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## Time and space in parallel streams: in place of an introduction

### Время и пространство в параллельных потоках: вместо предисловия

Laura A. Janda

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We are pleased to present *Space and Time in Russian Temporal Expressions* as a special issue of *Russian Linguistics*, guest edited by Laura A. Janda, Stephen M. Dickey, and Tore Nessel. Here we offer some of the research results of the CLEAR (Cognitive Linguistics: Empirical Approaches to Russian) group<sup>1</sup> at the University of Tromsø and our collaborators. This research was sponsored by a grant from the Norwegian Research Council for a project entitled *Neat Theories, Messy Realities* and by a grant from the Centre for Advanced Study at the Norwegian Academy of Science and Letters for a project entitled *Time is Space: Unconscious Models and Conscious Acts*.<sup>2</sup>

The theme of this special issue of *Russian Linguistics* is the expression of time in Russian, a topic that raises two larger issues in linguistics:

1. What is the relationship between time and space in language?
2. How are choices made between rival linguistic forms?

The first question connects us to the metaphorical structure of linguistic cognition, which draws parallels between the experience of space and the understanding of time. While the overwhelming strategy is to map structures known to exist in the spatial dimension to the temporal one, the relationship is not one-to-one, but also shows divergence between the two domains. The articles in this special issue detail this complex relationship as revealed by adverbs, prepositions, aspectual morphology, and the etymologies of lexical items.

The second question connects us to language structure and processing. Rejecting traditions that have assumed elaborate hierarchical structures in language, a recent proposal (Frank et al. 2012) offers a model based instead on sequential structure. In this model, the constructions of a language appear in parallel, and complex sequences are aggregated by

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<sup>1</sup>[http://uit.no/publikum/prosjekter/prosjekt?p\\_document\\_id=220486](http://uit.no/publikum/prosjekter/prosjekt?p_document_id=220486).

<sup>2</sup><http://www.cas.uio.no/research/1112timeisspace/index.php>.

51 navigating among parallel streams. This model can account for the choice of rival forms  
52 as the selection of elements from one stream while bypassing nearly-synonymous elements  
53 in a parallel stream. The contributors to this special issue present data on choices between  
54 various lexical items and between grammatical constructions at both the syntactic and the  
55 morphological level.

56 All of the authors represented herein take an empirical approach to their respective topics,  
57 relying on various combinations of corpus data and statistical analyses. Some of the corpora  
58 and statistical applications described here are highly innovative. Their presentation is de-  
59 signed to promote best practices and encourage other scholars to take advantage of similar  
60 methods. This raises a third general theme for this volume:

### 61 3. What are the best practices for the empirical investigation of language? 62

63 The three sections of this introductory article examine the contributions in this special issue  
64 in more detail from the three vantage points outlined above: parallels between time and space,  
65 the parallel stream model for rival forms, and the use of new empirical methods to collect  
66 and analyze linguistic data. In this introductory article, the contributions in this issue will  
67 be referenced by their authors' names as Nessel et al., Baayen et al., Makarova and Nessel,  
68 Kuznetsova et al., and Plungian and Rakhilina.

## 71 1 Parallels between time and space and where they break down 72

73 All of the articles in this special issue test the limits of the TIME IS SPACE metaphor. While  
74 there is plenty of confirmation for the hypothesis that time is understood in terms of space,  
75 we find that the metaphor is not sufficient to explain all the phenomena we observe. Time is  
76 not merely a temporal version of space. Some structures that are found in the spatial domain  
77 do not appear in the temporal one, and the reverse is also true in some cases, suggesting that  
78 time can operate independently of space too.

79 Nessel et al. compare the Russian spatial terms for 'here', *zdes'* and *tut*, and find that the  
80 latter, but not the former, is often used instead to mark a point as metaphorically 'here' in the  
81 temporal domain, as in *vot ja za stolom, otodvigaju jaščik i tut zamečaju na stole anketu* 'so  
82 I am sitting at my desk and I open the drawer and here / now I notice a questionnaire on the  
83 desk'. *Tut* presents a clear case of the TIME IS SPACE metaphor, but there is a restriction that  
84 prevents us from applying this metaphor to *zdes'*. There is likewise a difference between the  
85 meanings of 'now' conveyed by *sejčas* and *teper'*, a difference that depends on a contrast in  
86 temporal location, but that does not seem to be motivated by any parallel in spatial expres-  
87 sion. *Vot* (like the French) 'voilà' behaves as a verbal pointing gesture incorporating both  
88 spatial and temporal deixis without giving primacy to either domain. Nessel et al. conclude  
89 that while temporal language does depend on spatial language, time also exercises consider-  
90 able autonomy from space, leading to space-time asymmetries, which are also identified by  
91 Makarova and Nessel.

92 Makarova and Nessel explore the use of prepositions meaning 'in(to)' with temporal  
93 nouns in five Slavic languages, as in Russian *v ponedel'nik* 'on Monday' (with the accusative  
94 case) and *v janvare* 'in January' (with the locative case). In all such expressions it is reason-  
95 able to assume that there is a connection between the (primary) spatial expression of the  
96 preposition and its use in temporal adverbials. However, there are also important asymme-  
97 tries between time and space. In all five languages we observe a complementary distribution  
98 of the accusative vs. locative case when 'in' is used with temporal nouns, as in the Russian  
99 examples above: days of the week require the accusative, but months require the locative. In

101 the spatial domain the distribution of cases is instead contrastive, distinguishing motion by  
102 the use of the accusative from rest by the use of the locative. Case usage in temporal expres-  
103 sions is more limited, but it is also true that temporal constructions, once established, may  
104 undergo relatively independent development.

105 Kuznetsova et al. continue the theme of prepositional constructions in which spatial mean-  
106 ings are extended metaphorically to the domain of time. *Pod* ‘under’ can signal simultaneity  
107 in *son pod šum doždja* ‘sleep to the patter of rain’, proximity to a temporal boundary in  
108 *pod utro* ‘towards morning’, and prospectivity in *bočka pod kvas* ‘barrel for kvass’. Only  
109 the last of these meanings is reflected by *iz-pod* ‘from under’, which can be used to signal  
110 retrospectivity in *bočka iz-pod kvasa* ‘empty kvass barrel’. All of these can be understood  
111 as temporal uses, but they differ from the spatial uses of the same prepositions in that very  
112 different semantic restrictions are relevant for the noun phrases in the spatial vs. temporal  
113 uses. The spatial uses also include specialized mini-constructions that have no correlates in  
114 the domain of time. Overall, temporal uses tend to change the relationship between central  
115 and peripheral meanings for a preposition, since meanings that are peripheral in the spatial  
116 domain often function as central in the temporal domain. Similar to Makarova and Nessel,  
117 Kuznetsova et al. found that in temporal expressions prepositions have a reduced range of  
118 case use, since *pod* can combine with both the accusative and the instrumental in spatial ex-  
119 pressions, but only with the accusative in temporal ones. The authors attribute the preference  
120 of temporal expressions for the accusative case, which indicates motion toward a goal, to the  
121 fact that time itself is often perceived as moving.

122 Russian adjectives denoting speed give Plungian and Rakhilina another perspective on  
123 the TIME IS SPACE metaphor. Rather than referring to distance traveled, adjectives like *bystryj*  
124 ‘quick’ are relatively detached from spatial reference and instead compare the temporal prop-  
125 erties of a target situation with a standard norm. Physics defines speed as distance divided  
126 by time, so a high speed implies covering a large distance in short time, but the same is  
127 not true for language. For example, *bystryj razgovor* ‘quick conversation’ does not indicate  
128 that a lot was conversed about in a short time, but rather just that the action was short, and  
129 thus this collocation is nearly synonymous with *korotkij razgovor* ‘short conversation’. Lin-  
130 guistic speed is more about duration than about (metaphorical) distance, and consequently  
131 relatively independent of space. There is also a bigger focus on high speed than on low speed  
132 in language, since we see more lexical elaborations for the former than for the latter.

133 The authors of the four articles described above all observe space-time asymmetries,  
134 which begs the question as to why such asymmetries should exist. If the conceptual con-  
135 struction of time is a metaphorical mapping of structures from space to time, then we would  
136 expect some differences due to the fact that such mappings are typically partial rather than  
137 complete (Janda 2010). In other words, we would not expect all of the structures that are  
138 found in the domain of space to be mapped over to the domain of time. This would account  
139 for greater restrictions in the use of expressions for time as opposed to space, as reported  
140 by Makarova and Nessel and Kuznetsova et al. But this does not account for the structures  
141 found only in temporal expressions observed in all four articles. This finding deserves more  
142 theoretical and empirical consideration in search of alternative motives beyond the TIME IS  
143 SPACE metaphor.

## 144 2 Activating parallel streams and switching between them

145  
146  
147  
148 Frank et al. (2012) challenge the prevailing assumption that languages possess a hierarchical  
149 structure as modeled in the hierarchical trees posited in generativism. On the basis of a review  
150

151 of recent neurophysiological, behavioral and computational studies, Frank et al. argue that  
152 linguists and psychologists are not justified in assuming hierarchical structure in language  
153 processing. They present evidence that sequential structure alone has sufficient explanatory  
154 power to account for many, perhaps most, linguistic phenomena. In other words, instead of  
155 analyzing utterances as composed of successively more complex units as in (1), it is probably  
156 the case that hearers analyze them according to the linear order of components as in (2).

157 (1) [Sentences [[can [be analyzed]]] [as [hierarchically structured]]]

158  
159 (2) [Sentences] [can be analyzed] [as hierarchically structured]  
160

161 Frank et al. (2012) point to a number of problems with the assumption of hierarchical struc-  
162 ture in language. For one thing, hierarchical structure has been attributed to an ability that  
163 is unique to human beings, but there is neither any viable evolutionary explanation nor any  
164 independent evidence for such a unique ability. Furthermore, hierarchical combination is  
165 probably too cognitively demanding to be applied recursively as has been asserted. Recent  
166 studies in the fields of cognitive neuroscience, psycholinguistics, and computational mod-  
167 eling point instead to sequential structure as the fundamental strategy for the structure of  
168 language.

169 Sequential structure makes sense from the perspective of both how language is used and  
170 what we know about how the brain works. Language production and comprehension are nec-  
171 essarily sequential because they take place along the temporal dimension. Sequential struc-  
172 ture is well established in terms of evolutionary continuity and general neural mechanisms.  
173 In other words, sequential structure does not force us to accept any ad-hoc assumptions that  
174 would apply only to human language.

175 Frank et al. (2012) offer an alternative non-hierarchical model in which components are  
176 combined from parallel streams, creating complexity without recourse to hierarchical struc-  
177 ture. This model makes room for interactions between components in parallel streams, since  
178 various factors can control the switching between them. Sequential processing thus involves  
179 the selection of components from parallel streams, and this is relevant because choice be-  
180 tween alternative forms is a major theme of this special issue.

181 Baayen et al. present four different case studies where Russian offers binary choices be-  
182 tween forms. At least two of these choices could be described as allomorphy, namely the  
183 choice between *nu*-suffixed and unsuffixed forms like *soxnuvšij* [participle] vs. *sox* [past  
184 tense] ‘dried’ and the choice between the prefix variants *o-* and *ob-* as in *osložnit* ‘make  
185 complicated’ [before an obstruent] vs. *obnovit* ‘renew’ [before a sonorant]. However, the  
186 data shows that the supposed constraints on allomorphy leak; instead of complementary dis-  
187 tribution, there is overlap and competition in some contexts, so one can find both *sox* and  
188 *soxnul* ‘dried’ and both *obskakat* [with *ob-* before an obstruent] and *onemečit* ‘german-  
189 ify’ [with *o-* before a sonorant]. There is thus a continuum ranging from allomorphy to rival  
190 forms. Even at the allomorphy end of this continuum we find some overlap in certain envi-  
191 ronments. Rival forms can be both partly overlapping and partly contrastive in distribution,  
192 like the prefixes *pere-* and *pre-* and the locative alternation constructions with theme–object  
193 in *gruzit’ seno na telegu* ‘load hay onto the cart’ vs. goal–object in *gruzit’ telegu senom* ‘load  
194 the cart with hay’. A wide variety of factors such as semantics and frequency come into play  
195 in regulating the distribution of each of these choices.

196 Two contributions in this issue discuss rival forms involving case and preposition con-  
197 structions. Makarova and Nessel examine adverbials expressing when an event takes place  
198 across various Slavic languages. In Russian, for example, there are choices between *v* ‘in(to)’  
199 in construction with either the accusative case as in *v ponedel’nik* ‘on Monday’ or locative  
200



**Fig. 1** Idealized relationship between form and meaning

case as in *v janvare* ‘in January’, plus other competing constructions such as the bare genitive with dates as in *pjatogo maja* ‘on the fifth of May’, bare instrumental as in *letom* ‘in the summer’, and *o* ‘about’ with the locative as in *o Roždestve* ‘at Christmas time’. These various options show different distributions across the Slavic languages, and in each language are associated with differences in the number and meaning of the temporal noun and whether it is modified by an adjective. Kuznetsova et al. discuss the competition between constructions such as *pod konec* vs. *k koncu* ‘toward the end’ and *(pristrojka) pod bassejn* vs. *dlja bassejna* ‘(extension) for a swimming pool’ and find that in both, the version with *pod* and the accusative case is much more restricted in terms of the nouns that can be used.

The remaining two contributions focus on lexical choices. Nessel et al. find that the five Russian words used to signal ‘here’ and ‘now’, *zdes*, *tut*, *sejčas*, *teper*, *vot*, inhabit a single network of spatio-temporal meanings, though their centers of gravity and ranges within that network vary. These words show different behaviors with respect both to their overall corpus distribution and to their use in TV broadcasting. Plungian and Rakhilina point out that Russian has many words that express speed, particularly among adjectives that can mean ‘quick’ such as *bystryj*, *skoryj*, *šustryj*, *sporyj*, etc. They carefully pick apart these near-synonyms, showing how metaphor and metonymy motivate differences in their meanings and use.

What is going on when speakers select one near-synonym out of multiple options for expressing the same (or nearly the same) idea? I will approach this question by examining first form-to-meaning relationships and then possible mechanisms for activating and making selections.

The expressions of a language are pairings of form and meaning, known as ‘constructions’ (Goldberg 2006) or as ‘symbolic assemblies’ (Langacker 2008, pp. 21–24). The latter concept is broad enough to account for all structures of grammar, but here we will use the term constructions to refer to linguistic elements at various levels, including morphemes (like prefixes and suffixes), grammatical constructions (like preposition and case constructions and the locative alternation constructions), and lexical items (like near-synonyms). The form-meaning relationship described here has its roots in De Saussure’s (1949[1916]) concept of language as a system of signs that express ideas.

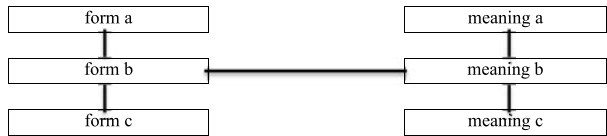
Ideally one might imagine a one-to-one relationship between form and meaning in a construction, as in Fig. 1.

The form end of the relationship can be complex in the case of allomorphy, where we have a default allomorph and its variants. Similarly, on the meaning end, we find that the majority of linguistic elements are polysemous (Langacker 2008, p. 37). We can represent polysemy as a radial category with the prototypical meaning of the element and its more peripheral meanings. We can diagram a form-meaning relationship with both allomorphy and polysemy as in Fig. 2. Here the various allomorphs are all labeled ‘form’. ‘Form b’ is the default allomorph and ‘meaning b’ is the prototypical meaning. One line connects the entire group of forms to the entire group of meanings in Fig. 2, though the relationships may be more complex, as shown below in Fig. 3.

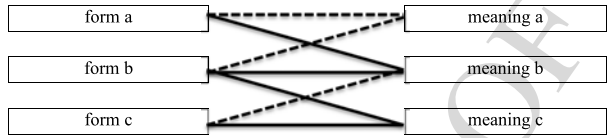
As shown by Baayen et al. and discussed immediately above, there is no clear division between allomorphic variation and rival forms, and even cases of allomorphy may involve some overlapping contexts. Rather than a strict allocation of forms according to contexts, it is more accurate to talk about statistical tendencies. Both allomorphy and rival forms can be understood as choices among forms that languages offer their users. Perfect synonymy



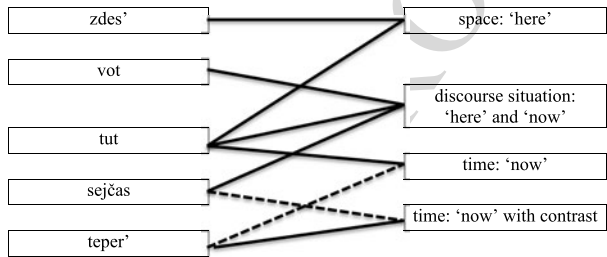
251 **Fig. 2** The form-meaning  
252 relationship representing  
253 allomorphy and polysemy  
254  
255



256  
257 **Fig. 3** Rival forms in  
258 relationship to their meanings  
259  
260  
261



262  
263 **Fig. 4** Form-meaning  
264 relationships for 'here' and 'now'  
265 in Russian (simplified)  
266  
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272



273 is likewise quite rare, so choices are further complicated on the meaning end. Rival forms  
274 present choices that have overlapping but not necessarily completely identical meanings.  
275 What is a prototypical meaning for one near-synonym may be peripheral for another. We  
276 can diagram a linguistic choice as in Fig. 3, where solid lines represent stronger connections  
277 and dotted lines represent weaker connections (these have been assigned randomly). Both  
278 the lines connecting the three forms and the lines connecting the three meanings have been  
279 removed.

280 In Fig. 3, Form b is associated with all three meanings, but more strongly with meanings b  
281 and c than meaning a. Form a is most strongly associated with meaning b, though meaning a  
282 also occurs, and form c is associated with both meaning b and meaning c, but more so with c.  
283 Figure 3 can be adjusted to fit any of the analyses found in this special issue. For example,  
284 the Russian words for 'here' and 'now' (Neset et al.) can be diagrammed as in Fig. 4.

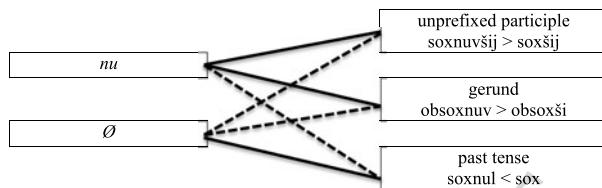
285 *Zdes'* connects only to the spatial meaning 'here' and *vot* connects only to the discourse  
286 situation 'here' and 'now'. *Tut* connects to both of those meanings and can also express the  
287 temporal 'now'. *Sejčas* connects to all the meanings containing 'now', but only weakly to  
288 uses where there is temporal contrast, which is the only meaning where *teper'* is preferred.

289 Where meaning is held constant, we can substitute context, with the understanding that  
290 of course context and meaning are closely connected. In other words, in the absence of any  
291 (lexical) meaning difference, different forms (allomorphs) can index different contexts. For  
292 example, *-u/-ju, -e, and -i* are allomorphs of the dative singular ending for Russian nouns.  
293 Though the meaning is the same, they do index different contexts since *-u/-ju* means that  
294 the noun is masculine or neuter, *-e* means that the noun ends in *-a* in the nominative, and *-i*  
295 means that the noun is feminine ending with a soft sign (mjagkij znak) in the nominative. In  
296 a similar, though less clear-cut fashion, the *nu*-suffix tends to index participles and gerunds,  
297 while the  $\emptyset$ -suffix tends to index past tense forms among verbs that show *nu*- vs.  $\emptyset$ -variation.  
298 The distribution of *nu*- vs.  $\emptyset$ -suffixes in Russian verbs in Baayen et al. could be represented  
299 as in Fig. 5.  
300

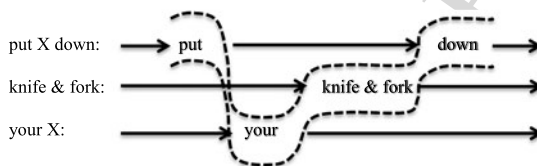


## Time and space in parallel streams

**Fig. 5** Form-context relationships for *nu* vs.  $\emptyset$  (simplified)



**Fig. 6** The parallel sequential streams model for combining elements of a construction (after Frank et al. 2012)



Both *nu* and  $\emptyset$  are found in all three contexts, but whereas *nu* is more strongly associated with the non-finite participle and gerund forms,  $\emptyset$  is preferred for finite past tense forms.

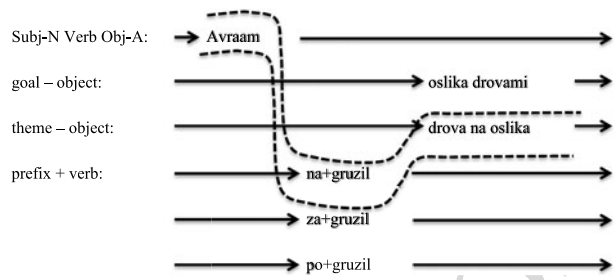
Let us assume that Figs. 4 and 5 illustrate our model for the form-meaning relationships, and now tackle the issue of how alternative forms and their meanings can be made available and selected. Here I propose that this can be modeled as selection from parallel streams. This proposal is an extension of the one made by Frank et al. (2012), showing how syntactic relationships that have previously been explained in terms of hierarchical structure can instead be accounted for in a model using sequential, non-hierarchical structure. In their model, items are combined from parallel sequential streams, eliminating any need for hierarchical processing. They give as an example the complex construction *put your knife and fork down*, which includes elements from the more schematic constructions *put X down* and *your X*, plus a chunked phrase *knife and fork* (for more on linguistic chunks, see Dąbrowska 2004, Chapter 9). The whole is processed by ‘changing lanes’ among the parallel streams, as diagrammed in Fig. 6 (note that the vertical ordering of constructions is arbitrary).

This model can be compared to a musical score for a symphony in which different instruments represent different parallel streams. Each instrument is silent for a while and then plays for a certain time, and then stops again. Note also the resemblance to non-linear models of phonology, where each articulator has its own stream.

The parallel sequential streams model proposed by Frank et al. (2012) is primarily aimed at comprehension and at syntax, but there is in principle no reason why it cannot be extended to production data (such as what we find in a corpus) and to other kinds of constructions (such as morphemes, preposition and case constructions, and lexical items). Furthermore, there is no reason why parallel streams should not include alternative rival forms in addition to the forms that are actually selected. In other words, relevant rival forms could be activated as parallel streams without necessarily being selected, and the selection could be regulated by various factors such as frequency, meaning, etc. (Frank p.c. 2013). Indeed we already know from priming studies that exposure to a given linguistic form activates other forms with similar meanings, function, and form, so the idea that the choice of rival forms could involve the activation of parallel streams, only one of which is actually chosen, is plausible.

Figure 7 shows how this extension of the parallel sequential streams model might work for rival forms in the production of the sentence *Avraam nagruzil drova na oslika* ‘Abraham loaded wood onto a donkey’, an example of the use of *gruzit* ‘load’ in the theme-object construction; cf. statistical models of how this verb and construction interact in Baayen et al. (this volume, Sect. 3.1). This sentence illustrates the transitive active verb construction with a subject in the nominative case and an object in the accusative case (Subject-N Verb

**Fig. 7** An example model of parallel sequential streams for *gruzit'* 'load' and its constructions



Object-A). Russian offers rival forms that can be modeled as parallel streams for both the locative alternation, with the theme-object vs. goal-object constructions, and for the perfectivization of the verb, which can be achieved using three different prefixes. All three perfectivizing prefixes and both types of object constructions can be activated in parallel streams and various factors are responsible for regulating the switching among streams that yields the actual utterance.

A similar model can be used to capture the relationships among rival forms described in all five articles in this issue. Collectively one could say that this issue describes the control mechanisms for switching among parallel streams and selecting one rival form over another. These control mechanisms receive both qualitative and quantitative attention in our articles, as described in the following section.

### 3 New empirical approaches

All of the studies in this issue rely on authentic language data from corpora, namely the Russian National Corpus (all five articles), the NewsScape Library of International Television News at UCLA (Nesset et al.), and the ParaSol corpus and Czech National corpus (Makarova and Nesset). It is no exaggeration to state that corpus data have become a mainstay of modern linguistic analysis, regardless of whether or not statistical methods are applied. In addition to providing concrete data for Russian, parallel corpora facilitate cross-linguistic comparisons, as we see in the comparison of temporal adverbials across Slavic languages made by Makarova and Nesset and in the lexical typological comparisons made by Plungian and Rakhilina. Additionally, a multi-modal corpus makes it possible to assess the relationship of linguistic forms to simultaneous visual signals such as gestures and images, as shown by Nesset et al.

The sheer quantity of data is constantly increasing; indeed the Russian National Corpus has doubled in size even during the one year in which this special issue was under production. The NewsScape Library was initiated while our research was underway and already contains billions of words in addition to accompanying images. In the face of so much data, it is becoming more and more common to apply statistical methods in order to probe the data for patterns. Three of the articles in this issue, Baayen et al., Nesset et al., and Makarova and Nesset, apply statistical tests to corpus data. However, this should not suggest any priority of quantitative methods over qualitative ones. The truth is that we need to continue to develop both kinds of analysis in order to move the field of linguistics forward. Without qualitative insights into linguistic questions, quantitative studies are meaningless. One needs considerable qualitative expertise in order to recognize what kinds of questions are linguistically interesting, figure out what kind of data it makes sense to collect, and then interpret the results.

401 However, even qualitative study should not take place in a vacuum based on armchair mus-  
402 ings over constructed examples. Instead, qualitative analysis should be informed by corpus  
403 data, as illustrated by Kuznetsova et al. and Plungian and Rakhilina.

404 Whereas qualitative analysis has a long tradition in linguistics, quantitative analysis is less  
405 established. We see a need to develop standards, both in terms of what kinds of statistical  
406 models to apply to given linguistic questions, and also how to present and share data and  
407 code.

408 The three articles in this issue that apply statistical methods attempt to provide good ex-  
409 amples of best practices. Nessel et al. demonstrate differences in the distribution of deictic  
410 words in the Russian National Corpus, and each time back up their data with a chi-square test  
411 for statistical significance and a test of the effect size. Taken together those two tests tell us  
412 whether an observed difference is likely to be indicative of a real difference (rather than being  
413 an artifact of a given sample) and whether the difference is big enough to be meaningful. It is  
414 reasonable to expect that all studies of corpus data that claim to find different distributions of  
415 forms should at minimum present the results of these or similar tests. Makarova and Nessel  
416 use some more sophisticated methods, namely a principle components analysis and linear  
417 regression to explore the relationship between the grammatical constructions of time adver-  
418 bials and the geographic locations of languages. These two methods yield similar results,  
419 confirming an east-west distribution of constructions. Baayen et al. explore the use of classi-  
420 fication tree & forest and naive discriminative learning models as alternatives to traditional  
421 logistic regression in modeling the choice of rival forms in Russian. They find remarkable  
422 convergence among these three methods in terms of classification accuracy and assessment  
423 of the relative importance of variables. Each method has a different set of strengths and weak-  
424 nesses. The tree & forest and naive discriminative learning models are non-parametric, which  
425 means that they are probably more appropriate for the kind of distribution of data we often  
426 find in language corpora, and they are also more plausible as models of linguistic behavior,  
427 since the individual trees ‘vote’ for various choices of rival forms (similar to choices made  
428 by individual speakers), and naive discriminative learning adjusts the weights of these asso-  
429 ciations (similar to what we presume happens in neural networks). Baayen et al. conclude  
430 that we can recommend tree & forest and naive discriminative learning models as methods  
431 to complement logistic models.

432 The authors of all three studies have posted their data and code to a publicly accessible  
433 website at <http://ansatte.uit.no/laura.janda/RLdata/RLdata.html> and use the open-source R  
434 software for their analysis. Readers are encouraged to inspect the data and run the code on  
435 their own computers. Our research adheres to the scientific standard of replicability in that  
436 anyone can verify our results. We hope that other scholars will complete the cycle of the  
437 scientific method by also reproducing similar results for similar kinds of data and research  
438 questions.<sup>3</sup>

#### 439 440 441 **4 Concluding remarks**

442  
443 On the level of specific contributions, this special issue offers detailed studies of Russian  
444 morphology, syntax, and lexicon used in the expression of time. Beyond that, this issue of  
445 *Russian Linguistics* addresses some core issues in linguistics. It provides a more nuanced

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448 <sup>3</sup>Collins (1985, p. 19) refers to replicability of results as the “Supreme Court of the scientific system”. Repro-  
449 ducibility is presented as a cornerstone of the scientific method in textbooks like that of O’Leary (2004, pp.  
450 58–64).

451 perspective on the TIME IS SPACE metaphor, showing that while the expression of time is  
452 largely motivated by patterns of spatial expression, time in language does not simply mirror  
453 space; time presents different restrictions and can be partially independent of space. The  
454 choice of linguistic forms also emerges as a major theme in this issue. Rival forms can be  
455 modeled in terms of parallel sequential streams, elaborating on a proposal that minimizes the  
456 need for hierarchical structure in language. Data analysis is a growing challenge for linguists,  
457 and we suggest some best practices for implementation of statistical methods and public  
458 access to files and code. We hope that these studies can serve as models that will inspire  
459 others to conduct similar research.  
460

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