An XMG account of derivational polysemy

Marios Andreou & Simon Petitjean

Heinrich Heine Universität

17.09.2016
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Introduction

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- instrument nouns (e.g. *blender, mixer*),
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- entities associated with an activity (e.g. diner, toaster), and
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- person nouns indicating place of origin or residence (e.g. Londoner, New Yorker).
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- we model and test the main theoretical approaches to derivational polysemy, using
  - Frame Semantics (Kallmeyer & Osswald, 2013; Löbner, 2013, 2014; Petersen, 2007)
  - XMG (eXtensible MetaGrammar)
- Data: -ment on psych verbs, e.g. *amusement, enrapturement* (Kawaletz & Plag, 2015; Plag et al., in press)
# Attribute-value matrix for psych verbs

<table>
<thead>
<tr>
<th>Frame Semantics</th>
<th>Action (psych causation)</th>
<th>Result (change of psych state)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STIMULUS</td>
<td>entity</td>
<td>initial state</td>
</tr>
<tr>
<td>EXPERIENCER</td>
<td></td>
<td>EXPERIENCER</td>
</tr>
<tr>
<td>CAUSE</td>
<td></td>
<td>RESULT STATE</td>
</tr>
<tr>
<td>ACTOR</td>
<td>animate</td>
<td></td>
</tr>
<tr>
<td>UNDERGOER</td>
<td>ANIMACY</td>
<td></td>
</tr>
<tr>
<td>EFFECT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**Marios Andreou & Simon Petitjean (HHU)**

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The suffix \textit{-ment}

Kawaletz and Plag (2015): \textit{-ment} on psych verbs derives

Somehow, building a luxury-liner suborbital rocket ship for the amusement of the ultrarich, ultrafamous and ultrabored will be a great victory for humanity. (COCA NEWS 2015)

Here comes a confoundment (new word I just made up :) ) for you. (Google COMM 2006)

experiencer readings and initial state readings do not surface.

How do we model polysemy?

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Kawaletz and Plag (2015): -ment on psych verbs derives

- EVENT ‘transpositional’

-stimulus
-activity
-change of psych state
-result state

e.g. event ‘transpositional’ reading:
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How do we model polysemy?
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- monosemy and
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Polysemy and Frame Semantics

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In the monosemy approach,

- more specific meanings of affixes derive from a general highly underspecified meaning by means of
  - semantic extension rules
  - interaction between the semantics of the base and the affix
  - contextual and encyclopedic information.
-ment and monosemy

Identification of meanings that are shared by all -ment derivatives.
-ment and monosemy

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Abstract core meaning of -ment: ‘eventuality or entity having to do with X’ (with ‘X’ denoting the base).
Problems with the monosemy approach

1. The disjunction ‘eventuality or entity’

- The disjunction 'eventuality or entity'

- How abstract should the meaning of the affix be?

- e.g. -er derivatives denote 'an entity having to do with X'. This may qualify as a unitary meaning since all -er derivatives do denote an entity.

- -ment derivatives, however, do not always denote an entity. They may be eventualities as well.

- The desirable underspecified meaning cannot always be reduced to a single unitary meaning.
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What kind of predictions would follow from the meaning ‘eventuality or entity having to do with X’ with respect to

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-ment derivatives could in principle denote all ‘entities’.

This is not verified by data (e.g. EXPERIENCER readings).
Polysemy

Under the polysemy approach, there is multiplicity of meaning in word formation patterns.
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- Given the architecture of Frame Semantics, this multiplicity of meaning can be expressed in an Inheritance hierarchy of lexeme formation rules (Bonami & Crysmann, 2016; Booij, 2010; Koenig, 1999; Plag et al., in press; Riehemann, 1998).
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- 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.

  - e.g. In an eventive noun, the reference of the derivative is identified with the EVENT argument of the base.
How can we constrain possible readings?
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- possible readings are considered as generalizations over already attested derivatives. Thus, EXPERIENCER and INITIAL STATE readings are ruled out since they are not part of the possible readings for -ment derivatives.
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- we constrain possible readings by introducing constraints. e.g. -ment derivatives are always inanimate.
eXtensible MetaGrammer

- XMG (Crabbé, Duchier, Gardent, Le Roux, & Parmentier, 2013): modular and extensible tool used to generate various types of linguistic resources from an abstract and compact description.

- Metagrammar: based on the concepts of logic programming and constraints.

- Dimensions: separate the different levels of linguistic description, and provide dedicated languages adapted to the structures the user wishes to generate.

- The <frame> dimension (Lichte & Petitjean, 2015): description of semantic frames using typed feature structures descriptions.

- XMG webpage: http://xmg.phil.hhu.de/
The implementation

- Idea: defining abstractions and combining them with logical operators

- Abstractions: for the base (*amuse*) and the affix (*ment*)

- Polysemy: generate the 5 valid models (event, stimulus, activity, change of psych state, result state) of the description

- 2 implementations: stating explicitly what is valid, or leaving it underspecified (+ constraints)

- Using type constraints → type hierarchy
An abstraction for *amuse*

class amused
{ <frame>
  ?Root[psych_causation,
  stimulus: ?Stimulus,
  experiencer: ?E,
  cause: ?Cause[activity,
    actor:?Stimulus[entity],
    undergoer:?E[entity,
      animacy:[animate]
    ]
  ],
  effect: ?Effect[change_of_psych_state,
    initial-state: [initial_state,
      experiencer:?E],
    result-state: ?Result[result_state,
      experiencer:?E[experiencer]] ] ]
}
An abstraction for *amuse*

\[
\begin{align*}
\text{psych causation} & \\
\text{STIMULUS} & 1 \text{entity} \\
\text{EXPERIENCER} & 2 \\
\text{CAUSE} & 3 \\
\text{UNDERGOER} & 2 \text{ANIMACY \ [animate]} \\
\text{change of psych state} & \\
\text{EFFECT} & 4 \\
\text{INITIAL STATE} & 5 \text{EXPERIENCER \ [animate]} \\
\text{RESULT STATE} & 6 \text{EXPERIENCER \ [animate]} \\
\end{align*}
\]
An abstraction for *ment*: fully specified rule

class ment
import amuse[]
declare ?Ref
{<frame>{
  [ment-lexeme,
   m-base:[event,
     sem:?Root]
   ref:?Ref
  ]
;,
}
}
An XMG description of polysemy

An abstraction for *ment*: fully specified rule

class ment
import amuse[]
declare ?Ref
{
    <frame>
    {
        [ment-lexeme,
            m-base:[event,
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            ref:?Ref
        ]
    }
}

\[
\begin{align*}
\text{ment lexeme} & \quad \text{event} \\
\text{M-BASE} & \quad \text{SEM:} \\
\text{REF} & \quad \text{(R)}
\end{align*}
\]

\[
\land \{ 0 \cup R \lor 1 \cup R \lor 3 \cup R \lor 4 \cup R \lor 6 \cup R \}
\]
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

0

EXPERIENCER

activity

ACTOR 1

UNDERGOER 2

ANIMACY [animate]

change of psych state

INITIAL STATE

RESULT STATE

ment lexeme

M-BASE

REF

event SEM: 0

MENT lexeme

R
An XMG description of polysemy

**psych causation**

- **STIMULUS**
  - [entity]

- **EXPERIENCER**
  - [animate]

- **CAUSE**
  - [activity]
    - [actor]
      - [event]
        - [SEM: 0]
    - [undergoer]
      - [result state]
        - [initial state]
          - [event]
            - [SEM: 0]

**change of psych state**

- [ment lexeme]
  - [M-BASE]
    - [REF]
      - [R]

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An XMG description of polysemy

psych causation

STIMULUS
EXPERIENCER
CAUSE
EFFECT

activity
ACTOR
UNDERGOER

change of psych state

INITIAL STATE
RESULT STATE

ment lexeme

M-BASE
REF

\[
\begin{array}{l}
\text{psych causation} \\
\text{STIMULUS} \\
\text{EXPERIENCER} \\
\text{CAUSE} \\
\text{EFFECT} \\
\text{activity} \\
\text{ACTOR} \\
\text{UNDERGOER} \\
\text{change of psych state} \\
\text{INITIAL STATE} \\
\text{RESULT STATE} \\
\text{ment lexeme} \\
\text{M-BASE} \\
\text{REF}
\end{array}
\]
An XMG description of polysemy

psych causation

STIMULUS

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M-BASE

REF

event

SEM: 0

REF R

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An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

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change of psych state

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event

initial state

result state

R

R

REF

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An XMG account of derivational polysemy

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An XMG description of polysemy

**psych causation**

- **STIMULUS:** [entity]
- **EXPERIENCER:**
- **CAUSE:** [activity]
  - **ACTOR:** [event]
  - **UNDERGOER:** [animacy: animate]
- **EFFECT:** [change of psych state]
  - **INITIAL STATE:** [initial state]
  - **RESULT STATE:** [result state]

**ment lexeme**

- **M-BASE:** [ref]
  - **SEM:** [0]
- **REF:** [0]
An XMG description of polysemy

Underspecification and frames

- XMG: traditionally uses constraints in descriptions
- The compiler generates all the models which do not violate any constraint
- `<frame>` dimension: introduction of a new operator, `>*`
- `?A >* ?B`: there is a path in the frame from `?A` to `?B`
An XMG description of polysemy

Paths in AVM

```
\begin{align*}
\text{event} & \rightarrow \text{effect} \\
\text{actor} & \rightarrow \text{experiencer} \\
\text{motion} & \rightarrow \text{START:} 1 \\
\text{END:} 4 \\
\end{align*}
```
An XMG account of derivational polysemy

Paths in AVM

```
  event
  EFFECT
  ACTOR
  EXPERIENCER

  motion
  START: 1
  END: 4

  event 0
  effect
  actor
  experiencer

  motion
  start
  end
```

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An XMG description of polysemy

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Paths in AVM

An XMG description of polysemy

event

EFFECT

START:

ACTOR

END:

EXPERIENCER

motion

start

end

motion

actor

effect

experience

event
An XMG description of polysemy

Paths in AVM

```
<table>
<thead>
<tr>
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<th>motion</th>
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</thead>
<tbody>
<tr>
<td>EFFECT</td>
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<tr>
<td>ACTOR</td>
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</tr>
<tr>
<td>EXPERIENCER</td>
<td></td>
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</table>

Start: 1
End: 4

Motion: 1
Event: 0
Effect: 0
Actor: 2
Experiencer: 3
```
Paths in AVM

An XMG description of polysemy

event

EFFECT

ACTOR

EXPERIENCER

motion

START: 1

END: 4

event 0

motion 1

actor

effect

start

end

experiencer

2

3

4
Paths in AVM

An XMG description of polysemy

event

EFFECT

START: 1
END: 4

motion

ACTOR

experiencer

motion

event 0

actor

0

effect

experiencer

2

3

START: 1
END: 4

1

4
An abstraction for *ment*: underspecified rule

\[
\begin{align*}
\text{ment lexeme} & \quad \text{event} \\
\text{M-BASE} & \quad \text{SEM:} 0 \\
\text{REF} & \quad R \\
0 & \geq R
\end{align*}
\]
An abstraction for *ment*: underspecified rule

<frame>{
  [ment-lexeme,
   m-base:[event,
     sem:?Root]
   ref:?Ref]
;?
Root >* ?Ref
}

\[
\begin{array}{c}
\text{ment lexeme}\\
\text{M-BASE} & \text{event} & 0 \\
\text{REF} & \text{SEM:} & R \\
0 & \geq & R
\end{array}
\]

→ Monosemy without constraints: overgeneration
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An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

0

EXPERIMENTER

activity

ACTOR

UNDERGOER

R

change of psych state

INITIAL STATE

RESULT STATE

R

ment lexeme

M-BASE

REF

event

SEM:

0

R

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psych causation

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</table>

cause

<table>
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<tr>
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<table>
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change of psych state

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<th>RESULT STATE</th>
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</thead>
</table>

ment lexeme

<table>
<thead>
<tr>
<th>M-BASE</th>
<th>REF</th>
</tr>
</thead>
<tbody>
<tr>
<td>[event]</td>
<td>[SEM: 0]</td>
</tr>
</tbody>
</table>

Marios Andreou & Simon Petitjean (HHU)
An abstraction for *ment*: underspecified rule with constraints

\[<\text{frame}>\{
\text{ment - lexeme,}
\text{m-base: [event,}
\text{sem: ?Root]}
\text{ref: ?Ref}
\}
\]

\[
\begin{align*}
\text{ment lexeme} & \\
\text{M-BASE} & \left[ \begin{array}{c}
\text{event} \\
\text{SEM: } 0
\end{array} \right] \\
\text{REF} & \left[ \begin{array}{c}
0 \geq R
\end{array} \right] \\
& \land \left\{ R\left[ \text{result state} \right] \lor R\left[ \text{event} \right] \lor R\left[ \text{entity, animacy: [inanimate]} \right] \right\}
\end{align*}
\]
**XMG modeling: the type hierarchy**

```plaintext
frame-constraints = {
    state event -> -, 
    ... 
    psych_causation -> event, 
    experiencer -> entity, 
    stimulus -> entity,

    experiencer stimulus -> -, 
    ... 
    entity -> animacy:animacy, 
    ...
}
```
XMG modeling: the type hierarchy

\[
\text{frame-constraints} = \{ \\
\text{state event} \to - , \\
\ldots \\
\text{psych_causation} \to \text{event} , \\
\text{experiencer} \to \text{entity} , \\
\text{stimulus} \to \text{entity} , \\
\ldots \\
\}
\]

\[
\text{experiencer stimulus} \to - , \\
\ldots \\
\text{entity} \to \text{animacy:animacy} , \\
\ldots \\
\}
\]
An XMG description of polysemy

**psych causation**

**STIMULUS**
- entity

**EXPERIENCER**
- experiencer

**CAUSE**
- cause

**ACTOR**
- activity

**UNDERGOER**
- entity

**change of psych state**

**EFFECT**
- effect

**INITIAL STATE**
- change of psych state

**RESULT STATE**
- result state

**ment lexeme**

**M-BASE**
- event

**SEM:**
- 0

**REF**
- R
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

activity

UNDERGOER

change of psych state

INITIAL STATE

RESULT STATE

ment lexeme

M-BASE

REF

event

SEM:

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R
An XMG description of polysemy

**psych causation**

<table>
<thead>
<tr>
<th>STIMULUS</th>
<th>EXPERIENCER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1[entity]</td>
</tr>
</tbody>
</table>

**cause**

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>ACTOR</th>
<th>UNDERGOER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**activity**

<table>
<thead>
<tr>
<th>entity</th>
<th>ANIMACY</th>
<th>animate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**change of psych state**

<table>
<thead>
<tr>
<th>INITIAL STATE</th>
<th>RESULT STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**ment lexeme**

<table>
<thead>
<tr>
<th>M-BASE</th>
<th>REF</th>
</tr>
</thead>
<tbody>
<tr>
<td>event</td>
<td>0</td>
</tr>
</tbody>
</table>

\[ M \rightarrow N \]
An XMG description of polysemy

psych causation

STIMULUS
EXPERIENCER
CAUSE

EXPERIMENTER

R [entity]

ACTOR
UNDERGOER

R

ANIMACY

animate

activity

ment lexeme

M-BASE

REF

event

SEM:

0

result state

entity

REF

ANIMACY

inanimate

initial state

result state

EXPERIENCER

2

EXPERIENCER

2

change of psych state

EFFECT

INITIAL STATE

RESULT STATE

∧

0

∧

0
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

EFFECT

mental lexeme

M-BASE

REF

event

SEM:

0

R

result state

R

0

R

0

R

ANIMACY

[animate]

[animate]

[initial state]

EFFECT

RESULT STATE

change of psych state

[entity]

3

R

UNDERGOER

2

[entity]

ANIMACY

[animate]

initial state

result state

[entity]

ANIMACY

[inanimate]
An XMG description of polysemy

**psych causation**

- **STIMULUS**
- **EXPERIENCER**
- **CAUSE**

**activity**

- **ACTOR**
- **UNDERGOER**

**change of psych state**

- **INITIAL STATE**
- **RESULT STATE**

**ment lexeme**

- **M-BASE**
- **REF**
An XMG description of polysemy

```
psych causation

STIMULUS
EXPERIENCER
CAUSE
EFFECT

MENT lexeme

event
SEM:

{ [result state] \lor [event] \lor [entity ANIMACY inanimate] }

[1] entity

[3] event

[5] initial state

[6] result state

[R]
```

Marios Andreou & Simon Petitjean (HHU)
An XMG description of polysemy

**psych causation**

<table>
<thead>
<tr>
<th>STIMULUS</th>
<th>entity</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIENCER</td>
<td>2</td>
</tr>
<tr>
<td>CAUSE</td>
<td>R</td>
</tr>
<tr>
<td>UNDERGOER</td>
<td>2</td>
</tr>
<tr>
<td>ANIMACY</td>
<td>inanimate</td>
</tr>
</tbody>
</table>

**change of psych state**

<table>
<thead>
<tr>
<th>EFFECT</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>INITIAL STATE</td>
<td>5</td>
</tr>
<tr>
<td>RESULT STATE</td>
<td>6</td>
</tr>
<tr>
<td>EXPERIENCER</td>
<td>2</td>
</tr>
</tbody>
</table>

**ment lexeme**

<table>
<thead>
<tr>
<th>M-BASE</th>
<th>event</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEM:</td>
<td>0</td>
</tr>
<tr>
<td>REF</td>
<td>R</td>
</tr>
</tbody>
</table>

\[ \land \left( \text{M-BASE} \right) \land \left\{ \text{R} \left[ \text{result state} \right] \lor \text{R} \left[ \text{event} \right] \lor \text{R} \left[ \text{entity} \right] \right\} \]
An XMG description of polysemy

**psych causation**

- **STIMULUS**
- **EXPERIENCER**
- **CAUSE**
- **EFFECT**

**activity**

- **ACTOR**
- **UNDERGOER**

**change of psycho state**

- **INITIAL STATE**
- **RESULT STATE**

**ment lexeme**

- **M-BASE**
- **REF**
An XMG description of polysemy

psych causation

<table>
<thead>
<tr>
<th>STIMULUS</th>
<th>EXPERIENCER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 [entity]</td>
<td>2</td>
</tr>
</tbody>
</table>

cause

<table>
<thead>
<tr>
<th>ACTOR</th>
<th>UNDERGOER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 [entity]</td>
<td>2 ANIMACY animate</td>
</tr>
</tbody>
</table>

change of psych state

<table>
<thead>
<tr>
<th>INITIAL STATE</th>
<th>RESULT STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 [initial state] EXPERIENCER 2</td>
<td>6 [result state] EXPERIENCER 2</td>
</tr>
</tbody>
</table>

ment lexeme

\[M\text{-BASE} \wedge \left\{ R \[result state\] \lor R \[event\] \lor R \[entity\] \right\} \wedge \left\{ M\text{-BASE} \wedge \left\{ R \[event\] \lor R \[result state\] \lor R \right\} \right\} \]
An XMG description of polysemy

**psych causation**

- **STIMULUS**
  - entity[1]

- **EXPERIENCER**
  - entity[2]

- **CAUSE**
  - activity[3]
    - actor[1]
    - undergoer[2]

- **EFFECT**
  - change of psych state
    - initial state[5]
      - entity[2]
    - result state[6]
      - entity[2]

- **ment lexeme**
  - event
    - SEM: 0

- **Marios Andreou & Simon Petitjean (HHU)**
  - An XMG account of derivational polysemy
  - 17.09.2016 25 / 27
An XMG description of polysemy

**psych causation**

- **stimulus**
  - [entity]
- **experiencer**
  - [entity]
- **cause**
  - [activity]
  - [actor]
  - [undergoer]

**change of psych state**

- **effect**
  - [change of psych state]
  - [initial state]
  - [result state]

**ment lexeme**

- $M$-BASE
- $SEM$:
  - [event]
  - [result state]
  - [event]
  - [entity]
  - [inanimate]
An XMG description of polysemy

**psych causation**

- **STIMULUS**
- **EXPERIENCER**
- **CAUSE**
- **EFFECT**

**activity**

- **ACTOR**
- **UNDERGOER**

**change of psych state**

- **INITIAL STATE**
- **RESULT STATE**

**ment lexeme**

- **M-BASE**
- **REF**
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

EXPERIENCER

activity

ACTOR

UNDERGOER

change of psych state

INITIAL STATE

RESULT STATE

ment lexeme

M-BASE

REF

SEM:

\[
\text{event} \quad \text{SEM:} \quad 0
\]

\[
\text{MENT lexeme} \quad \land
\]

\[
\text{M-BASE} \quad \text{REF} \quad 0
\]

\[
\{ R[\text{result state}] \lor R[\text{event}] \lor R[\text{entity}] \}
\]

\[
\land
\]

\[
\text{animacy} \quad \text{inanimate}
\]
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

EXPERIENCER

activity

ACTOR

UNDERGOER

ANIMACY

animate

change of psych state

INITIAL STATE

RESULT STATE

ment lexeme

M-BASE

SEM: 0

REF

R

\{ R[result state] \lor R[event] \lor R[entity]

\}

\{ R[animacy] \inanimate \}\}
An XMG description of polysemy

psych causation

STIMULUS

EXPERIENCER

CAUSE

EXPERIENCER

activity

ACTOR

UNDERGOER

change of psych state

INITIAL STATE

RESULT STATE

ment lexeme

M-BASE

REF

event

SEM: 0

\[ \wedge \left\{ R \left[ result \ state \right] \lor R \left[ event \right] \lor R \left[ entity \ ANIMACY \ [inanimate] \right] \right\} \]
Conclusion

- Our analysis allows one to model and test the various theoretical approaches to a long-standing issue in word formation.

- XMG implementation: shows that the underspecified meaning of affixes cannot always be reduced to a single unitary meaning.

- Also shows that an extreme version of the monosemy approach leads to massive overgeneration.

- Claim: the polysemy approach and the introduction of type constraints into derivational rules is more judicious.

- Future research: more verb classes, affixes.
Thank You


