

Describing derivational polysemy with XMG

Marios Andreou Simon Petitjean

Heinrich Heine Universität Düsseldorf, Düsseldorf, Germany

Marios.Andreou@uni-duesseldorf.de , petitjean@phil.uni-duesseldorf.de

RÉSUMÉ

Décrire la polysémie dérivationnelle avec XMG.

Dans cet article, nous modélisons et testons les approches monosémique et polysémique à la multiplicité des sens en morphologie dérivationnelle, en utilisant la sémantique des cadres (Frame semantics) et XMG. Pour illustrer nos hypothèses et propositions, nous utilisons des exemples de nominalisations déverbales avec le suffixe *-al* sur des verbes de changement de possession en anglais (par exemple, *rental*, *disbursal*). Dans notre implementation XMG, nous montrons que le sens sous-spécifié des affixes ne peut pas toujours être réduit à un simple sens unitaire et qu'en conséquence l'approche polysémique est plus judicieuse que l'approche monosémique. Nous introduisons également des contraintes sur les potentiels référents. Ces contraintes prennent la forme de contraintes de type et spécifient quels arguments de la base verbale sont compatibles avec le référent de la forme dérivée. L'introduction de contraintes de type rend certaines dérivations impossibles en raison d'échecs d'unification entre frames causées par des types incompatibles.

ABSTRACT

In this paper, we model and test the monosemy and polysemy approaches to derivational multiplicity of meaning, using Frame Semantics and XMG. In order to illustrate our claims and proposals, we use data from deverbal nominalizations with the suffix *-al* on verbs of change of possession (e.g. *rental*, *disbursal*). In our XMG implementation, we show that the underspecified meaning of affixes cannot always be reduced to a single unitary meaning and that the polysemy approach to multiplicity of meaning is more judicious compared to the monosemy approach. We also introduce constraints on the potential referents of derivatives. These constraints have the form of type constraints and specify which arguments in the frame of the verbal base are compatible with the referential argument of the derivative. The introduction of type constraints rules out certain readings because frame unification only succeeds if types are compatible.

MOTS-CLÉS : morphologie, dérivation, XMG, frame semantics.

KEYWORDS: frame semantics, XMG, word formation, derivation.

1 Introduction

A characteristic property of the outcomes of word formation processes is polysemy (Lieber, 2004; Rainer, 2014). In this paper, we model and test the monosemy and polysemy approaches to derivational multiplicity of meaning, using Frame Semantics and XMG. In order to illustrate our claims and proposals we use data from deverbal nominalizations with the suffix *-al*. Following recent advance-

ments in the study of the semantics of derived words in Frame Semantics (Plag *et al.*, forthcoming), we focus on a well defined class of bases and examine attestations in context. In particular, in the present paper we examine *-al* nominals that are based on verbs of change of possession (e.g. *rental*, *disbursal*).

What is a frame? A frame is a general format of mental representations of concepts which is also applicable to linguistic phenomena. It is a recursive attribute-value structure that provides information about a referent (Petersen, 2007; Kallmeyer & Osswald, 2013; Löbner, 2013). Word formation in Frame Semantics is generally treated in terms of referential shifts (Plag *et al.*, forthcoming). For example, as we will see in the analysis, the suffix *-al* can target particular arguments of the base verb and shift reference from the original referent (i.e. causation event) to a new referent (e.g. theme).

What is XMG? XMG (eXtensible MetaGrammar, (Crabbé *et al.*, 2013)) is a modular and extensible tool used to generate various types of linguistic resources from an abstract and compact description. This description, the metagrammar, relies on the concepts of logic programming and constraints. XMG comes with a system of dimensions, allowing to separate the different levels of linguistic description (e.g. syntax and semantics), and providing dedicated languages adapted to the structures the user wishes to generate. In this work, the dimension we used is the <frame> dimension, proposed in Lichte & Petitjean (2015), where semantic frames can be described using typed feature structures descriptions.

The rest of this paper is structured as follows: In section 2 we examine which readings are possible in context for *-al* nominals which are based on verbs of change of possession. We then provide a modeling of multiplicity of meaning using XMG. In section 3 we focus on monosemy approaches and in section 4 we offer a modeling of the polysemy approach. Section 5 concludes the paper.

2 *-al* on verbs of change of possession

In this paper we focus on the suffix *-al* on verbs of “change of possession” (Levin, 1993). The class of verbs of change of possession comprises “give” verbs (e.g. *give*, *rent*), “contribute” verbs (e.g. *submit*, *betroth*), verbs of “future having” (e.g. *promise*, *bequeath*), verbs of “providing” (e.g. *provide*, *redress*), verbs of “obtaining” (e.g. *retrieve*, *accrue*), verbs of “exchange” (e.g. *exchange*, *swap*), and “berry” verbs (e.g. *nest*, *clam*).

Verbs of change of possession describe caused possession of the kind ‘x causes y to have z’, in which x is the agent, y is the recipient, and z is the theme (Goldberg, 1995, 2006; Jackendoff, 1990; Rappaport Hovav & Levin, 2008). The general schema for verbs of change of possession in Frame Semantics is given in Figure 1 in the form of an attribute-value matrix.

In Figure 1, we model verbs of change of possession as causation events that involve three arguments; an agent, a theme, and a recipient. Given that verbs of change of possession are causation events, they come with a bipartite structure that comprises a CAUSE and an EFFECT (for more on the modeling of events in Frame Semantics see Plag *et al.*, forthcoming; Kallmeyer & Osswald, 2012). A typical causation event involves a relationship between situations and entities in which a particular entity (e.g. an agent) causes another entity (e.g. theme) to go from an initial situation to a result situation. In the case of verbs of change of possession, there is a start, i.e. an initial state, in which the agent is the possessor of the theme, and an end, i.e. a result state, in which the recipient is the possessor of the theme. As captured by the constraint “6 ≠ 7”, the initial state and the result state are not equal (Plag

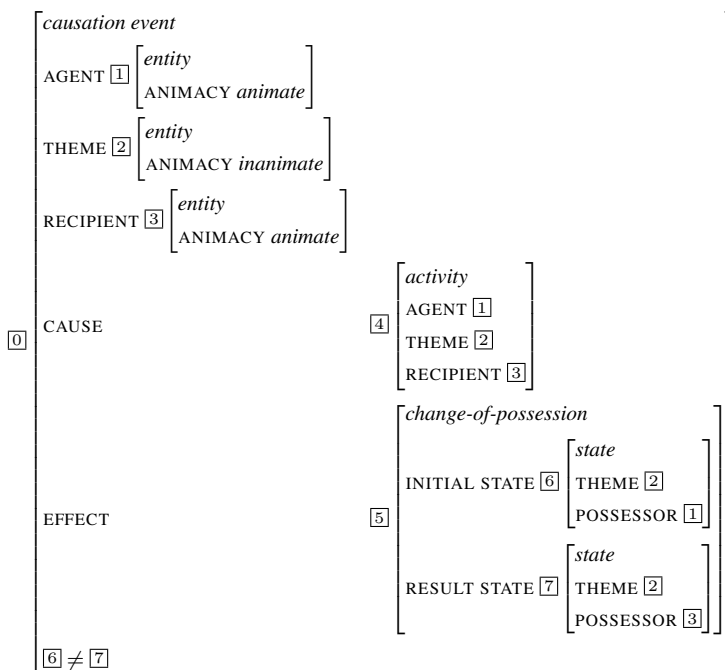


Figure 1: Verbs of change of possession

et al., forthcoming).

The suffix *-al* on verbs of change of possession derives event, result, and inanimate theme noun readings. Consider the following examples from the Corpus of Contemporary American English (COCA):

- (1)
- a. Event reading: This results in delays in the **disbursal** and utilization of funds – especially at the Gram Panchayat level.
 - b. Result reading: At the same time as it emerged that Fitzroy was terminally ill with ‘a rapid consumption’, Henry learned of Margaret Douglas’s **betrothal** to Thomas Howard.
 - c. Inanimate theme reading: The room was technically full of locals, people from Bianca’s life before she headed West, friends who crossed the bridge searching for more affordable **rentals** in Williamsburg or Long Island City.

In the first case, i.e. event reading, the nominalization lexicalizes the event denoted by the verb. This type of nominalization is also referred to as ‘transpositional’ in that the nominalization ‘transposes’ (recategorizes) the word from verb to noun without altering the sense of the verbal base. Thus, *disbursal* in (1-a) can be paraphrased as “event of disbursing”. In the case of result readings, the nominalization denotes “the outcome of verb-ing”. Thus, *betrothal* in (1-b) can be paraphrased as “the outcome of betrothing”. Finally, *-al* nominalizations may lexicalize the inanimate patient reading, that is, “the thing verb-ed, the thing affected by verb-ing”. In (1-c), *rental* can be paraphrased as “the

thing that someone rented”.¹

The foregoing discussion suggests that the suffix *-al* can manipulate the frame of a verb of change of possession and target certain arguments of it. In particular, it can target the *causation event* argument (i.e. [0]), the *result state* argument (i.e. [7]), and the *theme* argument (i.e. [2]). Thus, the referent of a form derived by *-al* can be identified with some of arguments of the verbal base, but not all of them. Observe, for instance, that the referent of *-al* derivatives is never the agent (i.e. [1]), the recipient (i.e. [3]), the cause (activity, i.e. [4]), the effect (change-of-possession, i.e. [5]) or the initial state (i.e. [6]).

3 Modeling monosemy

There are two approaches to multiplicity of meaning in derivation: monosemy and polysemy. In this section we examine the monosemy approach. Under this approach, multiplicity of meaning is reduced by assigning a more vague meaning to an affix. Thus, more concrete meanings of affixes derive from a general highly underspecified meaning.

In order to apply the monosemy approach to *-al*, we have to reduce multiplicity of meaning by identifying meanings that are shared by all *-al* derivatives. As we saw in the previous section, *-al* derivatives denote (a) eventualities (e.g. event ‘transpositional’ readings), and (b) entities (e.g. inanimate theme readings). Thus, the abstract core meaning of *-al* can be characterized as ‘eventuality or entity having to do with X’ (with ‘X’ denoting the base).

Monosemy approaches to the semantics of derivation are confronted with two problems to which we turn our attention. The first problem is that it is very hard to establish a unitary meaning for an affix. In particular, the aim of monosemy approaches is to reduce multiplicity of meaning by postulating a unitary abstract meaning. Forms derived by *-al*, however, denote both eventualities and entities. Thus, the disjunction ‘eventuality or entity’ that is needed in order to capture the multiplicity of meaning of *-al* derivatives reveals that the desirable underspecified meaning of affixes cannot always be reduced to a single unitary meaning.

The second problem with the monosemy approach to the semantics of derivation is (massive) over-generation. As we saw earlier, the abstract meaning for *-al* informs us that *-al* forms denote both eventualities and entities. This gives rise to the question: *What kind of predictions follow from the abstract meaning ‘eventuality or entity having to do with X’?* This particular formulation of the abstract meaning of *-al* leads one to expect that *-al* derivatives could in principle denote all ‘entities’ and all ‘eventualities’. Our data, however, suggests that not all ‘entities’ and not all ‘eventualities’ can be denoted by *-al* derivatives. For instance, the referents of *-al* derivatives may be inanimate themes (e.g. *houses* in the case of *rentals*) but not recipients.

The first XMG implementation we propose makes the modeling of the monosemy approach possible by using a scope-over constraint, expressing the fact that the reference of *-al* can be identified with any of the elements of the verbal base.

We first need to describe the frame given in Figure 1, by means of a XMG reusable abstraction which we will name *rent*. This abstraction describes the class of verbs of change of possession:

```
| class rent
```

¹Other meanings exist and may be lexicalized. For example, the referent of *boat rental* could be the place where boats are rented or the company that rents boats.

```

export ?X0 ?X1 ?X2 ?X3 ?X4 ?X5 ?X6 ?X7
declare ?X0 ?X1 ?X2 ?X3 ?X4 ?X5 ?X6 ?X7
{<frame>{
  ?X0[causation,
    agent: ?X1[entity , animacy:[animate]],
    theme: ?X2,
    recipient : ?X3[entity ],
    cause: ?X4[ activity ,
      agent:?X1,
      theme:?X2,
      recipient :?X3[entity , animacy:[animate]]
    ],
    effect : ?X5[change_of_possession,
      initial –state: ?X6[ initial_state ,
        theme:?X2[entity ],
        possessor :?X1],
      result –state: ?X7[ result_state ,
        theme:?X2[entity ],
        possessor :?X3 ] ]
  }
}

```

where the first lines define the set of unification variables which can be used within the class (**declare**) and outside of it (**export**). **<frame>** means that the description belongs to the Frame Semantics dimension. The structure described in the frame dimension, labeled by ?X0, is a straightforward translation of the one in Figure 1, where all variables ?X0 ,..., ?X7 stand for the boxed numbers from 0 to 7.

To define the scope-over relation mentioned earlier, we can use a new abstraction (a class we will name *al_nominal*). This class, as its name suggests, models the semantics of *-al* derivatives, which for the purposes of this study are based on verbs of change of possession.

```

class al_nominal
import rent []
declare ?Ref
{
  <frame>{
    [al–lexeme,
      m–base:[event,
        sem:?X0]
      ref :?Ref
    ]
  ;
  ?X0 >* ?Ref;
}
}

```

With **import** *rent* [], i.e. we make the structure defined in the class *rent* available in the current class, together with its variables (we can refer to all variables ?X0 ,..., ?X7 in the current class as

they are exported by *rent*). The operator $>*$ means that there must be a “path” (as it would be in a graph representation² of the frame) from the root $?X0$ to the semantic reference $?Ref$. Concretely, the compiler will try to generate structures where the reference is identified with another label, starting with the whole frame ($?X0$), and then exploring all of its subparts, recursively. As we do not specify any other constraint here, the reference will be able to unify with every possible subpart. This means that readings such as initial state, which should be ruled out, are also generated when this first version of the metagrammar is executed.

In this section we modeled the first approach to multiplicity meaning, i.e. monosemy, and showed that it leads to massive overgeneration. In the next section we focus on the second approach to multiplicity of meaning, i.e. polysemy.

4 Modeling polysemy

Under the polysemy approach, there is multiplicity of meaning in word formation patterns. Given the architecture of Frame Semantics, this multiplicity of meaning can be expressed in an inheritance hierarchy of lexeme formation rules (Riehemann, 1998; Koenig, 1999; Plag *et al.*, forthcoming). Thus, attested readings of words of a given morphological category result from indexation of particular elements (e.g. arguments) of the semantic representation of the verb, combined with inheritance mechanisms.

An open question is how we can model the polysemy approach in XMG and constrain possible readings. We suggest that there are two ways to tackle this issue. First, via a fully specified (and explicit) rule, which will replace the scope over relation in the previous class *al_nominal*:

$$\mid \{ ?X0=?Ref \mid ?X2=?Ref \mid ?X7=?Ref \}$$

where \mid and $=$ are respectively the disjunction and the unification operators, $?X0$, $?X2$ and $?X7$ respectively correspond to the boxed numbers 0, 2 and 7 of Figure 1, and $?Ref$ is a variable representing the semantic reference.

Under this approach, possible readings are considered as generalizations over already attested derivatives. Thus, agent, recipient, and initial state readings are ruled out since they are not part of the possible readings in the fully-specified-rule; the rule models readings that are already attested in *-al* derivatives.

The second way to model the polysemy approach in XMG is the introduction of an underspecified rule with constraints on types. In this case, the referent of an *-al* nominal can have three possible types: causation, result state, or entity.

$$\mid \begin{array}{l} ?X0 >* ?Ref; \\ \{ ?Ref[\text{result_state}] \mid ?Ref[\text{causation}] \\ \mid ?Ref[\text{entity} , \text{animacy}:[\text{inanimate}]] \} \end{array}$$

Here, the first line is once again the scope over relation, but of course, in this case, only the structures where no type constraint is violated will eventually be generated.

²An attribute-value matrix can be seen as a directed graph in which every attribute-value pair is an edge labeled by the attribute and pointing to the node representing the value.

In the second line, we express the fact that the referent of an *-al* derivative can have any of the three types previously stated. In the case of entity, only the theme should be a possible referent. We, therefore, add information about animacy (here, inanimate), which makes the reference of *-al* derivatives incompatible with frames of type animate, such as the agent and the recipient. This is in accordance with findings in the literature on possible constraints on animacy (see Lieber (2016) on *-al* and Kawaletz & Plag (2015) on the suffix *-ment*). When the referent of an *-al* derivative is a state, the type `result_state` is given to prevent unification with the initial state frame (of type `initial_state`). This way, agent, recipient, and initial state readings are ruled out because frame unification only succeeds if types are compatible. The type constraints (for example incompatibility of event and entity) are also specified in the metagrammar.

5 Conclusion

In a nutshell, our analysis allows one to model and test the various theoretical approaches to a long-standing issue in word formation. The XMG implementation revealed that the underspecified meaning of affixes cannot always be reduced to a single unitary meaning and that the monosemy approach leads to massive overgeneration. As we showed, the polysemy approach to multiplicity of meaning is more judicious compared to the monosemy approach.

In order to deal with overgeneration, we proposed to introduce constraints on the potential referents of *-al* derivatives. These constraints have the form of type constraints and specify which arguments in the frame of the verbal base are compatible with the referential argument of the derivative. The introduction of type constraints rules out certain readings because frame unification only succeeds if types are compatible.

In the present paper, we focused on *-al* derivatives which are based on verbs of change of possession. The next step is to apply the proposed analysis to other affixes and classes of bases as well. This will allow us to identify which constraints are specific to particular classes or affixes, and which constraints are shared across classes or affixes. Of course, the main advantages of the metagrammatical framework will become more obvious as the linguistic resource grows: for example, inheritance will help sharing information across classes with similar behaviors.

Acknowledgements

The authors gratefully acknowledge financial support by the Deutsche Forschungsgemeinschaft (DFG Collaborative Research Centre 991: ‘The Structure of Representations in Language, Cognition, and Science’, Project C08 ‘The semantics of derivational morphology: A frame-based approach’)

- CRABBÉ B., DUCHIER D., GARDENT C., LE ROUX J. & PARMENTIER Y. (2013). XMG : eXtensible MetaGrammar. *Computational Linguistics*, **39**(3), 1–66.
- GOLDBERG A. (1995). *Constructions: A Construction Grammar approach to argument structure*. Chicago, IL: University of Chicago Press.
- GOLDBERG A. (2006). *Constructions at Work. The Nature of Generalizations in Language*. Oxford: Oxford Univ. Press.
- JACKENDOFF R. (1990). *Semantic structures*. Cambridge, MA: MIT Press.
- KALLMEYER L. & OSSWALD R. (2012). A frame-based semantics of the dative alternation in Lexicalized Tree Adjoining Grammars. In C. PIÑÓN, Ed., *Empirical Issues in Syntax and Semantics 9*, p. 167–184. ISSN 1769-7158.
- KALLMEYER L. & OSSWALD R. (2013). Syntax-driven semantic frame composition in lexicalized tree adjoining grammars. *Journal of Language Modelling*, **1**(2), 267–330.
- KAWALETZ L. & PLAG I. (2015). *Predicting the Semantics of English Nominalizations: A Frame-Based Analysis of -ment Suffixation*, In L. BAUER, L. KÖRTVÉLYESSY & P. ŠTEKAUER, Eds., *Semantics of Complex Words*, p. 289–319. Springer International Publishing: Cham.
- KOENIG J. (1999). *Lexical Relations*. Stanford Monographs in Linguistics. Cambridge University Press.
- LEVIN B. (1993). *English Verb Classes and Alternations*. The University of Chicago Press.
- LICHTE T. & PETITJEAN S. (2015). Implementing semantic frames as typed feature structures with XMG. *Journal of Language Modelling*, **3**(1), 185–228.
- LIEBER R. (2004). *Morphology and lexical semantics*. Cambridge: Cambridge University Press.
- LIEBER R. (2016). *English nouns: The ecology of nominalization*. Cambridge: Cambridge University Press.
- LÖBNER S. (2013). *Understanding semantics*. London: Arnold, 2nd, revised edition edition.
- PETERSEN W. (2007). Representation of concepts as frames. In J. SKILTERS, Ed., *The Baltic international yearbook of cognition, logic and communication*, volume 2, p. 151–170.
- PLAG I., ANDREOU M. & KAWALETZ L. (forthcoming). A frame-semantic approach to polysemy in affixation. In O. BONAMI, G. BOYÈ, G. DAL, H. GIRAUDO & F. NAMER, Eds., *The lexeme in descriptive and theoretical morphology*. Berlin: Language Science Press.
- RAINER F. (2014). Polysemy in derivation. In R. LIEBER & P. ŠTEKAUER, Eds., *The Oxford handbook of derivational morphology*, Oxford Handbooks in linguistics, p. 338–353. Oxford: Oxford University Press.
- RAPPAPORT HOVAV M. & LEVIN B. (2008). The English dative alternation: The case for verb sensitivity. *Journal of Linguistics*, **44**, 129–167.
- RIEHMANN S. Z. (1998). Type-based derivational morphology. *Journal of Comparative Germanic Linguistics*, **2**(1), 49–77.