

# A6 Frame Semantics for Verbs

## 1 General information

New project

### 1.1 Applicant

Prof. Dr. Robert D. VAN VALIN, Jr.

### 1.2 Topic

Frame Semantics for Verbs

### 1.3 Scientific discipline and field of work

General Linguistics, Verb Semantics

### 1.4 Scheduled total duration

Three years

### 1.5 Application period

Three years

### 1.6 Summary

The goal of the project is the development of a frame semantics for verbs, building on a cross-linguistically motivated theory of lexical decomposition that forms part of the input to a theory of the syntax-semantics interface, Role and Reference Grammar (e.g. Van Valin 2005a). While this decompositional system has been used successfully to capture linguistically significant generalizations, it is not fine-grained enough to make possible the expression of further important generalizations. The new decompositional system developed in this project will be based on the expressive frame formalism of Barsalou (1992), using the formalized version proposed by Petersen (2007). Frames appear to be a suitable representational device for the conceptual modeling of verb semantics at the right level of granularity and with the right amount of flexibility. They permit a transparent modeling of all meaning components of a verb, as well as the interrelations between these components and the constraints on them. The linguistic analysis part of the project will focus on a limited but representative set of action, cognition and perception, and psychological verbs. The primary languages to be investigated are German, English, Tagalog, and Lakhota. The grammatical phenomena to be accounted for concern complementation patterns (in the broadest sense) in both simple sentences, i.e. the assignment of case and argument-marking prepositions, and in complex sentences, i.e. the selection of clausal and sub-clausal dependent units (complementation in the narrow sense). The results of the project will not only represent an advance in the representation of verb seman-

tics, but will also be an important step forward in the development of Role and Reference Grammar.

## 2 State of the art, preliminary work

### 2.1 State of the art

#### Verb meaning and lexical decomposition

The representation of verb meaning has long been a central issue in semantic theory and grammatical theory. Work in the 1960's by Gruber (1965) and Fillmore (1968) introduced the notion of 'semantic role' into linguistic theory, and Fillmore in particular proposed a notion of 'case frame' in which the argument structure of a verb would be represented by a list of semantic roles, e.g. agent, patient, instrument, etc. These notions were widely adopted in different linguistic theories and provide a minimal representation of aspects of the meaning of verbs. While useful in many regards, lists of semantic roles associated with a verb have been criticized as being ad hoc, stipulated representations; the list associated with a particular verb is not motivated in any principled way. Unlike Fillmore (1968), who proposed no semantic representation for a verb beyond its case frame, Gruber proposed a system of lexical decomposition in terms of which the semantic roles were defined. Jackendoff (1977) expanded this idea, which eventually became his 'lexical-conceptual structures' in later work (e.g. Jackendoff 1990). This approach suffered from the flaw that the decompositions were not independently motivated. Dowty (1979) proposed an *Aktionsart*-based system of verb decomposition, which had the virtue of positing syntactic and semantic tests for motivating the decompositions, but semantic roles played no part in Dowty's 1979 system (whereas his 1991 proto-role approach abstains from decomposition).

In Foley & Van Valin (1984) the Gruber/Jackendoff idea of deriving semantic roles from decompositional representations was combined with Dowty's system to create a system of lexical decomposition based on linguistic tests, in terms of which semantic roles could be defined. This system was further developed in Van Valin & LaPolla (1997) and Van Valin (2005a). Similar ideas have been developed in e.g. Jackendoff (1983, 1990), Pinker (1989), Wunderlich (1997, 2006), Rappaport & Levin (1998) and Fong, Fellbaum & Lebeaux (2001). Almost all of these systems involve relatively shallow, term-based decompositions. Two simple notational variants of such a decomposition of causative *break* are shown in (1), formulated along the lines of Van Valin & LaPolla (1997) and Rappaport & Levin (1998), respectively.

- (1) a. [**do** (x, Ø)] CAUSE [INGR **broken** (y)]  
 b. [[x ACT] CAUSE [BECOME [y <*BROKEN*>]]]

Shallow decomposition is adequate for syntactic phenomena like subject and object selection and assignment of the main syntactically-relevant cases. However, as has been pointed out by Pinker (1989), Levin (1993) and others, certain very common linking alternations hinge on a set of meaning elements, e.g. contact, motion (ballistic vs. continuous), and effect, that are not captured by simple *Aktionsart* distinctions and are often stated separately as influencing grammatical/syntactic behavior. Similarly, Mairal Usón & Faber (2005) criticize decomposi-

tional representations of the kind shown in (1) as being too restrictive to encode important semantic parameters.

In the literature we find three strategies for dealing with the challenges of decomposing meaning: The most popular strategy to keep decomposition structures simple is the assumption of a second level of meaning, the conceptual structure, which is seen as comprising world knowledge and cultural knowledge and serves as the ‘interpretation and evaluation background’ of a much simpler semantic structure (cf. Bierwisch 1983, Lang 1994, Wunderlich 1997). This very appealing approach usually has the drawback that neither the conceptual level nor the semantic-conceptual interface is explicitly formalized, as the interaction between semantic representation and conceptual structure is seen as simply one of ‘inference’ via ‘common knowledge’, thus leaving a lot of questions open. In its extreme form (e.g. Dölling & Heyde-Zybatow 2007) the semantic representation is viewed as radically underspecified with regard to conceptual structure and argument structure, thus leading to a need to bring together meaning and argument structure in the correct way again. In addition, there is a need for a multitude of conceptual and pragmatic conditions to derive an interpretation of the highly underspecified semantic representation, most of which are left to future work.

The opposite approach is to decompose meaning in an attempt to leave almost nothing un- or underspecified (e.g. Engelberg 2000), so as to predict every single possible meaning variation, meaning shift and all of the syntactic contexts in which a verb can appear. While this approach has provided excellent and thorough research on usage, meaning and interpretation of lexical elements, it faces the objection of lacking generalizations by simply listing a multitude of highly specific meaning variants (see Dölling & Heyde-Zybatow 2007 for more criticism).

### **Frames and lexical semantics**

Fillmore (1982) laid out a vision for an enriched ‘frame semantics’ which would contain a much richer representation of the meaning of verbs and which would play a role in the interpretation of texts and linguistic interactions (see also Fillmore & Atkins 1994). In the currently most prominent realization of this idea, Fillmore’s FrameNet project (e.g. Fillmore, Johnson & Petruck 2003, Boas 2005), however, the arguments and adjuncts in sentence are tagged with what are in effect verb-specific semantic role labels; aside from the much greater specificity and number of role labels, this is not all that different from the representations proposed in the 1960’s. The FrameNet approach is thus based on flat role structures, with the option of adding so-called frame-to-frame relations such as causation and inchoativization, which are employed, however, only in a rather ad-hoc fashion. It is difficult to see how FrameNet, in its present form, can contribute to a theory of the syntax-semantics interface, besides providing a large set of annotated sentences (which may nevertheless serve as a useful empirical resource).

Heid (1997) describes a study that employs Fillmore’s frame semantics for lexical semantic modeling as part of an experimental parallel lexicon building project. In this project, lexical entries for a small set of perception and speech act verbs have been modeled by means of a typed feature formalism. Only flat frames without decomposition are employed and no attempt has been made to capture regularities at the syntax-semantics interface. An interesting aspect of this project is its formal rigor in using a carefully designed set of basic semantic

sorts and relations, which are subject to fully formalized constraints.

As emphasized by Petersen (2007), building on Carpenter's (1992) work on typed feature structures, there is a close relationship between frames, viewed as rooted labeled directed graphs, and (recursive) attribute value structures. Attribute value structures, which are typically presented as attribute value matrices, are widely used for linguistic representations, especially in approaches with a computational orientation. This also includes the representation of lexical semantics (see e.g. Saint-Dizier and Viegas 1995). But attribute value structures often serve as mere data structures for representing information about a linguistic entity in a systematic way without necessarily reflecting structural assumptions about that entity. Almost none of the approaches to lexical semantics that use attribute value structures employ these representations to model lexical decomposition in a systematic way.

The Ontological Semantics (OntoSem) approach of Nirenburg and Raskin (2004) provides another application of frames to lexical semantics. However, since the main goal of the OntoSem approach is knowledge representation and automated reasoning, subframe decomposition is in general not motivated by, and also not necessarily sensitive to, linguistic analysis. Accordingly, the OntoSem lexicon explicitly assigns syntactic realization patterns to argument roles, without any attempt to reveal regularities at the syntax-semantics interface.

The Generative Lexicon of Pustejovsky (1995) and its implementation in the SIMPLE lexical semantic resource (Busa et al. 2001) also rest heavily on attribute value matrices but, again, the attributes themselves are not intended to represent relational semantic structure. So, the decomposition information is distributed over several components of the attribute value structures: The event decomposition is specified under the EVENT-STRUCTURE attribute, the sortal characterizations of the event components are described by the QUALIA attributes AGENTIVE and FORMAL, and the description of the participants is listed under ARGUMENT-STRUCTURE, which encodes part of the syntax-semantics interface.

While Pinker (1989) does not subscribe to a frame semantic approach of any sort, it is nevertheless illustrative to look at his representations from such a perspective. Pinker (as well as Jackendoff 2002) employs trees to represent decomposition structures. His representation of causative *break* is shown in Figure 1.

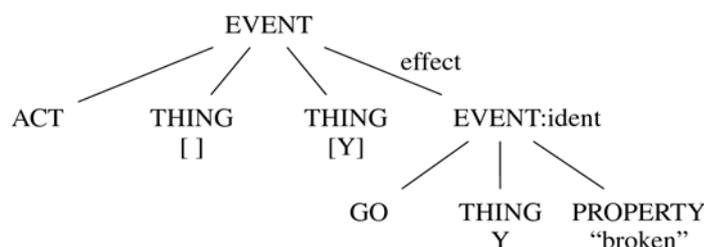


Figure 1: Lexical semantic structure of causative *break* taken from Pinker (1989, p. 198)

What is missing in this structure to become a frame, i.e. a labeled directed graph, is, first, an explicit direction, which, however, could be identified with the top-down orientation of the figure, and, second, a systematic and non-ambiguous labeling of the arcs. The second requirement is essential because otherwise the distinction between the two arguments of ACT rests solely on their linear ordering in Figure 1. Another of Pinker's examples is shown in Figure 2, which represents the meaning of *remind* in the context of the sentence *The picture reminds Bob of Mary*. The figure shows an important advantage of the tree representation

over the linear term representation: It is easy to add specifications if necessary, without resorting to cumbersome diacritics.

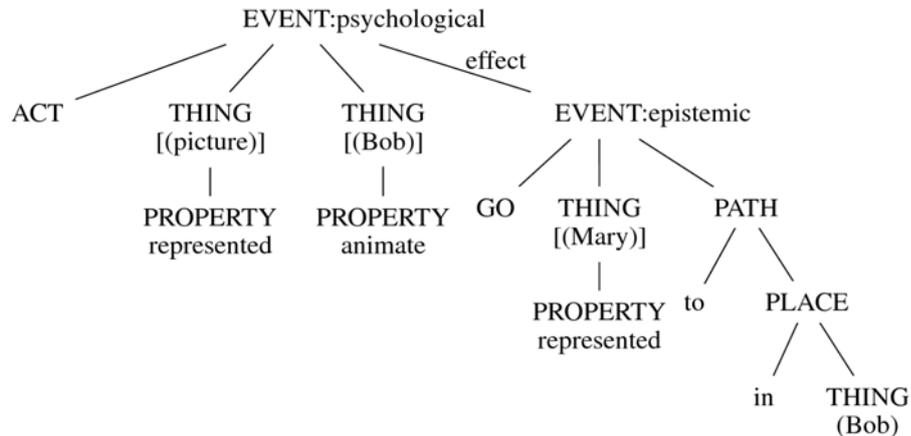


Figure 2: Lexical semantic structure of non-agentive *remind* taken from Pinker (1989, p. 205)

It is the goal of the present project to develop a formally grounded, frame-based system of semantic representations that allows such extended representations.

An approach worth mentioning in this context is that of Koenig and Davis (2006), which leans on the decompositional analyses of Pinker and Jackendoff as well as on Fillmore's vision of a scenario-based approach to lexical semantics, where a lexical entry picks out only part of the underlying scenario. Koenig and Davis criticize the fixation on tree-shaped representations of Pinker, which they regard as too inflexible to model diathesis alternations appropriately. Instead of a single tree structure, Koenig and Davis suggest using sets of trees, represented by attribute value structures interlinked via co-indexing, for representing the semantics of lexical entries, with one of these trees singled out as the "key" of the entry. While this combination of Fillmore's view with a decompositional approach seems fruitful, and will be investigated further in the present project, the specific modeling decisions of Koenig and Davis are problematic in so far as they adhere to coarse level relations such as ACTOR, UNDERGOER, and STATE-OF-AFFAIRS, which should be regarded as derived semantic notions. Typically enough, they treat the *with*-variant of the locative alternation as semantically on a par with regular instrumental constructions, which is untenable both from a conceptual and a cross-linguistic point of view.

The idea of frames has been used in other areas of cognitive science. Barsalou (1992) argued that frames provide the fundamental representation of knowledge in human cognition. Barsalou's frames have much richer informational context than, e.g. FrameNet representations, including structural invariants, i.e. systematic correlations between attributes, and further dependencies between attribute values. One of the few applications of Barsalou's model to lexical semantics is Edmonds & Hirst's (2002) experimental lexical choice system, where frames are used to represent fine-grained distinctions in semantic clusters of words; see Figure 3 for an example within the cluster of *order* verbs.

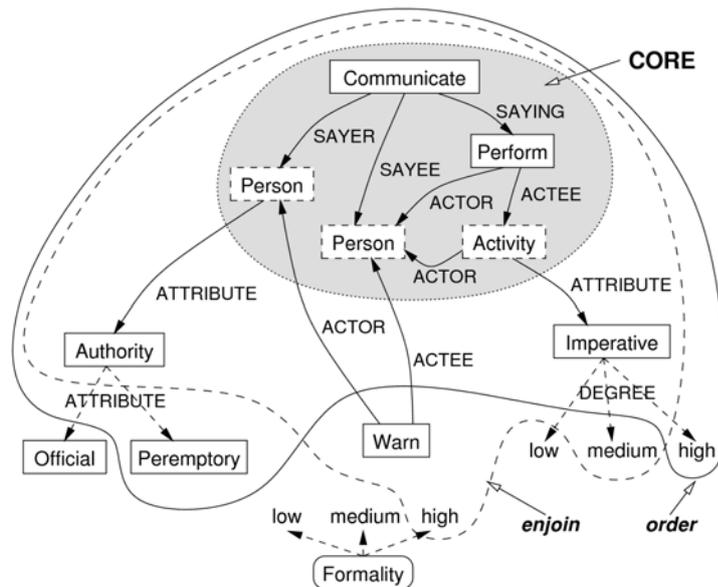


Figure 3: Frame-based distinction between near synonymous verbs (from Edmonds & Hirst 2002)

The general concern of Edmonds & Hirst is lexical choice with applications to machine translation and text generation. They do not take *Aktionsart* classes into account nor do they aim at explanations at the syntax-semantics interface.

The extended means of representation provided by Barsalou frames are particularly useful for modeling decompositional verb semantics because they allow one to capture dependencies such as temporal relations between subevents and interdependent incremental changes on participating entities (in the sense of Krifka 1992). The formalization of these means will be pursued in cooperation with project B1.

### The syntax-semantics interface

One of the most important functions of a theory of verb semantics is its role in the investigation of the syntax-semantics interface (see Levin & Rappaport Hovav 2005 for an overview). This has been at the forefront of linguistic theory for decades, and as pointed out above, much of the work, especially that coming from the syntax side, has assumed rather impoverished semantic representations consisting at best of a list of semantic roles (thematic relations, theta roles). Richer semantic representations make possible the capturing of generalizations that would be impossible in terms of simple semantic role analyses. Moreover, many grammatical phenomena which have been analyzed syntactically can be shown to be better analyzed semantically; indeed, Van Valin & LaPolla (1997) argue that the more semantically motivated a grammatical phenomenon is, the less cross-linguistic variation there will be and the more universal it will be. A rich system of lexical representation for verbs will take analysts deeper into the semantic heart of language. The importance of richer semantic representations has also been noticed by linguists working in syntactocentric frameworks (e.g. Ramchand 2008; see also Rosen 2003). In recent generative work there have been multiple attempts to integrate more semantic information into the syntax, thus taking semantics to be a sub-domain of syntax and representing semantic decomposition in terms of syntactic projections. The present theoretic framework, however, rejects this conflation of syntax and semantics and considers semantics to be the ‘engine’ that drives language.

A richer system of lexical decomposition is necessary for linking theories of the syntax-semantics interface, i.e. theories that analyze grammatical phenomena in terms of a direct mapping between the semantics and the overt syntactic form of sentences. Role and Reference Grammar is such a linking theory, as are Lexical Decomposition Grammar (Wunderlich 1997, 2000, 2006), Lexical-Functional Grammar (Bresnan 2000), and the Koenig & Davis (2003) version of Head-driven Phrase Structure Grammar. Hence the results of this project will be directly relevant to a range of theories of the syntax-semantics interface.

The study of complementation patterns (in the broadest sense) has been uneven. There has been a great deal of work on case assignment (see Butt 2007 for an overview), considerably less work on adposition assignment, as most work in this area has concentrated on the semantics of spatial prepositions (e.g. Tyler and Evans 2007) rather than their argument-marking functions (e.g. Rauh 1993, Jolly 1993), and even less work on complement selection by verbs taking ‘clausal’ complements (e.g. Grimshaw 1979, Rudanko 1989, Van Valin & Wilkins 1993). A simple thematic relations-based analysis of preposition assignment and clausal complement assignment is seriously inadequate, and a decompositional analysis of verbs and the adpositions themselves makes possible a more insightful and principled analysis, as the initial attempts by Jolly and Van Valin & Wilkins show.

A6

### **Verb classes to be investigated**

References concerning specific linguistic phenomena of the languages to be investigated will be given in the methodology section 3.2. As to previous investigations of the verb classes (action, cognition/perception, and psychological verbs), there is a large number of references of various kinds (see e.g. Levin 1993). However, the perspective of the present project, which aims at a frame-based decompositional representation, has not been adopted in any of these studies. Certainly many of the properties of the verb classes, which the frame-semantic representation tries to capture, have been studied before; for instance, the property of cognition verbs to take clausal complements (e.g. Butulussi 1991, Van Valin & Wilkins 1993) and the property of perception and causative verbs to take different kinds of infinitival complements (e.g. Lightfoot 1991). There are also various cross-linguistic studies of the way perception events are semantically structured (e.g. Rojo & Valenzuela 2004-5) and relate to cognition events (e.g. Evans & Wilkins 2000). Especially psychological verbs (psych-verbs) have drawn much interest: First, they are known for their interesting pattern of argument realization (e.g. Grimshaw 1990, Pesetsky 1995, Filip 1996, Klein & Kutscher 2002, Primus 2004), which has been used as an early argument against using semantic roles for predicting argument realization, since the experiencer role is realized as the subject in the case of *fear* and as the object in the case of *frighten*. Moreover, (stative) psych-verbs show considerable cross-linguistic variation with respect to argument realization (e.g. Croft 1993). In addition, psych-verbs have been treated very inconsistently in the literature concerning their aspectual properties (e.g. Grimshaw 1990, van Voort 1992, Pesetsky 1995). Finally, the event structure of causative psych-verbs is typically analyzed as different from that of causatives from the physical domain (e.g. Pustejovsky 1995).

## **2.2 Preliminary work**

Robert Van Valin has done research on lexical decomposition of verbs for the past 25 years,

developing ever more complex systems of decomposition within the framework of a theory of the syntax-semantics-pragmatics interface, Role and Reference Grammar (Foley & Van Valin 1984, Van Valin & LaPolla 1997, Van Valin 2005a). This research has involved data on verb systems from many languages, and therefore the work is strongly cross-linguistically motivated. It has concerned itself primarily with the *Aktionsart*-level of decomposition, although some limited work has been done on deeper levels of semantic structure, including a first, term-based proposal of an extended decomposition to explain the complement taking behavior of cognitive verbs (Van Valin & Wilkins 1993). Moreover, the development of the system is situated within a typologically motivated theory of the syntax-semantic interface, which has dealt with a wide range of grammatical phenomena in structurally diverse languages from all over the world. Van Valin has also worked on Lakhota for many years, which is one of the languages to be investigated in this project.

Rainer Osswald has been involved in maintaining and extending a large computational lexicon (Hartrumpf, Helbig & Osswald 2003; Osswald 2004), which serves as the core lexical semantic resource of a natural language understanding approach developed at the FernUniversität in Hagen. The semantic descriptions employed in that lexicon are based on a semantic network formalism (Helbig 2006), with lexical entries seen as lexicalized concepts. Although the larger part of the verb entries in HaGenLex carries only flat semantic role frames, there have been several initiatives towards equipping verb entries with more elaborate semantic structures. In particular, this step has turned out necessary to adequately capture the lexical semantics of verbs with prepositional complements (Osswald, Helbig & Hartrumpf 2006). The semantic representation of implicit creation verbs and of deverbal nouns in the lexicon has also led to developing more advanced semantic representations for verbs (Osswald & Helbig 2005). The formal and logical properties of attribute value structures and theories have been investigated in Osswald (1999, 2002).

Anja Latrouite has done research on event structure, argument linking and lexical decomposition of verbs in non-Indo-European languages with a special focus on Philippine languages within the DGfS funded SFB-project ‘Theories of the Lexicon’. She is currently finishing her Thesis on verb semantics, voice and case in Tagalog and has published work on the dynamic structure of verbs and valence alternations (Latrouite & Naumann 1999a) as well as on voice induced meaning changes and linker alternations (Latrouite & Naumann 1999b, Latrouite 2000). Her latest work is concerned with event-structural prominence and forces in verb meaning change in Tagalog (Latrouite 2007). She has had formal training in RRG and Formal Semantics and has worked within the frameworks of Lexical Decomposition Grammar and Dynamic Event Semantics.

### **3 Goals and work schedule**

#### **3.1 Goals**

The goal of the project is the development of a decompositional frame semantics for verbs, building on a cross-linguistically motivated theory of lexical decomposition that forms part of the input to a theory of the syntax-semantics interface, along the lines of Role and Reference

Grammar (RRG; Van Valin & LaPolla 1997, Van Valin 2005a). The decompositional system will lean on the expressive frame formalism proposed by Barsalou (1992), using the formalized version proposed by Petersen (2007) and its extension in project B1. In order to make sure that the frame-semantic system is able to adequately model essentially all grammatically relevant meaning components and to overcome the limitations of current representations, the project will include an extensive linguistic analysis, which will provide both, an empirical justification for positing certain frame-semantic constructions and a test bed for their adequacy as input to the syntax-semantics interface. The linguistic analysis will focus on a limited but representative set of action, cognition and perception and psych-verbs. These verbs will be investigated in several languages: German, English, French (for selected phenomena only), Tagalog, and Lakhota. The grammatical phenomena to be accounted for include complex derivational morphology, case assignment by verbs, adposition assignment by verbs, and complement selection in complex sentences.

Although the frame representations developed in the project will be empirically tested with respect to the syntax-semantics interface of RRG, it will be possible for other linking theories to make use of the project's results, as long as they use some sort of decompositional analysis. Moreover, the frame-semantic system ties in directly with research in cognitive psychology, cognitive neuroscience, as well as in computational lexical semantics and knowledge representation.

The goals of the project can be subdivided into the following subgoals:

- 1) Development of a system of lexical decomposition for verbs, based on a frame formalism, which can serve as an input to a theory of the syntax-semantics interface.
  - a) Frame-based reconstruction of the term-based decomposition schemes, starting with the ones used in RRG, with an eye to those suggested by Rappaport Hovav & Levin (1998), Pinker (1989), Wunderlich (2006), and others.
  - b) Development of a set of meta-language primitives, including sortal and relational terms, and elementary constructional frame templates for simple and complex events.
  - c) Formulation of semantic composition by means of frame unification.
  - d) Extension of the frame-semantic representations to cover new aspects such as propositional and predicative arguments and complex interrelations between arguments, plus an extended decomposition of selected verbal roots.
  - e) Integration of the frame-semantic representations into the RRG model of the syntax-semantics interface.
- 2) Analysis and frame-semantic representation of a limited but representative set of verbs from three verb classes (action verbs, perception/cognition verbs, psych-verbs) based on data from several languages (primarily German, English, Tagalog, Lakhota).
  - a) Frame-semantic analysis of a selected set of verbs from the three verb classes, starting with German and English verbs (with selective examples from French).
  - b) Analysis of how the frame-semantic representations developed under a) are lexicalized in Tagalog and Lakhota.

- c) Comparison of the semantic structure of verbs cross-linguistically, with the goal of explicitly capturing the differences and similarities of verbs in the same semantic domains in terms of frames.
- d) Application of the frame-semantic representations, as part of the grammatical model, to the analysis of grammatical phenomena cross-linguistically and investigation of the extent to which grammatical differences can be related to lexical semantic differences among verbs in different languages.

### 3.2 Methods and work schedule

#### Frame-based semantic representation for lexical decomposition

The term-based decompositional system of RRG will be reformulated by means of a frame-semantic representation [**Subgoal 1a**]. To this end, all representational elements will be analyzed as to how they can be represented within a frame. The RRG lexical semantic system has the following components: an inventory of primitive state and activity predicates (e.g. **dead**, **run**), on the one hand, and limited inventory of operators which combine with the state and activity predicates to derive the other *Aktionsart* classes and subclasses, i.e. BECOME, INGR[ESSIVE], PROC[ESS], CAUSE, NOT, & ‘and then’ and  $\wedge$  ‘and’, on the other. For example, the CAUSE operator combines two event (or state) descriptions. An ad hoc frame representation of this construction could then look as in Figure 4a), where causation itself is posited as a representational (semantic or conceptual) unit, which is assumed to have two attributes, CAUSE and EFFECT, whose values in turn are events, the cause and the effect of the causation, respectively. (Strictly speaking, the restriction to events should be relaxed, since the CAUSE operator of RRG also applies to states.)

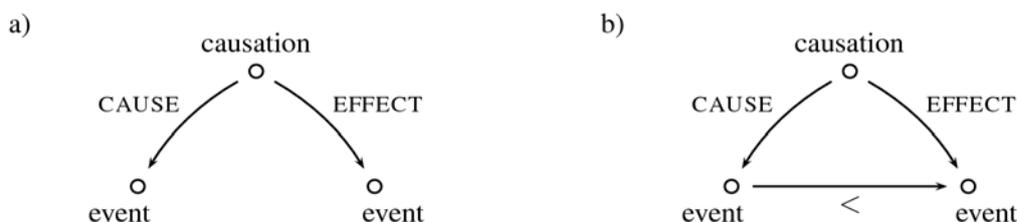


Figure 4: Ad hoc representation of the CAUSE operator as frame template

Figure 4b) gives a simple example of a relational dependency between attribute values, where the relation  $<$  indicates immediate precedence between events. (See Pustejovsky 1995, Sect. 5.3, for a similar idea to specify temporal relatedness in different types of event structures.)

In contrast to term-based representations, frames easily allow, due to their flexible recursive structure, the addition of semantic specifications where necessary, without resorting to diacritic notations such as sub- or superscripts. The greater expressiveness of frames comes at the price of formulating appropriate constraints to restrict arbitrary combinations. On the positive side, this means that all structural constraints become explicit and transparent. For example, the constraints on the values of the attributes in the causation frame of Figure 4 can be formalized as in (2a) (see e.g. Osswald 2002). Similarly, the constraint (2b) states that causations are specific events.

- (2) a. causation  $\leq$  CAUSE:event  $\wedge$  EFFECT:event  
 b. causation  $\leq$  event

Figure 5a) gives a first idea of what a frame representation of the decomposition structure (1a) could look like. Whether to choose this representation or whether it is more appropriate to prefer a frame structure like Figure 5b), which does not posit an additional causation event in addition to the causing event, is a typical question to be investigated during the project. Criteria for preferring one frame structure over another are (i) semantic/conceptual adequacy and (ii) linguistic support via the syntax-semantics interface.

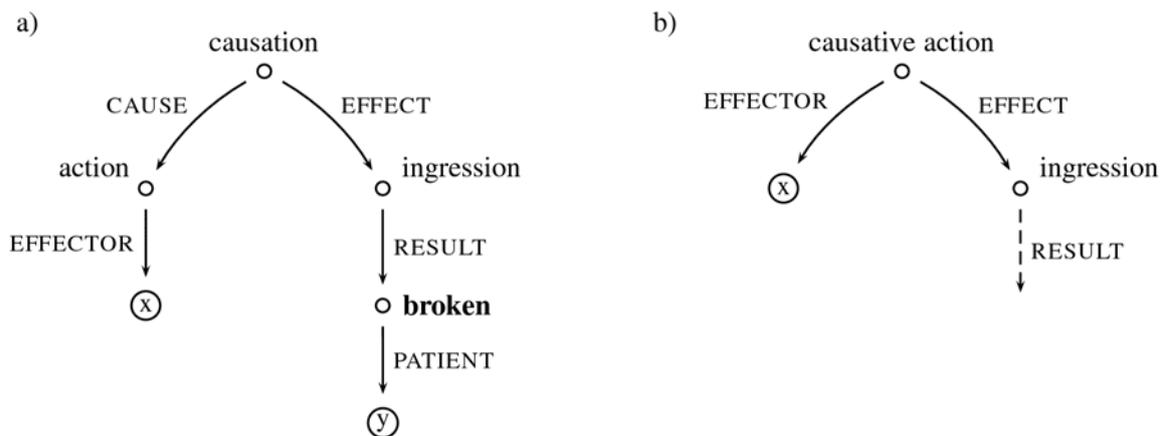


Figure 5: Preliminary sketches of frame representation for *break*

Some of the possible constraints that apply to the frame shown in Figure 5a) are stated in (3):

- (3) action  $\leq$  event, ingression  $\leq$  event  $\wedge$  RESULT:state, **broken**  $\leq$  state

It is well known that frames can be logically interpreted in various ways (e.g. Hayes 1979). For example, the frame of Figure 5a) could be straightforwardly associated with the open first-order formula (4), possibly (partially) closed by existential quantification (see also Osswald 1999).

- (4) causation(e) & CAUSE(e,e') & EFFECT(e,e'') & action(e') & EFFECTOR(e',x)  
 & ingression(e'') & RESULT(e'',s) & **broken**(s) & PATIENT(s,y)

Such a correspondence between frames and first-order formulas of type (4) may allow for a more traditional, “neo-Davidsonian” event semantics perspective on frames, e.g. along the lines of Parsons (1990). But notice that the structural properties of frame representations, which are crucial for the syntax-semantics interface, are, at best, implicit in the logical reformulation. Suitable logical interpretations for frames will be further explored in cooperation with Project B1.

In order to develop a frame-semantic system for a given verb class, one has to determine a system of sortal and relational semantic primitives sufficiently fine-grained to draw all meaning distinctions which have grammatical effects [**Subgoal 1b**]. In addition, the possible combinations of these primitives in frame representations have to be specified by stating appropriate constraints, as exemplified in (2) and (3) above. The frame representation of a verb contains information that is essential to the interpretation of the sentence, and this information

will also be available to the linking system. Although lexical semantic representations are language-specific, the meaning components are assumed in this project to be part of a cross-linguistically valid semantic metalanguage. There have been several proposals for such a semantic metalanguage, most notably by Wierzbicka (1996) and Mel'čuk (1988), which can serve as starting points for the semantic metalanguage to be used in the project. Other potential sources for suitable metalanguage elements are linguistically motivated ontologies (e.g. Pustejovsky et al. 2006, Stein 2007), which, however, are often not fine-grained enough.

A crucial question is how the decompositional representation is determined. For the basic event structure representation, the syntactic and semantic tests proposed in Van Valin & LaPolla (1997) and Van Valin (2005a) serve as a starting point and will be refined. These tests are *Aktionsart* tests in the widest sense: they include the Dowty-Vendler type criteria such as compatibility with different temporal adverbials and the progressive to elicit the aspectual core of the verb in question. Further tests involve manner adverbials; for instance, manner adverbials such as *vigorously* indicate an underlying activity. Causative paraphrases are taken as indicators for an underlying causative structure. Since paraphrases of this type are often disputable and tend to become unreliable if not treated with care, the assumed causative nature of a verb will also be checked cross-linguistically, e.g. by looking at languages with overt causative morphology. A further goal of the project is to model the different types of causation represented by English *make*, *have* and *let* causatives, as well as other distinctions (see also Talmy 2000, Chap. 8).

A central aspect of decompositional approaches is the ability to model compositional phenomena, covering both the semantics of morpho-lexical and morpho-syntactic composition. Examples are complex verb morphology with more than one root or a root plus semantically rich affixes, and aspectual composition by argument-adjuncts (e.g. *walk* [activity] vs. *walk to the station* [(active) accomplishment]; see also Rothstein 2004). Within RRG and similar approaches, composition is realized by applying operators. Transferred to a frame-based decompositional representation, modeling semantic composition comes down to specifying appropriate mechanisms of frame unification [**Subgoal 1c**], where established unification mechanisms in use for attribute value structures will serve as a starting point (see also Petersen 2007).

In addition to providing decomposition patterns with a sound conceptual and formal basis, the main advantage of frames over term-based templates is their flexibility, which allows one to add semantic specifications if necessary without switching to a new representational format. The project will illustrate this advantage by applying the frame-semantic approach to representational problems such as a much more fine-grained semantic decomposition of verb roots and derivational affixes on the one hand, and, on the selection of clausal complements by certain verbs, on the other [**Subgoal 1d**]. This part of the project will be accompanied by an extensive linguistic analysis of a selected set of verbs across several languages [**Subgoal 2**] (see below).

In RRG, as well as in many other term-based decompositional approaches (e.g. Ehrlich & Rapp 2000), thematic relations are defined in terms of argument positions in decomposition structures. Within a frame representation, thematic relations are then naturally defined as (possibly composed) attributes, which are functional, by definition. The syntax-semantics interface of RRG makes reference to certain generalizations over these relations. Adapted to the

frame-semantic system, these generalizations are to be defined over the frame attributes [Subgoal 1e]. (Defining hierarchies on the space of frame attributes will also be a topic of Project B1.) A concluding feasibility study will investigate to what extent the frame-semantic representation allows a similar adaption of other decomposition-based linking mechanisms like that of Wunderlich (1997, 2000) and Levin & Rappaport (1998, 2005).

### Languages to be investigated

The languages to be investigated are German, English, Tagalog, Lakhota (Siouan, North America), and, more selectively, French. Tagalog has multi-functional focus/voice-affixes that interact with verb meaning in intricate ways. Lakhota has complex derivational morphology in its verb system, and it is a split-intransitive language. Compared to the three Indo-European languages, much less work has been done on the lexical semantics of verbs in the two non-Indo-European ones, and accordingly this project will contribute to the analysis of these languages. Furthermore, because one of the most important goals of the project is a system of lexical decomposition which is cross-linguistically valid, the inclusion of Tagalog and Lakhota is critical; otherwise the system would be based primarily on the analysis of two closely related Germanic languages. For languages with complex verb morphology, particularly derivational morphology, the lexical semantic analysis should be the basis for insightful and explanatory accounts of these morphological systems.

**German, English, French.** Considerable work has already been done on the lexical semantics of German and English verbs, and the primary task with respect to these languages is to build on this work and to formalize the resulting analyses in terms of frames. Examples from French will be investigated selectively, in cases where it seems appropriate to consult a third Indo-European language for further contrast. The analysis of German, English and French verbs will be extensively supported by accessing on-line corpora and large lexical resources, including valency dictionaries. Preposition assignment is a challenging aspect of these languages. The current RRG system of lexical representation is already able to predict some argument-marking prepositions, e.g. *to*, *from* and *with* in English (Jolly 1993, Van Valin & LaPolla 1997). However, to go beyond this more semantic detail is required, and this is especially true with respect to case assignment by adpositions in German and other languages, which may involve not only detailed decomposition of the verb but also decompositional representations of the adpositions. It has moreover been observed that verb dependent preposition assignment is semantically regular within narrow subclasses (for German see e.g. Lerot 1984, Breindl 1989, Osswald, Helbig & Hartrumpf 2006).

**Tagalog.** Tagalog is known to exhibit a set of so-called focus/voice-affixes (Actor voice affixes: *ma-*, *um-*, *mag-*; Undergoer voice affixes, *i-*, *-in*, *-an*) that heavily affect the meaning and argument structure of verbs. The pervasive multi-functionality of affixes in Tagalog sheds insight into the way events are conceptualized and poses an interesting challenge to decompositional approaches. Voice/focus affixes signal, among other things, different degrees of agentivity, e.g. control versus lack of control/intention, or the ways the arguments in the sentence are involved in the event, e.g. whether the Actor performs a single action or a repetitive (collective or habitual) action as well as whether there is a result with respect to the Undergoer or if the Undergoer is specific, animate, and a possible controller. In other words, the properties and the interrelations of the participants in the event are reflected in the grammar and overtly

marked on the verb. This is different from Indo-European languages where the properties and the interrelation of the participants in the event are often inferred or made explicit via other linguistic means, e.g. adverbs. Hence, the voiced verbs contain a multitude of information that definitely calls for more elaborate verb representations. The data in Tagalog are thus highly interesting and relevant with respect to the subgoals 1c) and 1d) of the project.

**Lakhota.** The vast majority of Lakhota transitive verbs are derived from state predicates or nouns via causativization by means of instrumental prefixes, e.g. from *xlóka* ‘hole’ one can derive *paxlóka* ‘to make a hole in a skin with an awl by sustained pressure’, *kaxlóka* ‘to make a hole in a skin by a sudden punch with an awl’, and *woxlóka* ‘to make a hole in a skin by throwing the awl from a distance’. Such forms present interesting challenges to semantic compositionality as captured in frame unification, since they involve the integration of semantically complex prefixes with semantically rich roots. In addition, stems which do not take instrumental prefixes can likewise be semantically rich, e.g. *kazúkzuka* ‘slimy material hang down’. The use of frames for the semantic representation of these roots will permit a more insightful representation than either thematic relations lists or logical representations.

### Verb classes to be investigated

The approach to be taken in the project is to examine three classes of verbs with distinctive semantic, morphosyntactic and linking properties. Only a limited number of selected verbs in each class will be analyzed. The verb classes are action verbs, perception/cognition verbs, and psych-verbs.

**Action verbs.** The class of action verbs represents canonical action verbs, with a potentially agentive subject and, if the verb is transitive, an affected patient as object. It includes verbs of destruction, verbs of motion and stance, and verbs of bodily action, such as *destroy*, *shatter* (transitive), *run*, *stand*, and *grasp*. Such verbs receive fairly consistent coding cross-linguistically, e.g. in terms of case assignment they exhibit either a nominative-accusative or an ergative-absolutive pattern. The other two classes, by contrast, are not canonical transitives and show substantial variation in the coding of arguments cross-linguistically. Some of the verbs chosen will be ones relevant to other projects, especially A4 on the historical development of functional nouns from concrete action verbs.

In Tagalog, many action verbs take the Actor voice affix *mag-*, some obligatorily and exclusively so, others allow for each of the three Actor voice affixes. Depending on the verb meaning *mag-*affixation may result in a reflexive reading (*umahit* ‘to shave someone’ vs. *magahit* ‘to shave oneself’), in a causative reading (*bumagsak* ‘to fall’ vs. *magbagsak* ‘to subvert s.th’), a collective reading (*kumanta* ‘x sings’ vs. *magkanta* ‘x and y sing’), an intensive/habitual reading (*sumulat* ‘to write’ vs. *magsulat* ‘to write a lot/professionally’) or in a change in direction of the action (*umabot* ‘to reach for sth’ vs. *magabot* ‘to hand so sth’). Clearly a merely *Aktionsart*-based decomposition is not enough to explain the data. Factors at work here revolve around the notions of agency, control (which is why the language has been characterized as an active language by Drossard 1984) and event prominence; see Latrouite (2008). The fact that the different readings of the affixes are strictly tied to specific verb groups calls for a systematic and more fine-grained representation of the verb meanings than currently available. It is clear that the voice affixes operate in the realm of a meaning space opened up by the verb stem and that the respective verb meanings cannot be inferred from the syntactic

environment in which the verb appears. While certain phenomena are definitely specific to Philippine languages, notions as control, intention, prominence play a role in many languages, so it is important to find out how to best integrate them into our frame-semantic system developed on the basis of the two Indo-European languages mentioned above.

The verbs of destruction are chosen because of their compositional semantic representation. As noted above, Lakhota action transitive verbs present complex compositionality issues. The semantics of each prefix would be represented as a frame; the prefixes are: *ya-* ‘with the mouth, by biting’, *yu-* ‘by pulling, with the hands’, *wa-* ‘by a sawing motion, with a knife’, *wo-* ‘by action from a distance’, *pa-* ‘by pushing along, pressure’, *ka-* ‘by sudden impact’, *na-* ‘with the foot or leg’, and *na-* ‘by inner force’. They range from the quite specific, e.g. *ya-* and *na-* (foot), to the much less specific, e.g. *wo-*. The roots to which the prefixes can be added can be quite semantically rich; they may contain information about the nature of its argument and the state in which it is in. There is no general verb meaning ‘break’ in Lakhota; rather there are dozens of verbs meaning ‘break’, generated from the instrumental prefixes plus the roots that specify the kind of object and the nature of the effect on it. Examples include: *-wega* ‘be fractured but not broken off, said of a stick-like object’, *-ksa* ‘be severed, said of a stick-like object’, *-blecha* ‘be shattered, said of a flat brittle object’. Figure 6 sketches a preliminary frame representation of the verb *kablécha* ‘to shatter by striking’:

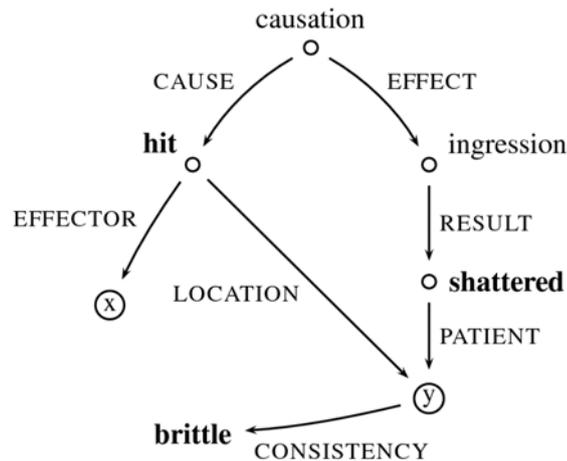


Figure 6: Preliminary sketch of semantic representation of *kablécha* ‘to shatter by striking’

Clearly, the primitive element **hit** could be further decomposed into ‘forceful instantaneous contact event’, which could be integrated into the frame representation by introducing a primitive sortal element ‘contact-event’, as a sub-sort of ‘event’, which in turn is further specified with respect to attributes like STRENGTH and DURATION. Moreover, the attribution of the property ‘brittle’ to a shattered object might be called into question. These and related issues will be addressed in the project, always keeping in mind that the frame representations are only required to cover semantic distinctions necessary for predicting the verb’s syntagmatic behavior.

**Perception/cognition verbs.** The verbs to be investigated include *see, hear, feel, know, believe, think, remember, recall, forget* etc. The perception/cognition verbs are typically stative and take an experiencer subject and an object that is not an affected patient; many of these verbs assign something other than nominative/ergative to their experiencer arguments, very often dative. They often exhibit interesting preposition assignment, e.g. *think of/about*,

*know of/about, hear of/about, see \*of/\*about* (*see about* has an unrelated meaning). Given that perception/cognition verbs typically take an experiencer argument, it is not surprising to find that Tagalog codes this argument via the so-called stative voice marker *ma-*. It is interesting to note, however, that it is *not* one of the Actor voice affixes that signal a high degree of agency and control, but the so-called Undergoer voice affixes that get chosen for this class of verbs to yield the reading that the perception or cognitive activity was controlled and intentional (*ma-puna* ‘to notice’ vs. *puna-hin* ‘to try to notice’; *ma-dinig* ‘to hear’ vs. *dingg-in* ‘to listen to’). This example suggests once again that the voice affixes do not simply signal the properties of the most salient argument, but that they convey information on the inter-relation of Actors and Undergoers in the event which can very well be modeled via constraints in a frame representation.

**Case study I** (*recall* vs. *remember*): Many existing decompositional approaches to verb semantics would represent the English verbs *remember* and *recall* simply as **remember** and **recall**, which indicates nothing about the meaning components they have in common and those that distinguish them. The same would be true of a simple semantic role analysis like [Cognizer, Theme]. However, *remember* and *recall* differ in a number of ways. For instance, *recall*, in contrast to *remember*, apparently presupposes volition and control on the part of the experiencer; witness (5):

- (5) a. John remembered/??recalled abruptly what had happened last night.  
 b. John was remembering/?recalling his father shoveling snow one cold morning.

In (5a), the return of John’s memory is unintended. Similarly, (5b) suggests an unintended, “contemplative” reading: John is thinking of something in the past without having it actively called back to mind. The volitional connotation of *recall* may be related to the fact that its original, non-cognitive sense refers to an action, as e.g. in *Russia recalled its ambassador*.

*Recall* differs from *remember* also in its complement selection properties: both verbs license sentential and gerundive complements (6a), whereas infinitival complements are acceptable for *remember* only (6b).

- (6) a. John remembered/recalled that he had closed the door/closing the door.  
 b. John remembered/\*recalled to close the door.

The three syntactic complement types of *remember* roughly correspond to the following semantic ones: fact (*John remembered that he had closed the door*), experience (*John remembered closing the door*), and intention/obligation (*John remembered to close the door*). These different interpretations are not a function of the complement types; rather they follow from the meaning of *remember* itself, because they can occur with simple NP objects; *John remembered his keys* can have three readings: *John remembered to do something with his keys*, e.g. bring them (intention/obligation), *John remembered seeing his keys* (experience), and *John remembered something about his keys* (fact).

Contrasting English *remember* and *recall* with German *sich erinnern* and French *se rappeler* (or *se souvenir de*) confirms the impression that the intention/obligation reading of the complement has a special status compared to the fact and experience reading: The German translation of *to remember to do* is *daran denken zu tun*, and similarly for French: *penser à faire*. So German *sich erinnern* (as well as French *se rappeler*) seems to pattern like English

*recall*, not *remember*. On the other hand, English *remind*, which is ‘cause to remember’, and German *erinnern*, the causative counterpart to *sich erinnern*, appear to be equivalent (and French *rappeler* behaves the same way). Notice that the causative versions in all three languages can take an infinitival complement with intention/obligation interpretation (*Mary reminded John to close the door*). Another interesting cross-linguistic facet of the lexical field spanned by *remember* is the German dative-experiencer achievement verb *einfallen*, which can mean “come to mind again”, in the sense of “remember suddenly”, but also simply “come to mind” (corresponding to the English experiencer verb *to occur to*).

Van Valin, Osswald & Latrouite (2008) argue that the meaning variants of *remember* are centered around the concept of “having something in mind again”, leaving it open for the moment whether to classify it as a cognitive state or activity since the standard *Aktionsart* tests are not fully reliable in the mental domain. In addition, *remember* allows one to focus on the ingression, i.e. the punctual onset of this state/activity, which comes along with an achievement reading (*John suddenly remembered his keys*, cf. 5a), and also to refer to the intentional evocation of this state (*John remembered the name of his first girlfriend without effort*). Keeping aside the intention/obligation interpretation, a first approximation of a frame representation for this analysis is shown in Figure 7. *Recall* covers only the ‘call-to-mind-again’ component. A more detailed representation would, e.g., decompose the ‘-again’ affix and cover more of the usages of *remember/recall/remind*.

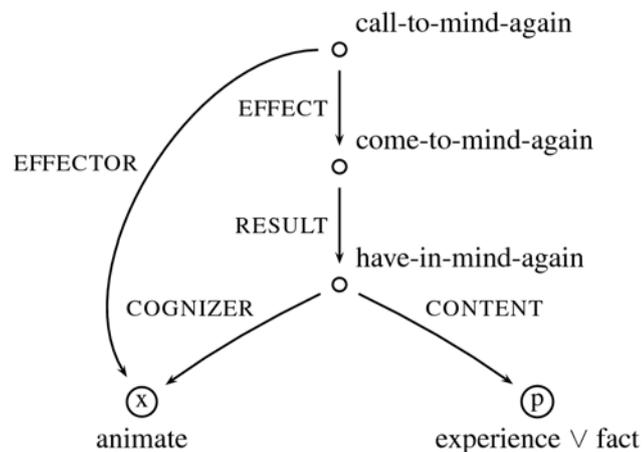


Figure 7: Preliminary sketch of frame representation for *remember*

Such a decomposition permits comparison with other verbs in the same semantic domain, both within and across languages. Van Valin & Wilkins (1993) compare three verbs from the Australian Aboriginal language Mparntwe Arrernte which cover the same semantic domain as *remember*, identifying how the semantic structure of each verb is similar to and differs from that of English *remember*. In Tagalog, there are also three different stems (*alaala* ‘memory’: *makalalaalaa* ‘be able to remember’, *maalaalaa* ‘remember sth.’, *alalahan-in* ‘to recall sth.’; *tanda* ‘retention’: *magtanda/tandaan* ‘to remember/bear in mind’, *matandaan* ‘to recollect’; *gunita* ‘remembrance’: *gumunita/gunitain* ‘to recall to mind’, *magunita* ‘to recur to one’s memory’) for events of the *remember/recall* type. Once again these may combine with a number of voice affixes that specify the participants in the event, e.g. as intentional, making an effort or as having the ability to remember. The data show that meaning components and meaning shifts that are not overtly marked in Indo-European languages are morphologically

marked in Tagalog and not just “inferred”. No analysis of the data would be possible without a sufficiently detailed decomposition for *remember*. Hence a frame semantics for verbs will provide a deeper, richer system of lexical decomposition, essential for such analyses.

**Psych-verbs.** Verbs to be investigated in this class include *fear*, *frighten*, *anger*, *amuse*, *upset*, *annoy*, etc. The psych-verbs show interesting variation in the expression of the experiencer. On the one hand, there are stative psych-verbs like *fear*, with the experiencer as subject and the thing feared as object, and there are also intransitive experiencer-subject predicates, which have the target of the psychological state as the object of a preposition e.g. *be angry at/with/about*, *be pleased \*at/with/about*, *be afraid \*at/\*with/\*about/of*. On the other hand, there are causative psych-verbs, like the ones listed above, which have the stimulus as the subject and the experiencer as the direct object; in certain respects they are closer to canonical transitive verbs than perception/cognition verbs since they are causative, and they have much discussed unusual linking and binding properties (cf. Section 2.1). Although there is no overt indication of causation in the form of the verbs in English, for example, such verbs may be paraphrased with an explicit causative component, e.g. ‘x upset y’ means ‘x cause y to be upset’. In Lakhota (as in e.g. Japanese and Barai; see Van Valin & LaPolla 1997), psych-verbs take explicit causative marking, e.g. *čqzé* ‘to become angry’ vs. *čqzé-ya* [-ya ‘cause’] ‘to anger’, *inihq* ‘to be scared, frightened, amazed’, vs. *inihq-ya* ‘scare, frighten, amaze’. This supports the analysis of these object experiencer psych-verbs as causative. In Tagalog, psych-verbs are often marked by the affix *ma-*. A causative reading is yielded either by affixing one of the Undergoer affixes (*ma-takot* ‘to fear’ vs. *takut-in* ‘to frighten, *ma-galit* ‘be angry’ vs. *galit-in* ‘make angry’) or by affixing the causative affixes (*ika-* or *pa-*. With normal property denoting stems, in contrast, the Undergoer voice introduces an assessment/attitude reading (*ma-tamis* ‘be sweet’ vs. *ma-tamis-in* ‘to take as sweet’).

A frame-semantic representation of psychological verbs that captures the idea of an extended semantic decomposition needs to account for the specific aspectual properties of these verbs, which have been observed to resist a straightforward Vendlerian classification, and also for an adequate analysis and representation of causation, which, for psych-verbs, has been argued to call for a semantic representation different from that of causation in the physical domain (e.g. Geuder 2000, Martin 2006).

**Case study II (*ärgern*):** The German transitive psych-verb *ärgern* (‘annoy’, ‘make angry’; 7a) has a reflexive counterpart, *sich ärgern* (‘be angry’; 7b), where the experiencer is realized as the subject and the theme or target is realized by an argument-adjunct that selects the preposition *über* (with accusative):

- (7) a. Jemand/etwas ärgerte Peter.  
b. Peter ärgerte sich über jemanden/etwas.

Following roughly Löbner & Stamm (2005), a preliminary sketch of a frame representation for *sich ärgern* could look as depicted by Figure 8a).

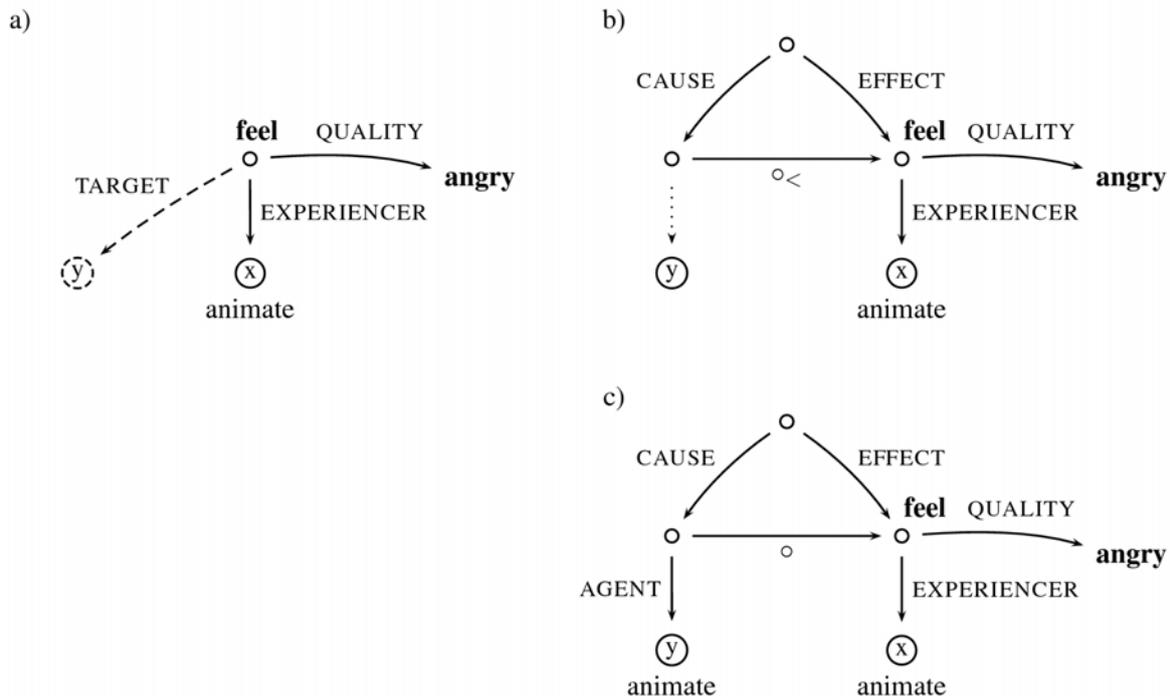


Figure 8: Preliminary sketch of frame representations for *(sich) ärgern*

The sortal primitive **feel** indicates a psychological state, which is further specified by the value **angry** of the attribute QUALITY. A more elaborated frame representation would employ attributes such as POLARITY and INTENSITY to characterize the quality of the psychological state.

As argued above, there are good reasons to analyze object experiencer verbs like *ärgern* as causative (see also Pesetsky 1995). A first sketch of the frame representation for *ärgern* is shown in Figure 8b), where  $o_{<}$  is ordered temporal overlap (see e.g. Pustejovsky 1995). As indicated by the dotted arrow, the relation between the cause and the entity denoted by the subject is not fully specified, in general, witness (8):

- (8) Der platte Reifen/Der Zeitungsartikel ärgerte Peter.

Moreover, *ärgern* also allows an intentional reading as in (9a), where the means used by the agent can be specified by a *mit*-PP. Notice that (9a) can be passivized without problems, in contrast to (9b).

- (9) a. Maria ärgerte Peter (mit abfälligen Bemerkungen).  
b. Marias abfällige Bemerkungen ärgerten Peter.

Figure 8c) provides a partial sketch of the frame representation for intentional *ärgern*. The  $o$  relation emphasizes the concomitance of cause and effect in this case, in contrast, e.g., to the resultative variant *verärgern*. A further aspect to be covered by a full-fledged frame representation for *ärgern* is what Levin (1993) calls the possessor-attribute factoring alternation as exemplified in (10):

- (10) An Maria ärgerte Peter, dass sie zu abfälligen Bemerkungen neigte.

The discussion of the foregoing examples shows that frames, due to their ability to represent specific meaning components, where necessary, and to allow partial, underspecified represen-

tations, if appropriate, provide a very promising, structure-oriented methodology for verb semantics.

## Work packages and work program

	2008-2	2009-1	2009-2	2010-1	2010-2	2011-1
<b>Work Package 1</b>						
Metalanguage Development	RO	RO	RO	RO		
Frame Representations	RO	RO	RO	RO	RO	
Adapt. of Syntax-Semantics Interfaces			RO AL	RO AL	RO AL	RO AL
<b>Work Package 2</b>						
English	RO AL	RO AL	RO AL	RO AL		
German	RO AL	RO AL	RO AL	RO AL		
Lakhota	RV	RV	RV	RV		
Tagalog	AL	AL	AL	AL		
Cross-linguistic Comparison				RO AL	RO AL	RO AL

## Milestones

### Work Package 1 (in parallel with Work Package 2) Estimated date of completion

- |                                                                    |       |
|--------------------------------------------------------------------|-------|
| 1. Basic frames for BECOME, CAUSE, etc.                            | 03/09 |
| 2. Decomposition of action verbs                                   | 07/09 |
| 3. Decomposition of cognition and perception verbs                 | 01/10 |
| 4. Decomposition of psych-verbs                                    | 07/10 |
| 5. Development of frame representations (final)                    | 01/11 |
| 6. Adaption of syntax-semantics interface to frame representations | 07/11 |

### Work Package 2

- |                                                                     |       |
|---------------------------------------------------------------------|-------|
| 1. Analysis of action verbs in English and German                   | 07/09 |
| 2. Analysis of cognition and perception verbs in English and German | 01/10 |
| 3. Analysis of psych-verbs in English and German                    | 07/10 |
| 4. Analysis of Lakhota and Tagalog                                  | 01/11 |
| 5. Comparison of semantic structure of verbs in target languages    | 07/11 |

## Publications by the research group

Hartrumpf, S., H. Helbig & R. Osswald (2003). The semantically based computer lexicon HaGenLex – Structure and technological environment. *Traitement automatique des langues*, **44**(2):81-105.

- Foley, W. A., & Van Valin, R. D., Jr. (1984). *Functional syntax and universal grammar*. Cambridge: Cambridge University Press.
- Latrouite, A. (2001). Linking in Tagalog: Argument encoding determined by the semantic properties of arguments. In: G. Booij & J. van Marle (eds) *Yearbook of Morphology 2000*, pp. 123-154. Kluwer Academic Publishers.
- Latrouite, A. (2007). Event-structural prominence and forces in word meaning change. Paper read at *Forces in Grammatical Structure (FIGS)*. Paris. [to be published in B. Copley (Ed.), *Forces in Grammatical Structure*. Amsterdam: John Benjamins.]
- Latrouite, A. (2008, in preparation). *Verbal semantics, case and voice in Tagalog*. Doctoral Dissertation, HHU Düsseldorf.
- Latrouite, A., & R. Naumann. (1999a). Unaccusative-causative alternations & the dynamic structure of verbs. In G.-J. M. Kruiff & R. T. Oehrle (Eds.), *Proceedings of Formal Grammar 1999* (pp. 115-130). Utrecht Institute of Linguistics.
- Latrouite, A., & R. Naumann. (1999b). On the interpretation of Tagalog voice affixes. In C. Smallwood & C. Kitto (Eds.), *Proceedings of the 6<sup>th</sup> Meeting of the Austronesian Formal Linguistics Association (AFLA 6)* (pp. 221-234). Toronto.
- Naumann, R. & A. Latrouite. (2000). Linking and the dynamic structure of verbs: Underspecification at the morphological-semantic interface. In L. Obrst (Ed.), *Proceedings of the Workshop on Semantic Approximation, Vagueness and Granularity* (pp. 39-50). AAAI Publications.
- Naumann, R., & R. Osswald (2002). A dynamic modal arrow logic for the analysis of aspectual phenomena in natural language. In *Proceedings of the 3rd and 4th International Symposium on Language, Logic and Computation*. Amsterdam: ILLC.
- Osswald, R. (1999). Semantics for attribute-value theories. In *Proceedings of the 12<sup>th</sup> Amsterdam Colloquium* (pp. 199-204). Amsterdam.
- Osswald, R. (2002). *A logic of classification – with applications to linguistic theory*. Doctoral dissertation, FernUniversität in Hagen.
- Osswald, R. (2004). Die Verwendung von GermaNet zur Pflege und Erweiterung des Computerlexikons HaGenLex. *LDV Forum*, **19**(1/2):43-51.
- Osswald, R., & H. Helbig (2005): Derivational semantics in HaGenLex – an interim report. In D. Schnorbusch & S. Langer (Eds.), *Semantik im Lexikon* (pp. 87-127). Tübingen: Narr.
- Osswald, R., H. Helbig & S. Hartrumpf (2006). The representation of German prepositional verbs in a semantically based computer lexicon. In *Proceedings of LREC 2006* (pp. 461-464). Genoa.
- Van Valin, R. D., Jr. (1990). Semantic parameters of split intransitivity. *Language*, **66**:221-260.
- Van Valin, R. D., Jr. (2005a). *Exploring the syntax-semantics interface*. Cambridge: Cambridge University Press.
- Van Valin, R. D., Jr. (2005b). Semantics in Role and Reference Grammar. In K. Brown (Ed.), *Encyclopedia of Language and Linguistics - 2nd Edition* (Vol. 11, pp. 158-67). Oxford: Elsevier.
- Van Valin, R. D., Jr. (2006). Semantic macroroles and language processing. In I. Bornkessel, M. Schlesewsky, B. Comrie & A. Friederici (eds), *Semantic role universals and argument linking: Theoretical, typological and psycho-/neurolinguistic perspectives* (pp. 263-302). Berlin: Mouton de Gruyter.
- Van Valin, R. D., Jr. (2007). The Role and Reference Grammar analysis of three-place predicates. *Suvremena Lingvistika*, **33**:31-64.
- Van Valin, R. D., Jr. (in press): Lexical representation, co-composition, and linking syntax and semantics. In J. Pustejovsky et al. (eds), *New Developments in the Generative Lexicon*. Dordrecht: Kluwer.
- Van Valin, R. D., Jr. & D. P. Wilkins (1993). Predicting syntactic structure from semantic representations: *remember* in English and Mparntwe Arrernte. In R. van Valin (ed), *Advances in Role and Reference Grammar* (pp. 499-534). Amsterdam: John Benjamins.

- Van Valin, R. D., Jr. & D. P. Wilkins (1996). The case for 'effector': case roles, agents and agency revisited. In M. Shibatani & S. Thompson (eds), *Grammatical Constructions* (pp. 289-322). Oxford: Oxford University Press.
- Van Valin, R. D., Jr. & R. J. LaPolla (1997). *Syntax: Structure, meaning & function*. Cambridge: Cambridge University Press.
- Van Valin, R. D., Jr., R. Osswald & A. Latrouite (2008): *Recall versus remember*. Unpublished manuscript. Heinrich-Heine-Universität Düsseldorf.

### Relevant publications

- Barsalou, L. W. (1992). Frames, concepts, and conceptual fields. In A. Lehrer & E. Kittay (Eds.), *Frames, Fields, and Contrasts* (pp. 21-74). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Bierwisch, M. (1983). Semantische und konzeptuelle Repräsentation lexikalischer Einheiten. In R. Ružička & W. Motsch (Eds.): *Untersuchungen zur Semantik* (pp. 61-99). Berlin: Akademie Verlag.
- Boas, H. C. (2005). From theory to practice: Frame semantics and the design of FrameNet. In: D. Schnorbusch & S. Langer (eds), *Semantik im Lexikon* (pp. 129-160). Tübingen: Narr.
- Breindl, E. (1989). Präpositionalobjekte und Präpositionalobjektsätze im Deutschen. Tübingen: Niemeyer.
- Busa, F., Calzolari, N., & Lenci, A. (2001). Generative lexicon and the SIMPLE model: Developing semantic resources for NLP. In P. Bouillon & F. Busa (Eds.), *The Language of Word Meaning* (pp. 333-349). Cambridge: Cambridge University Press.
- Butt, M. (2007). *Theories of Case*. Cambridge: Cambridge University Press.
- Butulussi, E. (1991). *Studien zur Valenz kognitiver Verben im Deutschen und Neugriechischen*. Tübingen: Niemeyer.
- Carpenter, B. (1992). *The logic of typed feature structures*. Cambridge Tracts in Theoretical Computer Science 32. Cambridge: Cambridge University Press.
- Croft, W. (1993). Case marking and the semantics of mental verbs. In J. Pustejovsky (Ed.), *Semantics and the Lexicon* (pp. 55-72). Dordrecht: Kluwer.
- Dölling, J. & Heyde-Zybatow, T. (2007) Verb meaning: How much semantics is in the lexicon? In A. Späth (Ed.), *Interfaces and Interface Conditions, Language, Context and Cognition* (pp. 33-75). Berlin: Mouton de Gruyter.
- Dowty, D. (1979). *Word meaning and Montague Grammar*. Dordrecht: Reidel.
- Drossard, W. (1984). *Das Tagalog als Repräsentant des aktivischen Sprachbaus*. Tübingen: Narr.
- Edmonds, P., & Hirst, G. (2002). Near-synonymy and lexical choice. *Computational Linguistics*, 28(2):105-144.
- Ehrich, V., & Rapp, I. (2000). Sortale Bedeutung und Argumentstruktur: ung-Nominalisierung im Deutschen. *Zeitschrift für Sprachwissenschaft*, 19(2):245–303.
- Engelberg, S. (2000). *Verben, Ereignisse und das Lexikon*. Tübingen: Niemeyer.
- Evans, N., & Wilkins, D. (2000): In the mind's ear: the semantic extensions of perception verbs in Australian Languages. *Language*, 76(3): 546-592.
- Filip, H. (1996). Psychological predicates and the syntax-semantic interface. In A. E. Goldberg (Ed.), *Structure, Discourse and Language* (pp. 131-147). Stanford: CSLI.
- Fillmore, Ch. J. (1968). The case for case. In E. Bach & R. T. Harms (Eds.), *Universals in Linguistic Theory* (pp. 1-88). Holt, Rinehart and Winston.
- Fillmore, Ch. J. (1982). Frame semantics. In *Linguistics in the Morning Calm* (pp. 111-137). Hanshin Publishing: Seoul.
- Fillmore, Ch. J., & Atkins, B. T. (1992). Toward a frame-based lexicon: The semantics of RISK and its neighbors. In A. Lehrer and E. F. Kittay (Eds.), *Frames, Fields, and Contrasts* (pp. 74-102). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Fillmore, C J., Johnson, C. R., & Petruck, M. R. L. (2003): Background to FrameNet. *International Journal of Lexicography*, 16(3):235-250.

- Fong, S., Fellbaum, C., & Lebeaux, D. (2001). Ghosts, shadows and resultatives: The lexical representation of verbs. *Traitement automatique des langues*, 42(3):755-784.
- Geuder, W. (2000). Oriented adverbs: Issues in the lexical semantics of event adverbs. Doctoral dissertation. Eberhard-Karls-Universität Tübingen.
- Grimshaw, J. (1979). Complement selection and the lexicon. *Linguistic Inquiry*, 10:279-326.
- Grimshaw, J. (1990). *Argument Structure*. Cambridge, MA: MIT Press.
- Gruber, J. (1965). *Studies in Lexical Relations*. Doctoral dissertation, MIT.
- Hayes, P. J. (1979). The logic of frames. In D. Metzger, *Frame conceptions and text understanding* (pp. 46-61). Berlin: de Gruyter.
- Heid, U. (1997). Zur Strukturierung von einsprachigen und kontrastiven elektronischen Wörterbüchern. Vol. 77 of *Lexicographica: Series maior*. Tübingen: Niemeyer.
- Helbig, H. (2006). *Knowledge representation and the semantics of natural language*. Springer.
- Jackendoff, R. (1977). *X-bar Syntax. A study of phrase structure*. Cambridge, MA: MIT Press.
- Jackendoff, R. (1983). *Semantics and cognition*. Cambridge, MA: MIT Press.
- Jackendoff, R. (1990). *Semantic structures*. Cambridge, MA: MIT Press.
- Jackendoff, R. (2002). *Foundations of language*. Oxford: Oxford University Press.
- Jolly, J. (1993). Preposition assignment in English. In Van Valin, R. (Ed.), *Advances in Role and Reference Grammar* (pp. 275-310). Amsterdam: John Benjamins.
- Klein, K., & Kutscher, S. (2002). Psych-verbs and lexical economy. Tech. Rep. 122, *Theorie des Lexikons. Arbeiten des Sonderforschungsbereichs 282*.
- Koenig, J.-P., & Davis, A. (2003). Semantically transparent linking in HPSG. In S. Müller (Ed.), *Proceedings of the 2003 HPSG Conference*, 222-35. Stanford: CSLI Online.
- Koenig, J.-P., & Davis, A. (2006). The KEY to lexical semantic representation. *Journal of Linguistics*, 42:71-108.
- Krifka, M. (1992). Thematic relations as links between nominal reference and temporal constitution. In I. A. Sag & A. Szabolcsi (Eds.), *Lexical Matters, CSLI Lecture Notes* (No. 24, pp. 29-53). Stanford, CA: CSLI Publications.
- Lang, E. (1994). Semantische vs. konzeptuelle Struktur: Unterscheidung und Überschneidung. In M. Schwarz (Ed.): *Kognitive Semantik/Cognitive Semantics. Ergebnisse, Probleme, Perspektiven* (pp. 25-40). Tübingen: Gunter Narr Verlag.
- Lightfoot, D. (1991). *How to set parameters: Arguments from language change*. Cambridge MA: MIT.
- Lerot, J. (1984). Die verbregierte Präposition in Präpositionalobjekten. In W. Abraham (Ed.), *Satzglieder im Deutschen. Vorschläge zur syntaktischen, semantischen und pragmatischen Fundierung* (pp. 261-291). Tübingen: Niemeyer.
- Levin, B. (1993). *English verb classes and alternations*. Chicago: University of Chicago Press.
- Levin, B., & Rappaport Hovav, M. (2005). *Argument Realization*. Cambridge: Cambridge University Press.
- Löbner, S., & Stamm, H. (2005). On the semantics of gradation verbs: The case of German emotion verbs. Handout at Sinn und Bedeutung 10. Berlin, 13-15 October 2005.
- Mairal Usón, R. & Faber, P. (2005). Decomposing semantic decomposition: Towards a semantic metalanguage in RRG. In *Proceedings of the 2005 International Conference on Role and Reference Grammar*.  
(<http://linguistics.buffalo.edu/people/faculty/vanvalin/rrg/Proceedings%20of%20RRG05.htm>)
- Martin, F. (2006). *Prédicats statifs, causatifs et résultatifs en discours. Sémantique des adjectifs évaluatifs et des verbes psychologiques*. Doctoral dissertation. Université libre de Bruxelles.
- Mel'čuk, I. A. (1988). Semantic description of lexical units in an explanatory combinatorial lexicon: Basic principles and heuristic criteria. *International Journal of Lexicography*, 1(3):165-188.
- Nirenburg, S. & Raskin, V. (2004). *Ontological semantics*. Cambridge, MA: MIT Press.
- Parsons, T. (1990). *Events in the semantics of English*, Cambridge, MA: MIT Press.
- Pesetsky, D. (1995). *Zero syntax. Experiencers and cascades*, Cambridge, MA: MIT Press.

- Petersen, W. (2007): Representation of concepts as frames. In J. Skilters, F. Toccafondi, & G. Stemberger (Eds.), *The Baltic International Yearbook of Cognition, Logic and Communication* (Vol. 2, pp. 151-170). University of Latvia.
- Pinker, S. (1989). *Learnability and cognition: The acquisition of argument structure*. Cambridge, MA: MIT Press.
- Primus, B. (2004). Protorollen und Verbtyp: Kasusvariation bei psychischen Verben. In R. Kailuweit & M. Hummel (Eds.), *Semantische Rollen* (Tübinger Beiträge zur Linguistik 472, pp. 377-401). Tübingen: Narr.
- Pustejovsky, J. (1995). *The generative lexicon*. Cambridge, MA: MIT Press.
- Pustejovsky, J., Havasi, C., Littman, J., Rumshisky, A., & Verhagen, M. (2006). Towards a generative lexical resource: The Brandeis semantic ontology. In *Proceedings of LREC 2006* (pp. 1702-1705).
- Ramchand, G. C. (2008). *Verb meaning and the lexicon. A first phase syntax*. Cambridge Studies in Linguistics 116. Cambridge: Cambridge University Press.
- Rappaport Hovav, M. & Levin, B. (1998). Building verb meanings. In M. Butt & W. Geuder (Eds.), *The projection of arguments: Lexical and compositional factors* (pp. 97-134). Stanford, CA: CSLI Publications.
- Rauh, G. (1993). On the grammar of lexical and non-lexical prepositions in English. In C. Zelinski-Wibbelt (Ed.), *The Semantics of Prepositions* (pp. 99-150). Berlin: Mouton de Gruyter.
- Rosen, S. T. (2003). The syntactic representation of linguistic events. In L. Cheng & R. Sybesma (Eds.), *The Second Glot International State-of-the-Article Book* (pp. 323-365). Berlin: Mouton de Gruyter.
- Rothstein, S. (2004). *Structuring events: A study in the semantics of lexical aspect*. Oxford: Blackwell.
- Rojo, A., & Valenzuela, J. (2004/5). Verbs of sensory perception. In *Languages in Contrast*, 5:219-243.
- Rudanko, J. (1989). *Complementation and case grammar*. Albany: SUNY Press.
- Saint-Dizier, P. & Viegas, E. (Eds.) (1995), *Computational lexical semantics*. Cambridge: Cambridge University Press.
- Stein, A. (2007). Motion events in concept hierarchies: Identity criteria and French examples. In A. C. Schalley & D. Zaefferer (Eds.), *Ontolinguistics: How ontological status shapes the linguistic coding of concepts* (pp. 379-394). Berlin: Mouton de Gruyter.
- Talmy, L. (2000). *Toward a cognitive semantics. Volume I: Concept structuring systems*. Cambridge MA: MIT Press.
- Viberg, Á. (1984). The verbs of perception: A typological study. In B. Butterworth, B. Comrie & O. Dahl (Eds.), *Explorations for Language Universals* (pp. 123-162). Berlin: Mouton de Gruyter.
- van Voorst, J. (1992). The aspectual semantics of psychological verbs. *Linguistics and Philosophy*, 15:65-92.
- Wierzbicka, A. (1996): *Semantics - Primes and universals*. Oxford: Oxford University Press.
- Wunderlich, D. (1997). Cause and the structure of verbs. *Linguistic Inquiry*, 28:27-68.
- Wunderlich, D. (2000). Predicate composition and argument extension as general options. In B. Stiebels & D. Wunderlich (Eds.), *Lexicon in focus* (pp. 247-270). Berlin: Akademie Verlag.
- Wunderlich, D. (2006). Towards a structural typology of verb classes. In D. Wunderlich (Ed.), *Advances in the theory of the lexicon*, 58-166. Berlin: Mouton de Gruyter.

### 3.3 Experiments involving humans or human materials

yes  no

### 3.4 Experiments with animals

yes  no

### 3.5 Experiments with recombinant DNA

yes  no