 4. 141–154.
- Yip, Moira, Joan Maling & Ray Jackendoff. 1987. Case in tiers. *Language* 63(2). 217–250. <https://doi.org/10.2307/415657>
- Zeman, Daniel et al. 2023. *Universal Dependencies 2.12*, LINDAT/CLARIAH-CZ digital library at the Institute of Formal and Applied Linguistics (ÚFAL), Faculty of Mathematics and Physics, Charles University, <http://hdl.handle.net/11234/1-5150>.
- Zolotova, G. A. 2006. *Sintaksičeskij slovar'. Repertuar sintaksičeskix edinic russkogo sintaksisa*. Moscow: Editorial URSS.
- Žele, A. 2008. *Vezljivostni slovar slovenskih glagolov*. Ljubljana: Založba ZRC.