

Representing achievements from Estonian transitive sentences

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Abstract

The article opens the complex issue of representing and acquiring aspectual (event structural) information from surface syntactic elements scattered over several phrases in an Estonian sentence. The more detailed example contains the problems of “reading semantics off the syntax and morphology” in sentences containing Estonian transitive achievement verbs and their partitive objects. The article presents a representation in terms of a unification-based approach in Lexical Functional Grammar (LFG), where the aspectual features of verbs and case are modeled via unification at the syntactic level of functional structure.

1 Credits

This article contains unpublished material and proposes a novel way of representing and acquiring the semantic content of predicates, more specifically, the event’s type on the basis of the verb classification and argument frame combined with other types of information such as object case. The analysis of the two classes of achievement verbs is novel and follows the theoretical grounds and the empirical generalizations in Tamm (2004) and the main points in Tamm (2007). It is an elaboration of Tamm (2005) on the Estonian verb classes in computational lexicography. Further main sources that form the theoretical basis of this account are Butt (2006), Butt and King (2005), Butt et al. (1997), Kiparsky (1998) and Nordlinger and Sadler (2004).

2 Introduction

The paper presents theoretical aspects of aspectual semantic content representation and the preliminaries of acquisition, that is, a sketch of a possible method and the tools of identifying the semantic content. The representational issues are addressed in the Lexical Functional Grammar (LFG) framework, which is equally accessible for formal generative as well as computational linguists, the more traditional functional as well as lexically oriented approaches.

Identifying the semantic content is understood as identifying the event types or the aspectual meaning in the text. The examples discussed are Estonian simple sentences, and the aspectual semantic event type of achievements (in the traditional Vendlerian classification). This seemingly narrow focus is due to many factors.

Firstly, simpler sentences are chosen since there are extremely few theories dealing with the topic in Estonian that are easily convertible into methods that could accomplish the identification of the aspectual meaning. Although aspect is obligatorily expressed in all Estonian sentences, there are no methods developed yet for capturing aspectual meaning.

Secondly, there are no works known to the author that would deal with the statistical extraction of the aspectual meaning in this language, but taking stock of at least some of the predictable future problems of statistical approaches is one of the goals of this article. Therefore, the article has chosen the data—achievement sentences—so that the information presented here could be valuable for both linguistic and statistical methods. A statistical

(surface) method can be predicted to give a reasonable solution to a high percentage of cases, but to regularly fail in cases where a combined method with a linguistic (deep) method can improve the results steadily. As an example from Hungarian speech synthesis and automatic stress assignment (Tamm and Olaszy 2005), the results of a combination with a linguistic, deep method and a more statistically oriented one show that the statistical method gives good results with little effort, but from a certain point it reaches its limits and the improvement process slows down. Improving the stress assignment algorithm with a more linguistically oriented method requires more effort, but allows for steady improvement of the error rate.

Thirdly, in general, the connections between the acquisition and representation of the volatile aspectual semantic content of the world's languages are a little studied topic. By volatile I mean the variety in the grammaticalization of the TAM categories across languages (and the terminologies used for describing the phenomena), the distribution of the morphemes and the division of labor between the purely lexical and the purely non-lexical; that is, between verbs, their internal argument NPs, PPs and a wide array of morphemes attaching to them and influencing the semantic content of the sentence they appear in. However, in the coming era of machine translation and other technical applications that build on the decoding and encoding of the semantic content, the bottlenecks of cross-linguistic TAM categories are better identified sooner than later, and preferably in a language with rich and explicit morphology, such as Estonian.

For several better studied, predominantly Indo-European languages (e.g., English, Dutch, Italian), the detection of argument frame, information about the verb's classification, the presence of certain adverbials or quantifiers, and the quantificational properties of the internal argument (the object) gives a fairly solid ground for the prediction of the compositional aspectual value of the sentence (cf. Verkuyl 1993). In the Slavic languages, the composition of the aspect is considerably reduced and the (morphologically complex) verb determines many key properties of the event (Filip 2001, Kiparsky 1998). However, the information about the morphological complexity of the verbs and the components of aspectual composition mentioned above is not sufficient for acquiring the semantic properties of the events in several Finnic lan-

guages. On the one hand, in languages such as Finnish, Livonian, Votic, Vepsan, or Estonian, the object case of a transitive verb is a far better indicator of the event type (this article defines it in terms of the opposition in boundedness as defined in Kiparsky 1998) than the morphological complexity or the quantificational properties of the internal argument. The objects of Estonian transitive verbs in active affirmative indicative clauses are marked with either the partitive or the total case; the latter is also known as the accusative in typological and theoretical approaches and as the morphological genitive or nominative. Roughly, partitive objects appear in unbounded sentences and total objects in bounded sentences. It is highly probable that this correlation between the event type and the semantically conditioned case (atelic-partitive, telic-total) will be detected by statistical methods. Do we need any additional semantic or syntactic information, then, if the event type is directly read off from the object's case?

I argue that we do, since on the other hand, the transitive verb's object case does not give sufficient ground for detecting the further details of the event's structure, such as its iterative, progressive etc nature of an event described in a sentence containing an achievement verb. In order to access further semantic content, an indication of the lexical aspectual verb class is necessary, and, as I will argue on the basis of the achievement verbs, providing the Vendler type is not sufficient. I propose to identify the semantic content in a combined way. Here I concentrate on the following intersection: the aspectual indications in the lexicon of the verb and the aspectual indications of the object cases. Here follow the possible components of the algorithm for sentence aspect.

1. The syntactic analyzer (by Kaili Müürisep, University of Tartu) that identifies the object and its case: partitive or non-partitive, total (see Appendix C for an analysis of the examples in this article).

2. The entries for the (aspectual) object case (as earlier theoretical works indicated in Section 1).

3. The aspectual lexicon of verbs (under construction at the Institute of Estonian Language, Tallinn).

4. LFG-type functional structures (for the unification of aspectual information from verbs and case).

This article has a rather specific focus: achievement (bounded event) meanings from transitive sentences with achievement verbs of the two types *leidma* ‘find’ and *võitma* (*kedagi*) ‘win (somebody)’ and with semantically conditioned partitive NP objects. The main difference between the two classes of achievement verbs is the following: the *leidma* ‘find’ type of achievement verbs is a so-called total object verb class and the *võitma* ‘win’ type is a partitive-object verb class (although the verb is polysemous and appears with total object with or without a resultative particle as well). This means that while the *find*-verbs typically appear with non-partitive (nominative or total) object case marking, the *win*-verbs in the given lexical achievement meaning appear with partitive object case only. However, in terms of the compatibility of verbs and object case, there is a marked difference between singular and plural (or mass) noun phrases. Namely, both *find* and *win* verb classes may appear with the partitive case in plural count (and mass singular) NP objects. In short, the *win* type is the problematic one, since the verb denotes an achievement, but the object case is not total as with event verbs, but partitive.

The problems and solutions are presented as follows: Section 3 introduces the basic facts about Estonian object case alternation and verbs. Section 4 presents the data that are the focus of the model. Section 5 addresses the verbs and Section 6 views the partitive objects. Section 7 illustrates the unification, and Section 8 is a conclusion.

3 Aspect and Object Case

Estonian clausal aspect is not entirely determined by the verb. Rather, the alternation of the partitive (1) and total-accusative (here, morphologically genitive) (2) object cases corresponds more closely to the aspectual oppositions as most clearly illustrated by the accomplishment verbs of creation.

- (1) *Mari kirjutas*
 M.nom write.3.sg.past
 raamatut.
 book.part
 ‘Mari was writing a/the book.’
- (2) *Mari kirjutas*
 M.nom write.3.sg.past
 raamatu.
 book.gen
 ‘Mari wrote a book.’

The example with the partitive object is aspectually unbounded (1); the example with the total object is aspectually maximally bounded (2). The telic *find* type of achievements resembles the accomplishments in object case matters, since it appears in maximally bounded sentences and with total objects as in (3).

- (3) *Mari leidis raamatu.*
 M.nom find.past.3.sg book.gen
 ‘Mary found a/some book.’

Unexpectedly, the telic verbs of the *win* type do not have aspectual case alternation. The article addresses this data in Section 4 and then proposes a way to understand and represent the partitive object case for achievement transitive verb classes of the types *find* and *win*.

4 Specific Data to Represent

As opposed to the type of event verbs such as *write* and *find*, event verbs of the *win* type do not have aspectual case alternation (4).

- (4) *Mari võitis Jürit.*
 M. won George.part
 ‘Mary won George.’

Both achievement verbs appear in bounded sentences, but they differ in their cumulativity in tests. The type of boundedness of these verbs is, consequently, different. The sentences with the *win* type achievements are semantically diverse, cumulative and not divisive (see Kiparsky, 1998) and the *find* type are diverse, not cumulative and not divisive. Diverse, cumulative and not divisive boundedness (4) is further referred to as minimal boundedness. Diverse, not cumulative and not divisive boundedness (3) is referred to as maximal boundedness. A predicate is not divisive if the proper parts of the event described by the predicate are not in the denotation of the predicate. This definition classifies the predicates *võitma* ‘win’ and *leidma* ‘find’ as non-divisive, since a part of a finding or a winning event cannot be always qualified as finding or winning. A predicate is cumulative if the sum of the events that are in the denotation of the predicate is in the denotation of the predicate (understood as temporally adjacent). This definition classifies the predicate *leidma* ‘find’ as non-cumulative, since another event denoted by that predicate cannot be qualified as finding the object referent, it can only be qualified as performing acts of ‘finding’ it again. On the contrary, despite its clearly similar

eventive character, *võitma* ‘win’ is lexically cumulative, since two events that qualify as winning (somebody) can still be qualified as winning him or her in this lexical meaning (‘more’, as in another game, not necessarily ‘again’ or ‘once more’ as with the *find* achievement). Both verbs allow objects and form bounded sentences with partitive case marked objects, but the restriction is that of mass or plural, as in (5) and (6).

- (5) Mari leidis raamatuid.
 M.nom find.past.3.sg
 book.part.pl
 ‘Mary found a/some book.’
 (6) Mari võitis poisse.
 M. won boys.part.pl
 ‘Mary won the boys.’

Testing captures the elusive eventive nature of Estonian sentences with the *leidma* type verbs “telic” verbs and partitive marked subjects or objects that are mass or plural NPs, as in *leidis raamatuid* ‘found books’. The predicate is not maximally bounded by the definition applied here, since it is cumulative; finding more books is still finding books, so the sum of the events that are in the denotation of the predicate *leidis raamatuid* is also in the denotation of the respective predicates. In my terminology, the sentences with partitive plural objects are minimally bounded (as the win verbs) in case of both achievement verbs.

The aspect of the sentence is needed for MT and also TTS applications need the exact object case, to mention some. For speech production it is important how to pronounce the case of objects if the object NP is a numeral, such as in the following real life example from the internet *Helen Mirren solvas Elizabeth II hingepõhjani* ‘HM offended Elizabeth II deeply’. As these verbs may appear with total objects as well, a purely statistical MT method for Estonian-English may wrongly translate the sentences with partitive objects to Progressive English verbs (*was winning*, *was finding*).

The boundedness feature that corresponds to the observed aspectual distinctions is a scalar (gradable) feature as proposed in Tamm (2004). The scale is formed from zero boundness (1) via minimal boundedness (4), (5), (6) to maximal boundedness (2), (3). The question is how to represent the cause of the following effect: the minimal boundedness of the sentence is in some cases due to the semantically conditioned partitive object, as in (5) and (6) and, in other cases, due to the verb, as

in (4). The article follows an analysis of Tamm (2004): the object case alternation is an aspectual semantic and functional syntactic phenomenon. Accordingly, the special focus is on the modeling of verbs and the aspectual object case at the syntactic level of the functional structure.

5 Achievement Verbs’ Entries

The main puzzle to solve in a model representing aspect, verbs, and case is the lexical minimal boundedness of the *win* type achievements, the relative aspectual freedom (boundability) of the *find* type achievements and the semantic effect of semantically conditioned partitive objects. The sentences with partitive plural objects are minimally bounded in case of both achievement verbs. Indications about the boundedness and boundability belong to the functional specifications in the entries and in the respective terminal node of the constituent structure (Tamm, 2004). The functional specifications that are associated with different nodes constrain the functional structures.

5.1 Bounded Achievement Verbs: *win*

The intuition to capture with these verbs is that their lexical grammatical properties prevent them from appearing in bounded sentences with total objects. If a verb is lexically minimally bounded, then its boundedness feature must be fully specified in the lexical entry. These specifications have the form of defining equations as in the verb entry of *võitma* ‘win’ (7).

- (7) *võitma*, V:
 $(\uparrow \text{PRED}) = \text{‘WIN} < (\uparrow \text{SUBJ}), (\uparrow \text{OBJ}) > \text{’}$
 $(\uparrow \text{B}) = \text{MIN}$

The information containing the functional specifications in the entry in (7) are mapped from the constituent structure (c-structure) to functional structure (f-structure) as illustrated in Figure 1.



Figure 1. *võitma* ‘win’ at the f-structure.

In this case, boundedness is specified in the lexical entry of the verb, and clausal aspect is determined by the verb. As the result of the mapping from constituent structure to functional structure, the f-

structure is constrained to contain the specified boundedness feature, that is, an attribute with a “fixed” value (Figure 1). Having a fully specified feature (a defining equation) as part of its lexical entry, such as $(\uparrow B) = \text{MIN}$, captures that the verb’s boundedness is lexicalized, that *win* is an inherently bounded verb (lexical sense of the verb). Since clausal aspect is modeled in terms of the unification of boundedness features at the f-structure, the failure in unification explains the restrictions on case marking patterns in the model, where case contributes different values. The effect of the constraint is that the verb is not boundable by further elements in syntax, and the range of aspectual case marking possibilities available for the verb is restricted.

5.2 The boundable achievement verbs: *find*

If the verb is boundable, that is, aspectually free, then its boundedness feature must be partially specified in the lexical entry. This specification has the form of an existential constraint as in the verb entry of *leidma* ‘win’ (8).

$$(8) \textit{leidma}, V: \\ (\uparrow \text{PRED}) = \langle \text{WIN} \langle (\uparrow \text{SUBJ}), (\uparrow \text{OBJ}) \rangle \rangle \\ (\uparrow B)$$

Having an existential constraint $(\uparrow B)$ means that the attribute B must be present in the f-structure feature matrix that corresponds to the verb in c-structure. As clausal aspect is modeled in terms of the unification of boundedness features in the functional structure, the possibility of the unification with features with different values explains the wider range of case marking patterns. The information containing the functional specifications in the entry in (8) are mapped from the c-structure to f-structure as illustrated in Figure 2.

$$\left[\begin{array}{l} \text{PRED 'FIND } \langle \text{SUBJ, OBJ} \rangle \\ B \end{array} \right]$$

Figure 2. *leidma* ‘find’ at the f-structure.

The next question is: given the incomplete f-structure, how will the values be obtained? In this model, the “underspecified” features become fully specified by the features of case-marked objects. Before discussing the verbs’ contribution to the

sentence in their interaction with case-marked objects, the features associated with the partitive case marker are presented.

6 Partitive

In their aspectual behavior, the partitive objects that do not have a restriction on the semantics of the object NP (example 1, 4) are different from those that have (example 5, 6). As this article concentrates on the new results in the representation of the semantic partitive, the semantically unrestricted partitive is regarded as a default (Tamm, 2004).

6.1 The Default Partitive

In several previous sources, the semantically unrestricted Finnish partitive is regarded as the default case. Estonian can be regarded similar in this respect, and the default is captured in an annotation at a c-structure node (9).

$$(9) X' \rightarrow X^0 XP \\ ((\downarrow \text{CASE}) = \text{PART})$$

On the other hand, the entry for the partitive case (10) encodes only the constraint that the sentence is not maximally bounded. As a default, the boundedness feature has the value “0”, for unbounded.

$$(10) \text{PARTITIVE}: (\uparrow \text{CASE}) = \text{PART} \\ ((\text{OBJ } \uparrow) B) = \neg \text{MAX} \\ ((\text{OBJ } \uparrow) B) = 0$$

The indication $(\text{OBJ } \uparrow)$ is the inside-out function application (Nordlinger and Sadler 2004). The association between the nominal and its grammatical function is established by virtue of the case marker attached to it. I leave the semantic constraints that constrain the mapping between the f-structure and semantic structure aside. A defining equation captures the constraint on boundedness on the corresponding f-structures (Figure 3).

$$\left[\begin{array}{l} \text{OBJ} \\ \left[\text{CASE PART} \right] \end{array} \right]$$

Figure 3. The partitive case at the f-structure.

The result is that the partitive NPs specify the information in the f-structure feature matrix as in Figure 3.

6.2 The Semantic Partitive

Singular mass noun and plural count noun partitive objects are specified as follows (adding the tentative possible semantic restrictions in prose for descriptive clarity) in (11).

(11) SEMANTIC PARTITIVE:

(↑CASE) = PART

(OBJ↑)

((OBJ↑)B) = MIN

the referent is homogeneous

The semantically conditioned partitive maps to the information in the f-structure feature matrix as illustrated in Figure 4, specifying the constraint on the aspectual minimal boundedness of the sentence.

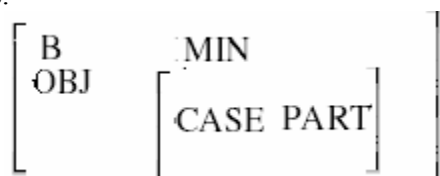


Figure 4. The semantic partitive case at the f-structure.

My representation is syntactic, but the semantic nature of several restrictions—as in (11)—points to the necessity of more explicit semantic structure, which ideally interacts with the morphosyntactic and lexical analysis as well as pragmatic discourse structures.

7 Feature Unification

Fully lexically inflected words enter the LFG c(onstituent)-structure terminal nodes. The lexical entries for the verbs *find* (12) and *win* (14) and the semantically conditioned partitive and the object are represented as in (13) and (15).

(12)

leidis, V:

(↑PRED) =

'find<(↑SUBJ), (↑OBJ)>'

(↑TNS) = PAST

(↑PERS) = 3

(↑NUM) = SG

(↑B)

(13)

raamatuid, N:

(↑PRED) = 'BOOK'

(↑CASE) = PART

(↑NUM) = PL

(OBJ↑)B) = MIN

(OBJ↑)

(14)

võitis, V:

(↑PRED) =

'win<(↑SUBJ), (↑OBJ)>'

(↑TNS) = PAST

(↑PERS) = 3

(↑NUM) = SG

(↑B) = MIN

(15)

poisse, N:

(↑PRED) = 'BOY'

(↑CASE) = PART

(↑NUM) = PL

((OBJ↑)B) = MIN

(OBJ↑)

The possible unifications determine the possible aspectual semantics for sentences in the unification-based approach of LFG. The aspectual features of verbs and case are unified at the functional structure. The lexical entries in the computational lexicon for transitive verbs are provided with valued or unvalued aspectual features in the lexicon. The *win*-verbs fully determine the sentential aspect, and the aspectual feature is valued in the functional specifications of the lexical entry of the verb; this is realized in the form of defining equations. If the aspect of the verb is variable, as with the *find*-verbs, the entry's functional specifications have the form of existential constraints. The partitive case is the default complement case and the case of the objects of unbounded predicates; mass and plural partitive NPs, however, can be optionally telizers or bounders (but not of the maximal type, though). The general well-formedness conditions on functional structures secure the sensitivity of aspectual case to verb classification.

The following two figures illustrate the unification of the aspectual information that has the form of constraints associated with the verb and object entries. Figure 5 corresponds to sentence (5) and Figure 6 corresponds to sentence (6).

| | |
|------|--|
| PRED | 'FIND <SUBJ, OBJ>' |
| B | MIN |
| TNS | PAST |
| NUM | SG |
| PERS | 3 |
| SUBJ | [PRED 'MARI' CASE NOM] |
| OBJ | [PRED 'BOOK' CASE PART NUM PL] |

Figure 5. The unification at the f-structure: *leidma* 'win' and the semantically conditioned partitive.

The minimal boundedness feature is contributed by the constraint associated by the object (see (13)) in the feature matrix in Figure 5, which corresponds to sentence (5) with the verb *find*. Appendix A provides the constituent structures for sentence (5) for an illustration.

In the feature matrix of Figure 6, which corresponds to sentence (5) with the verb *win*, the minimal boundedness feature is contributed by the constraint associated with the verb (see (14)). Appendix B provides the constituent structures for sentence (5).

| | |
|------|---------------------------------------|
| PRED | 'WIN <SUBJ, OBJ>' |
| B | MIN |
| TNS | PAST |
| NUM | SG |
| PERS | 3 |
| SUBJ | [PRED 'MARI' CASE NOM] |
| OBJ | [PRED 'BOY' CASE PART NUM PL] |

Figure 6. The unification at the f-structure: *võitma* 'win' and the semantically conditioned partitive.

8 Summary

This article proposes a way to represent and some preliminaries of how to acquire event structural semantic content from Estonian transitive sentences. The parser identifies the finite verb, its object and its object's case; the lexicon contains

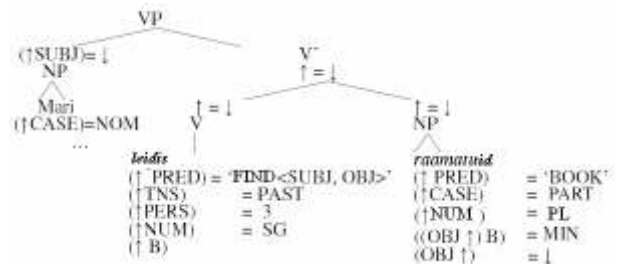
entries with aspectual information attached to verbs and case morphemes. The article presents a unification based model of two classes of Estonian transitive achievement verbs and partitive objects, including those that have semantic restrictions on the NP. This classification accommodates the systematic compatibility of verb classes with clausal aspectual object case marking patterns.

The article applies the Lexical Functional Grammar (LFG) formalism and its methodology. Clausal aspect is understood in terms of boundedness and represented with a clausal boundedness feature. Clausal boundedness is encoded in the form of features at the LFG's syntactic level of f(unctional)-structures. A clause or a sentence is maximally bounded if it describes an event with a definite, maximal endpoint. A clause or a sentence is minimally bounded if it describes an event with an endpoint that is not maximal.

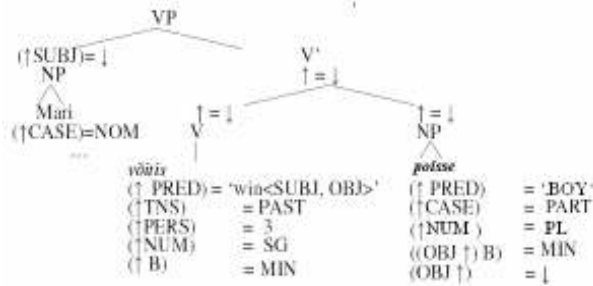
Achievement verbs fall into two aspectual classes, distinguished from each other according to the pattern of the attributes and values in the functional specifications of the verbs' lexical entries. The lexical entries for the *find* type achievements are provided with underspecified boundedness features in the proposed LFG lexicon. The lexical entries for the *win* type achievements are provided with specified boundedness feature MIN (for minimally bounded). The lexical entries for the case markers specify constraints as well. The semantically conditioned partitive is provided with specified boundedness feature MIN.

The aspect-related attributes and values encode constraints on the f-structure, which interfaces with semantics.

Appendix A. Minimally bounded sentence (5). The constituent structure of the Estonian achievement verb *find* and a partitive plural object.



Appendix B. Minimally bounded sentence (6). The constituent structure of the Estonian achievement verb *win* and a partitive plural object.



Appendix C. Illustration of the relevant parts of the output of Mürisep's syntactic analyzer based on Mürisep (2000), sentences (5) and (6).

```

Mari
Mari+0 // _S_ prop sg nom #cap // **CLB @SUBJ
mari+0 // _S_ com sg nom #cap // **CLB @SUBJ
mari+0 // _S_ com sg nom #cap // **CLB @SUBJ
võitis
võit+is // _V_ main indic impf ps3 sg ps af #FinV #NGP-P
#In // @+FMV
poisse
poiss+e // _S_ com pl part // @OBJ
poi+sse // _S_ com sg ill // @ADVL
...
leidis
leid+is // _V_ main indic impf ps3 sg ps af #FinV #NGP-P
// @+FMV
raamatuid
raamat+id // _S_ com pl part // @OBJ

```

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