

## **EMERGENCE OF AKTIONSPORTEN: THE FIRST STEP TOWARDS ASPECT**

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Slavic aspect has remained a mystery for centuries and continues to fascinate linguists. The genesis of this intricate grammar category is even a greater puzzle. This paper aims at computationally reconstructing the prerequisite for aspect – the emergence of a system of markers for Aktionsarten. We present an experiment where artificial language users develop a conventional system as the consequence of their distributed choices in locally situated communicative acts.

### **1. Introduction**

Little is understood about the evolution of the infamously complex Slavic aspect. The literature on this subject is highly controversial. It is traditionally assumed that the aspectual system was already fully developed in the earliest Slavonic texts. Presumably already in Old Church Slavonic (established by Saints Cyril and Methodius in the 9th century AD) no verbs were exempted from the aspectual opposition which is identical with that in the modern Slavic languages (Dostal, 1954; Vaillant, 1966). Other scholars disagree with this view due to considerable discrepancies between verbal usage in Old Russian and modern Russian (Ruzicka, 1957). Additionally, some recent work (Bermel, 1997; Dickey, 2007) indicates that aspect as we know it in Russian today was sorted out much later, in the 16th-17th centuries. Not all scholars accept these recent results. However, even if one supports the more traditional view of a rather stable system it only reschedules but does not answer the question: How did this system come to existence?

In his exciting and comprehensive work, Forsyth (1972) proposes successive steps of how aspect could emerge and develop in complex tension with tense. He suggests that the perfectivity of a prefixed verb is basically nothing more than a by-product of the word-building process by means of which forms with new semantic nuances – new Aktionsarten – were derived. Further, he points to revealing statistics of modern as well as Old Russian concluding that aspectual opposition resides essentially in the contrast between simple verbs and their prefixal counterparts – those with new Aktionsarten – which nowadays account for ca 80 percent of the total verb occurrences. Another elaborate hypothesis about the origin of

aspect is presented by Maslov (1961). Although it differs from that of Forsyth (1972) in later stages, the beginning of aspect remains the same – the existence of the general principle of prefixation to derive new Aktionsarten.

We propose to trace the genesis of aspect through computational simulations, since processes that took place long ago are notoriously difficult to verify otherwise. With this paper focusing on the prerequisite of Slavic aspect development, namely derivation of new Aktionsarten through prefixation, we demonstrate the emergence of prefixal forms in artificial populations.

This paper consists of two parts. The first part explains through a case study of Russian that aspect in Slavic languages is very distinct from a sporadic expression of aspect in other languages, and it addresses some historical facts. In the second part, we report on an experiment where a prefixal system becomes conventionalized in an artificial community, ending with discussion and future work.

## **2. Linguistic Background**

### **2.1. Dimensions of Aspect**

Russian aspect is notorious for its complexity. However, it is omnipresent in the grammar, and every verb in all forms and tenses expresses aspect. Moreover, it is the *primary* temporal distinction made by verbs in all modern Slavic languages and by far outranks tense. Russian aspect involves two dimensions: the *grammatical* category of aspect and the *semantic* category of Aktionsart. Grammatical aspect is manifested as a contrast between Perfective and Imperfective. Perfective aspect expresses the action as a *total event* summed up with reference to a single *junction*, and Imperfective is characterized by the absence of that notion (Forsyth, 1972). The *junction*, or position of the event's boundary, is fundamental for the Aktionsart of the verb, but the notion of perfectivity does not discriminate between the different possible positions (Bickel, 1997; Stoll, 1998). For example, the *ingressive* Aktionsart expresses the notion of beginning of an event, as in the verb *заговорить* (*zagovorit*, 'start-talking.PFV'), whereas the Perfective sums up this beginning as a single undividable whole presenting it as a total event. Similarly, the *terminative* Aktionsart is characterized by focusing on the final boundary of the corresponding event, as in *договорить* (*dogovorit*, 'finish-talking.PFV'), and the Perfective expresses this final phase of *talking* as a total.

### **2.2. Morphology**

The morphology of Russian aspect mirrors the complexity of its semantics. In contrast to many other languages such as Turkish and English, it is the Perfective rather than Imperfective which is the marked member of the opposition, and there are numerous morphological markers expressing it. Russian verbs can be roughly divided into 'simple' verbs, consisting of a stem and a conjugated ending, e.g. *читать* (*čitat*, 'read.IPFV'), *щипать* (*šipat*, 'pinch.IPFV'), and 'complex' verbs,

which are derived from the latter by the addition of aspectual markers, e.g. by prefixation *перечитать* (*perečitat*, 're-read.PFV'), *выщипать* (*vyšipat*, 'pinch out.PFV'). Simple verbs typically describe activities and are Imperfective. The addition of a prefix changes the aspect of simple verbs into Perfective. Russian has nineteen verbal prefixes that productively form Perfective (Krongauz, 1998).

In modern Russian, verbs can undergo more than one aspectual derivation. After a prefix is added to the simple verb, which made it Perfective, the so-called imperfectivizing suffixes can flip the verb's aspect to Imperfective again. But historically, the second imperfectivization developed only after the prefixal derivatives became 'perfective'. As already mentioned, awareness of the aspectual opposition is focused in the contrast between simple imperfective and prefixed perfective forms (and not between the latter and secondary imperfectives) which together account for ca 80 percent of the total verb occurrences (Forsyth, 1972).

### **2.3. Historical development of aspect**

What is known for sure is that Old Church Slavonic had a complex set of tenses, including a Present, two Past tense forms (Aorist and Imperfect), a Future, and four periphrastic tenses (Perfect, two Pluperfects, Future Perfect, see Andersen, 2006). In this proto-system aspect was nascent, but dominated by tense. In the modern Slavic languages we see a reversal of roles, and the dominant factor, aspect, displays typologically unusual behavior (Dahl, 1985).

In his attempts to trace the origin of aspect, Forsyth (1972) wonders: What is so special about the prefixation in Slavonic as compared to e.g. Latin, which did not develop a grammatical system of aspect? In the latter language, prefixes were used purely for derivation of new words, e.g. in Latin *fēci* 'made, did' → *confēci* 'accomplished', which is a new verb lexeme with more precise lexical meaning distinct from that of the simple verb, and which could be used in any syntactic function in the sentence. In Slavonic, however, prefixes had the dual role of providing not only lexical derivatives but also *Aktionsart* modifications of the basic verb (e.g. temporal modifications), and the disposition for the latter resulted in the spread of a generalized meaning of *totality* of the action, differing from, but overlapping with the *Aktionsarten* (as it is in modern Russian). Thus, the analogous process became linked with the grammatical meaning, not necessarily of actual completion of the action as an objective fact, but essentially with the syntactically restricted functions of expressing result, aim, sequence, condition, etc. Forsyth assumes that such meaning of totality developed first in one or another tense/mood form and only gradually spread until it embraced the whole paradigm.

Together with the fact that also in Old Russian the great majority of verb forms, at least in written texts, are simple verbs and primary prefixed 'perfectives' (Forsyth, 1972), the conclusion seems inescapable that the prefixed forms are at the heart of aspect. In sum, perfectivity of a prefixed verb is the consequence of the word-building process – *Aktionsarten* derivation. Thus, the derivation of new

temporal modifications of verbs is the fundament of the origin of Slavic aspect.

### 3. Experiment

Derivation of Aktionsarten is the precondition for the development of Slavic aspect and is the subject of our modeling. We aim at demonstrating how such a system can be developed as the consequence of distributed processes whereby language users continuously shape and reshape their language in locally situated communicative interactions. Since our focus is not on lexicon formation (Steels, 1996), the interacting agents are assumed to operate a fully developed lexicon.

#### 3.1. *Language Game for Aspect*

The setup of the experiment is inspired by psychological studies of Stoll (1998), who investigated how Russian children develop their understanding of aspect. Toddlers were interviewed after watching pairs of short movies, each illustrating what would be described by a different aspectual form of the same verb stem. Analogically to children, artificial agents in our experiment observe pairs of events differing in temporal semantics and afterwards engage in dialogs about these events. The experiment is framed as an incarnation of a *Language Game* (Steels, 2001) and consists of routinized communicative acts of identical form between members of an artificial community. A single interaction is best explained by looking at an example interaction between two agents – speaker and listener.

**Example interaction** Both agents perceive a shared context consisting of two events of the same kind but with different temporal semantics, e.g. *Michael read for a while* versus *Masha read the whole time*. The speaker chooses one event from the context as a *topic* she wants to communicate about, e.g. *Michael read for a while*. The communicative goal of the speaker is to ask a question about the protagonist of the topic. The question should unambiguously discriminate the protagonist, here this means that the event's temporal structure has to be incorporated into the question. For example, *Who read for a while?* discriminates Michael because only he was involved in the action for a short period of time (Masha was reading the whole time). Then, the speaker verbalizes the constructed question<sup>3</sup>. The hearer parses and interprets the meaning of the question by comparing it to the facts in the context. If the hearer is able to answer the question, i.e. identify the protagonist of the topic by comprehending the included temporal semantics, she verbalizes her answer by saying *Michael*. Otherwise, she gives up. The correct answer means communicative success, no answer is a failure. In the case of either incorrect or absent answer, the speaker reveals the desired answer. Based on the

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<sup>3</sup>Language processing of agents is implemented in the Fluid Construction Grammar (FCG, see [www.fcg-net.org](http://www.fcg-net.org)); the details can be found in Gerasymova, Steels, and van Trijp (2009).

outcome, both agents consolidate their grammatical knowledge by increasing or decreasing the scores of constructions as well as creating or deleting them.

### 3.2. Cognitive Mechanisms

In order to be able to deal with communicative problems, agents are equipped with cognitive problem-solving tactics. These cognitive mechanisms consist of problem diagnostics and repair strategies and are crucial for the emergence process.

**Inability to express meanings** Imagine the speaker is confronted with the context as in the example interaction: there are two events *Michael read for a while* versus *Masha read the whole time*. Let us suppose that her chosen topic is the event where *Michael read for a while*, so she tries to verbalize the question *Who read for a while?*; especially the temporal semantics *for a while* of the corresponding reading has to be incorporated into the question, because this information is essential to make the question discriminative. She starts producing and, with the help of a given lexicon, produces the utterance: *Who read?* Rather than transmitting this utterance directly to the hearer, the speaker first *re-enters* – parses – it to predict the effect it might have on the hearer (Steels, 2003). Obviously, the parsed meaning does not correspond to the intended one and does not single out the topic-event as necessary. There are consequently two hypothesis for the answer. The failed production forces the speaker to examine what went wrong, and finally the inability to express the intended meaning *for a while* is detected.

To repair this problem, the speaker invents<sup>b</sup> a new marker, e.g. *hippi-* or *po-* as in Russian, to cover the needed meaning *for a while* and attaches it to the verb. There is empirical evidence of such language inventions, e.g. deaf children confronted with an atypical learning environment and without a tutor spontaneously invent a gesture system to communicate (Goldin-Meadow & Mylander, 1983). Thereafter, the speaker tries to produce again and this time succeeds.

**Inability to parse strings** Imagine the listener encounters the problem that she cannot entirely parse the question uttered by the speaker, e.g. *Who hippy-read?* from the above example. The linguistic parts that can be processed are *who* and *read*, but the newly invented prefix *hippy-* is left unprocessed. This leads to ambiguity in the interpretation of the topic (since both events are about *reading*) and consequently two hypotheses about the protagonist involved in the event. Because of this ambiguity, the interaction fails and the speaker reveals the right answer.

The listener tries to learn from this shortfall and stores the observed marker. Additionally, she can discover its semantics by searching the context for the meaning that could differentiate *Michael* from *Masha*, since questions are assumed to

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<sup>b</sup>The agent could also reuse a device already existing in the language system, e.g. spatial preposition (*po* is preposition in Russian), but this possibility is not yet included into the presented model.

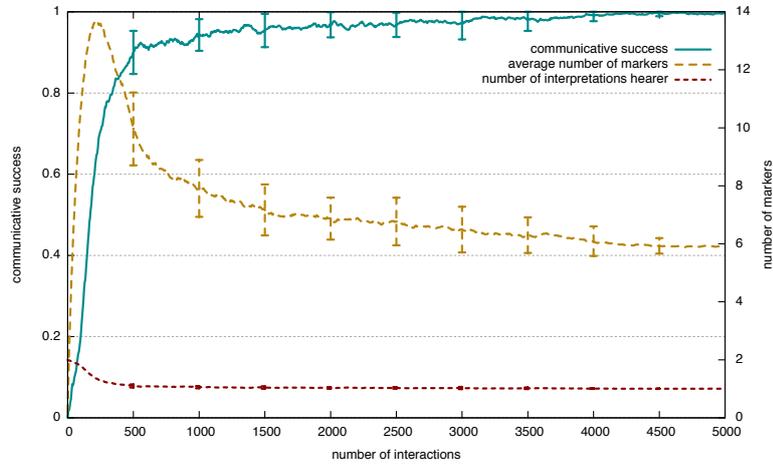


Figure 1. Communicative success (fraction of successful games in the last 100 interactions) and inventory of markers in a population of 10 agents playing 5000 aspect language games (avg. 10 runs).

be discriminative. The distinctive feature for *Michael* is the temporal structure of his *reading*, which is *for a while*, in contrast to the *ongoing reading* of *Masha*. Thus, the stored string of the marker is associated with this deduced information.

### 3.3. Results

Let us look at the development of a prefixal system in a community. In the world of agents, different events can take place and exhibit six temporal semantic features: *begin*, *finish*, *once*, *for a while*, *ongoing*, *complete*. Hence, grammatical markers for *ingressive*, *terminative*, *semelfactive*, *delimitative*, *durative*, *telic* Aktionsarten, respectively, should pop up in the population driven by the need to express these when communicating about events. Fig. 1 displays the communicative success and inventory of markers throughout the game, averaged over 10 runs. The beginning is characterized by the overshoot of the required number of markers and later phases display their convergence on the optimal number of six. The communicative success grows very quickly when the sufficient amount of markers starts floating in the population. There are however synonyms, which can be seen in Fig. 2 that zooms into one simulation and captures the development of markers.

By their invention, markers are assigned a score of 0.5 that is updated over time using a scoring mechanism (lateral inhibition) which rewards markers that were used often and successfully in communication and punishes competitors. Some

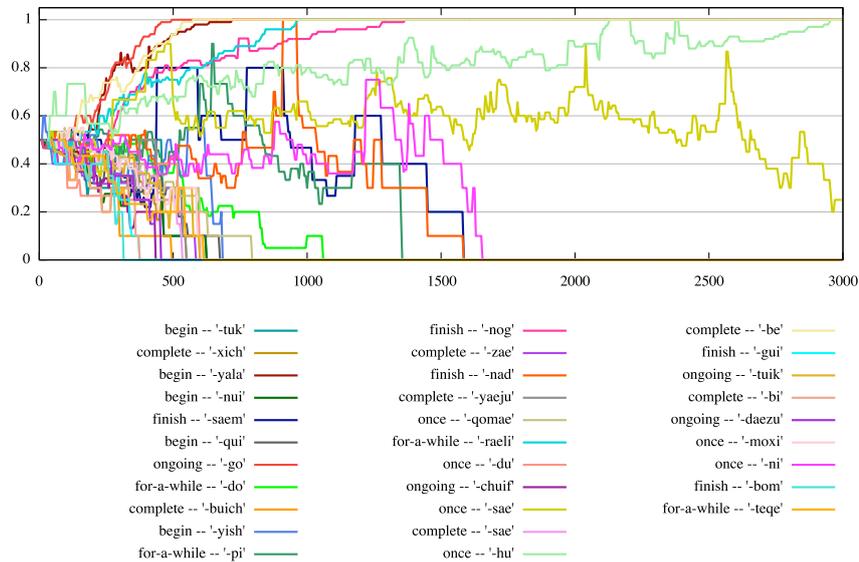


Figure 2. Development of markers for Aktionsarten in a population of 10 agents (population avg.).

markers lose the competition, reach the minimal score of 0.0 and are eliminated from the inventory. Others reach the maximum score of 1.0 and win the battle.

Through repeated interactions of the aspect language game, the population of agents was able to develop a conventional system of markers for Aktionsarten.

#### 4. Conclusion and Future Work

This paper presented the first step in reconstructing processes responsible for the evolution of Slavic aspect and their dynamics computationally. The prerequisite for aspect – the emergence of a conventional system of markers for Aktionsarten – was successfully tackled. For that, we pinpointed situations that necessitate the expression of new semantic nuances of events and their incorporation into a language system. We also identified cognitive mechanisms required by the members of a community, such as the ability to identify the cause of failures in communication and to be inventive enough to dare creative usage of already established morphemes or even brand new forms. Future work will be devoted to further steps tracing and modeling the evolution of aspect. Therewith, we target at core controversies in both Slavic and cognitive linguistics, controversies that are important for our understanding of language evolution and human cognition in general.

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