An XMG account of derivational polysemy

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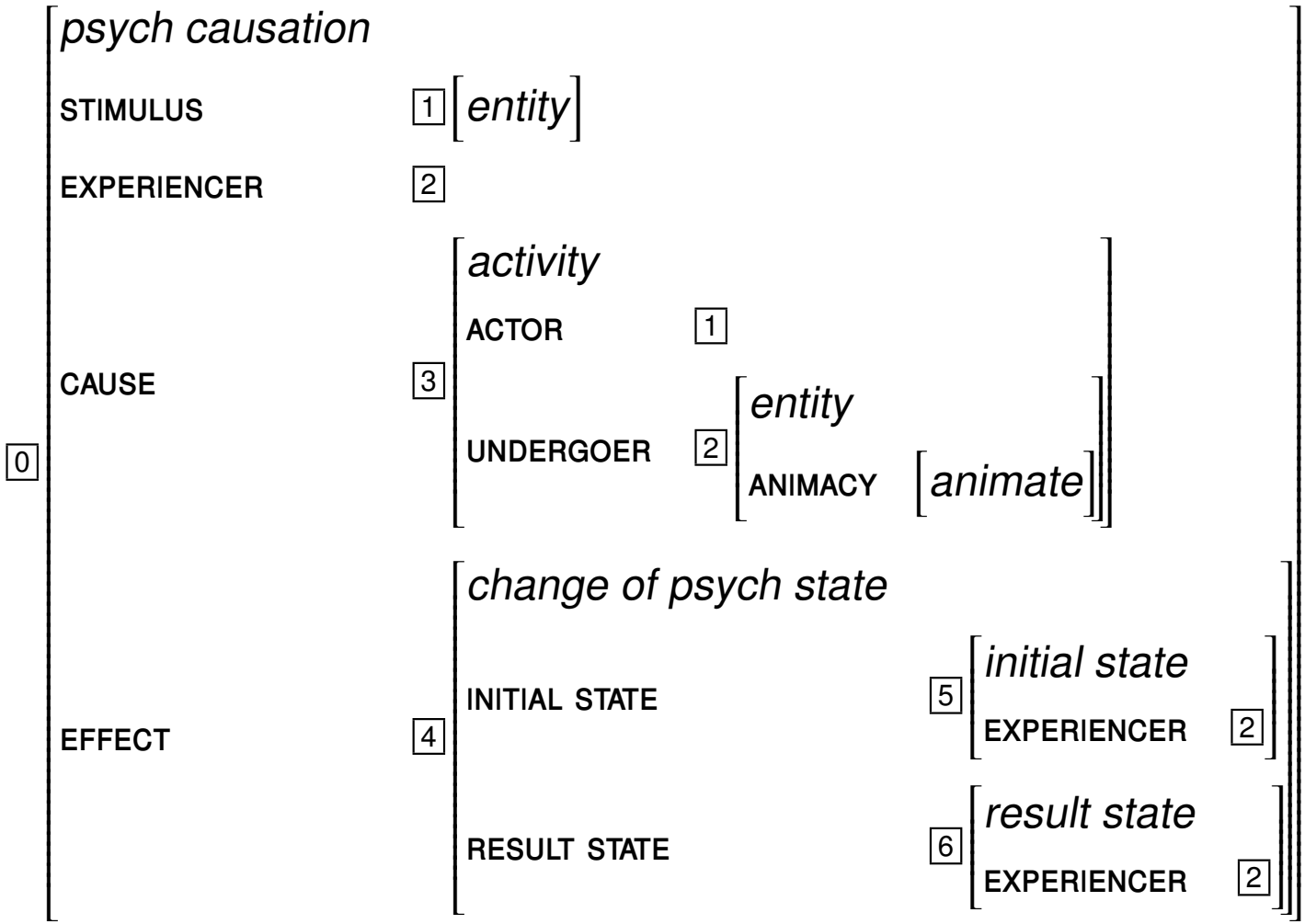
- we model and test the main theoretical approaches to derivational polysemy, using
  - Frame Semantics (Kallmeyer & Osswald, 2013; Löbner, 2013, 2014; Petersen, 2007)
  - XMG (eXtensible MetaGrammar)
- Data: *-ment* on psych verbs, e.g. *amusement*, *enrapturement* (Kawaletz & Plag, 2015; Plag et al., in press)

Attributre-value matrix for psych verbs



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- 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.

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

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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).

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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.

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- we constrain possible readings by introducing constraints. e.g. *-ment* derivatives are always inanimate.

eXtensible MetaGrammar

- 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 explicitely what is valid, or leaving it underspecified (+ constraints)
- Using type constraints → type hierarchy

An abstraction for *amuse*

```
class amuse
export ?Root ?Cause ?Stimulus ?Effect ?Result
declare ?Root ?E ?Cause ?Stimulus ?Effect ?Result ?T
{<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]] ] ]
                   }
}
```

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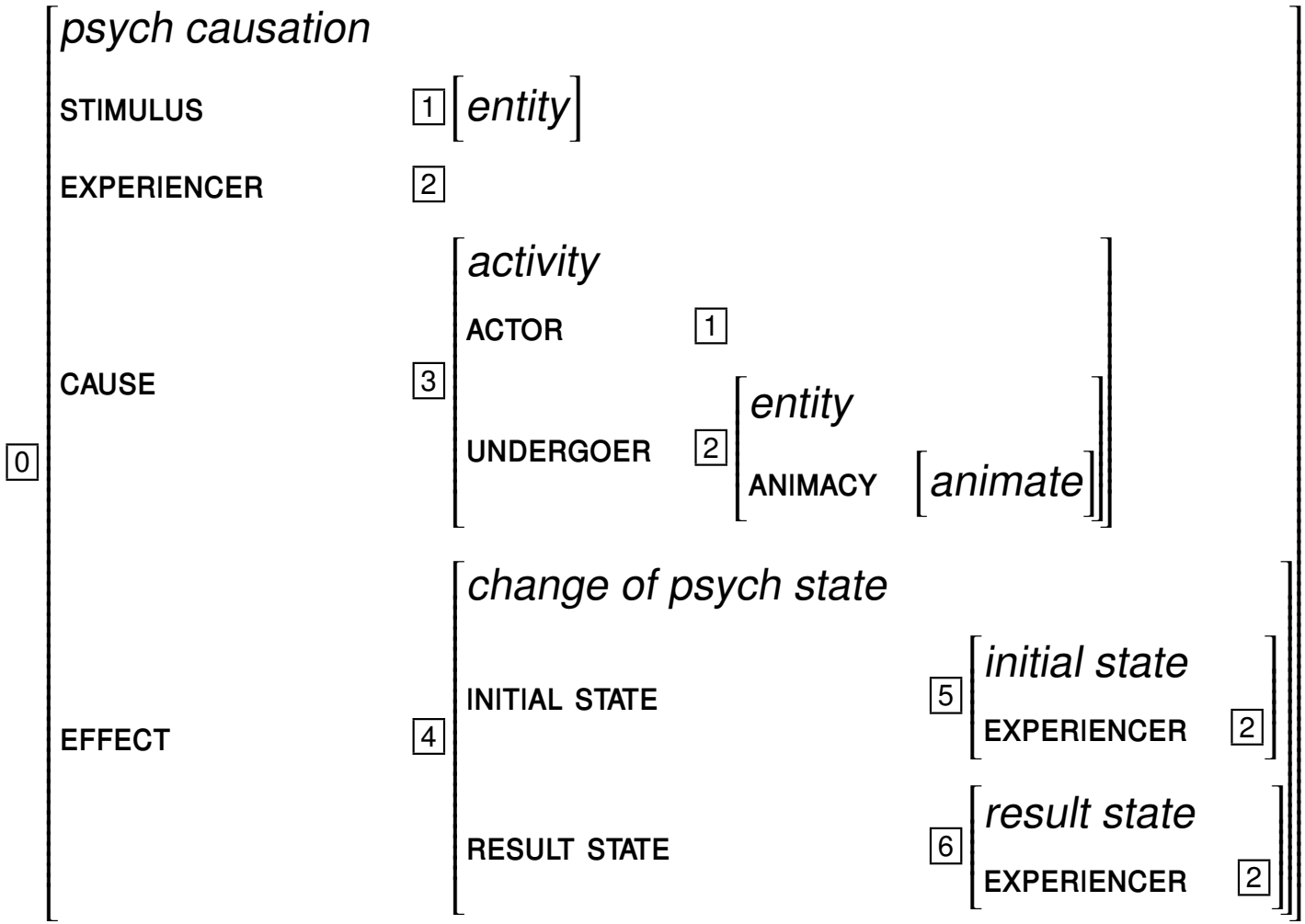

An abstraction for *ment*: fully specified rule

```
class ment
import amuse[]
declare ?Ref
  {<frame>{
   [ment-lexeme,
         m-base:[event,
                sem:?Root]
         ref:?Ref
   ]
   ;
   {   ?Root=?Ref    | ?Cause=?Ref   | ?Stimulus=?Ref
     | ?Effect=?Ref | ?Result=?Ref }
  }
}
```

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```

$$\left[\begin{array}{ll} \textit{ment lexeme} & \\ \textsc{m-base} & \left[\begin{array}{ll} \textit{event} & \\ \textsc{sem:} & \boxed{0} \end{array}\right] \\ \textsc{ref} & \boxed{R} \end{array}\right] \wedge \{ \quad \boxed{0} \cup \boxed{R} \vee \boxed{1} \cup \boxed{R} \vee \boxed{3} \cup \boxed{R} \vee \boxed{4} \cup \boxed{R} \vee \boxed{6} \cup \boxed{R} \ \}$$

$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
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\end{array}\right]
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\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
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\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
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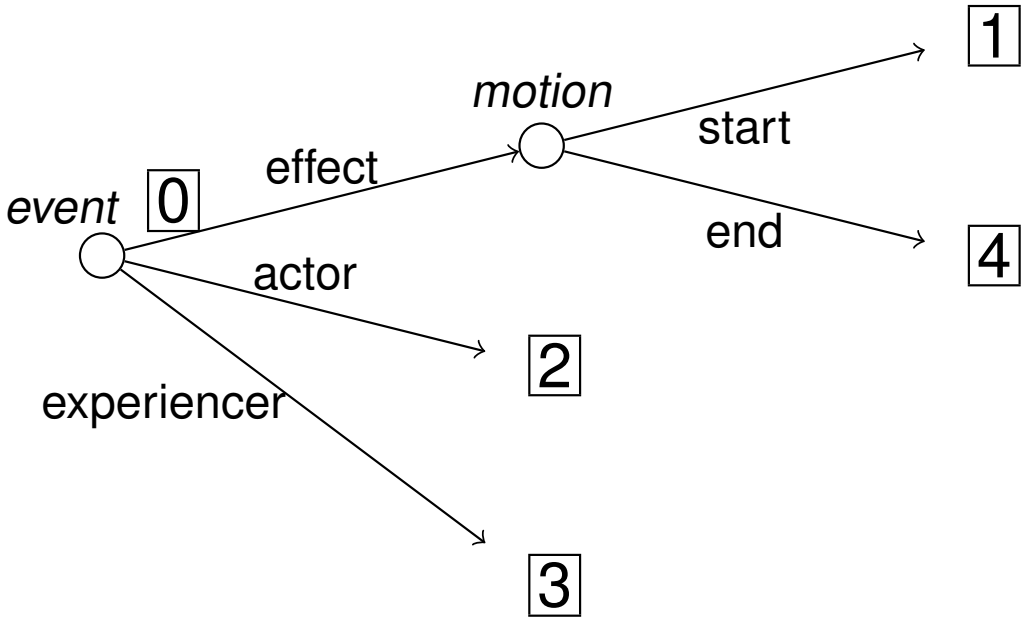
Underspecification and frames

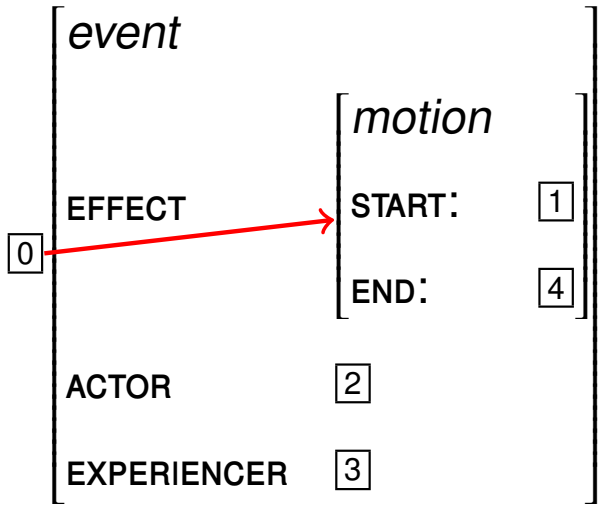
- XMG: traditionally uses constraints in descriptions
- The compiler generates all the models which do not violate any constraint
- **<frame>** dimension: introduction of a new operator, >*
- **?A** >* **?B**: there is a path in the frame from **?A** to **?B**

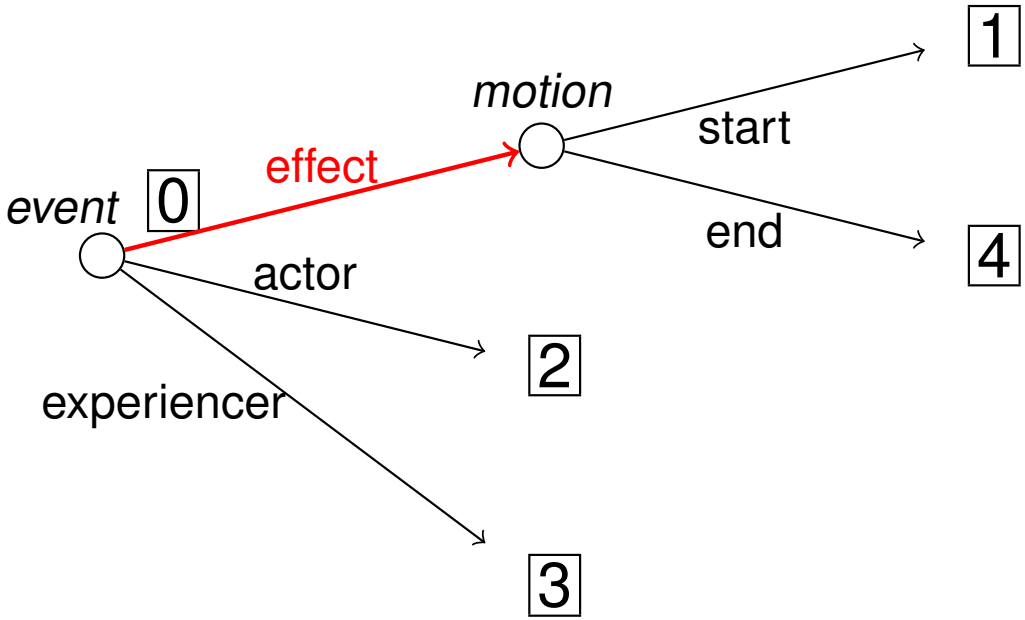
Paths in AVM

$$\boxed{0}\begin{bmatrix} \textit{event} & \\ \textsc{effect} & \begin{bmatrix} \textit{motion} & \\ \textsc{start}: & \boxed{1} \\ \textsc{end}: & \boxed{4} \end{bmatrix} \\ \textsc{actor} & \boxed{2} \\ \textsc{experiencer} & \boxed{3} \end{bmatrix}$$

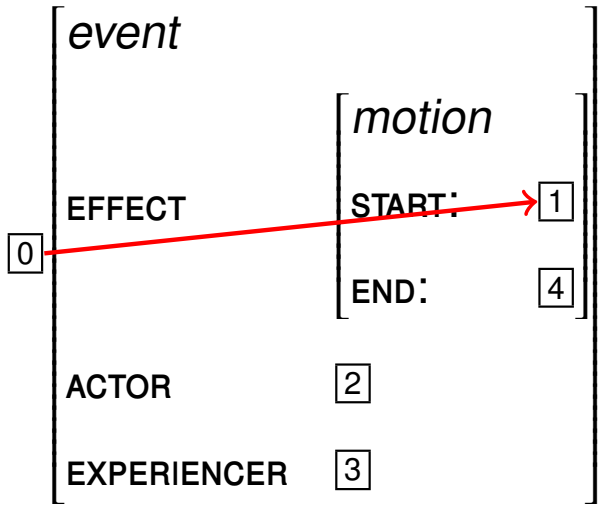


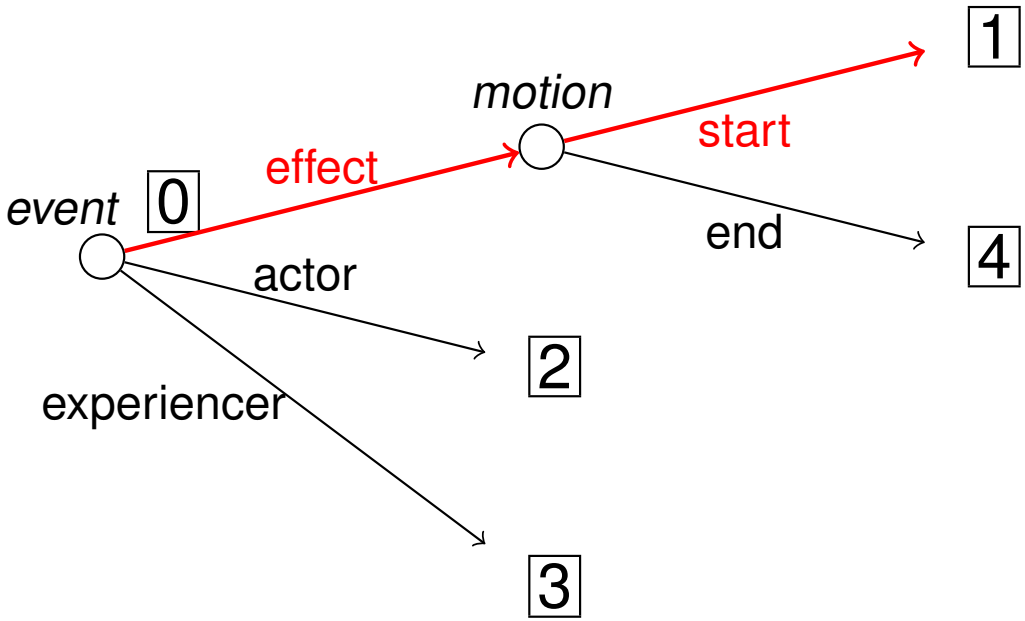
Paths in AVM


event
motion
EFFECT
START:
1
0
END:
4
ACTOR
2
EXPERIENCER
3

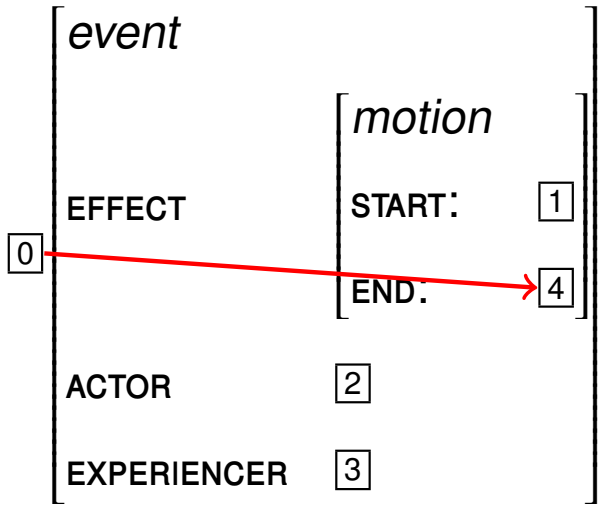

1
motion
start
effect
event
0
end
4
actor
2
experiencer
3

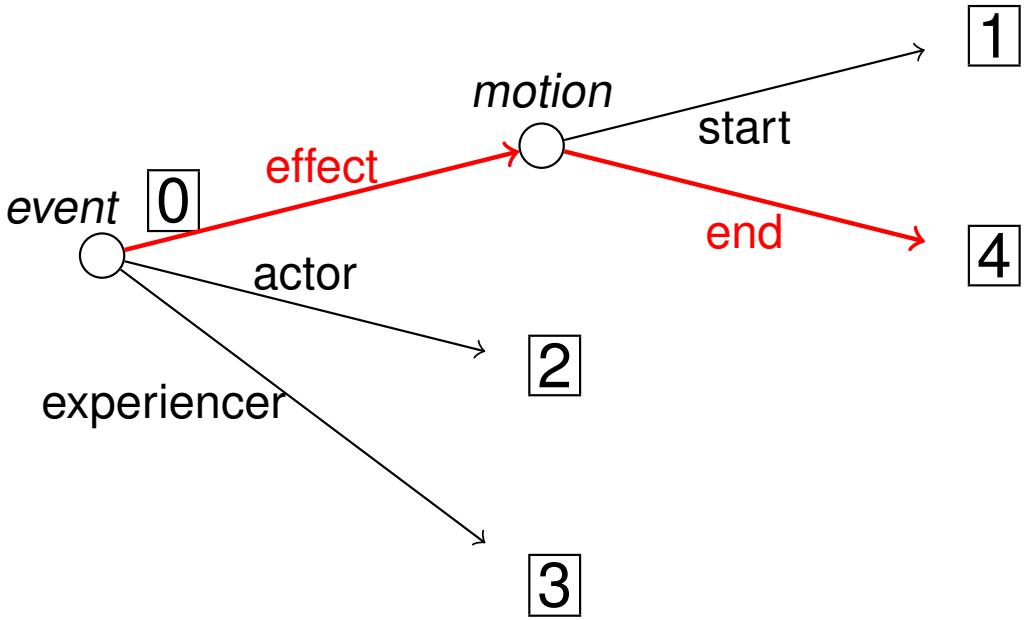
Paths in AVM


event
motion
EFFECT
START:
1
0
END:
4
ACTOR
2
EXPERIENCER
3

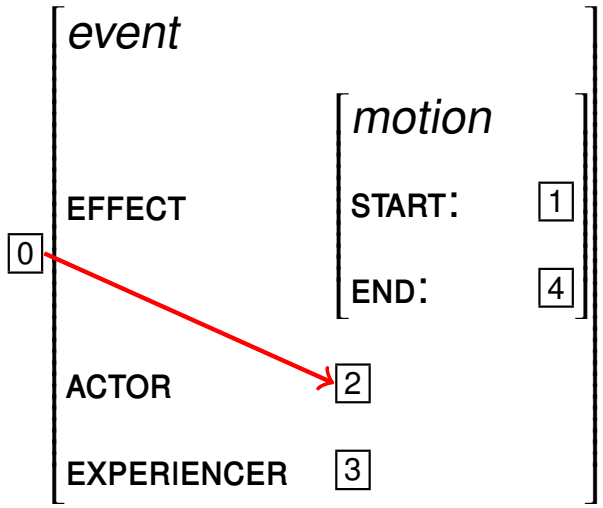

1
motion
start
effect
event
0
end
4
actor
2
experiencer
3

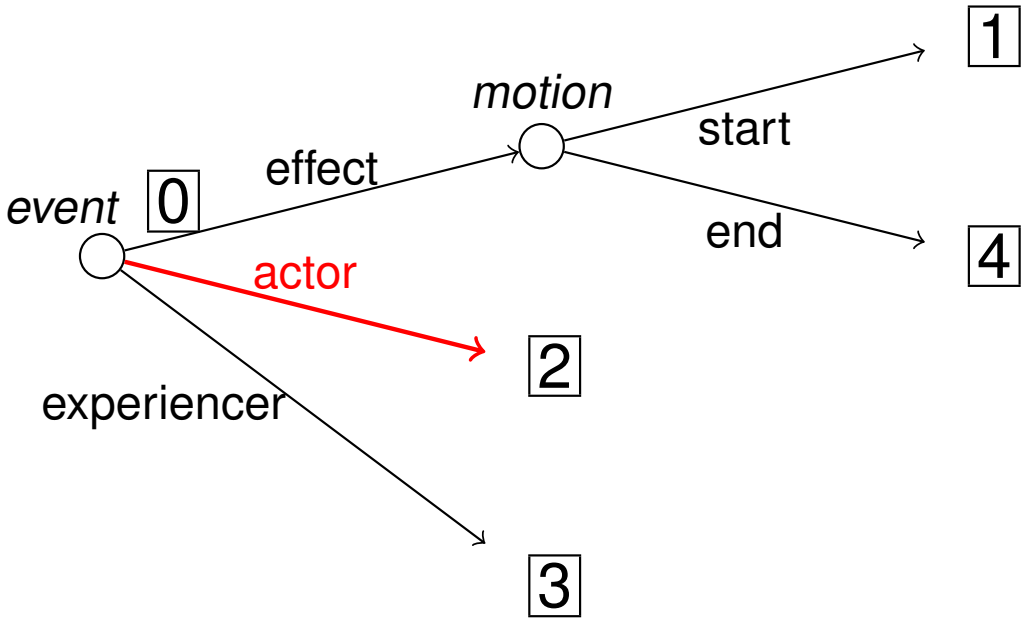
Paths in AVM


event
motion
EFFECT
START:
1
0
END:
4
ACTOR
2
EXPERIENCER
3

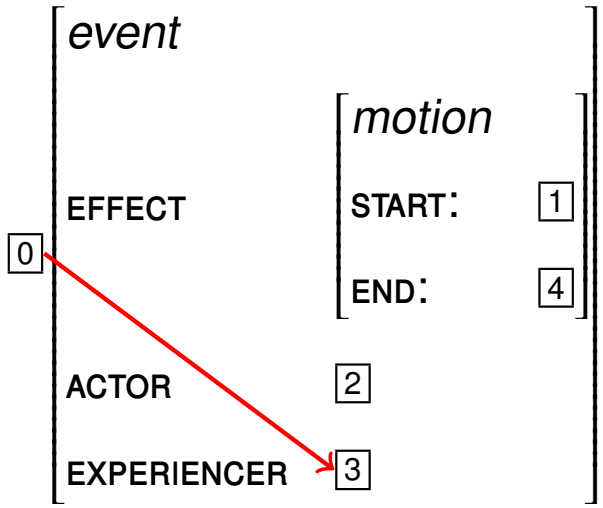

1
motion
start
effect
event
0
end
4
actor
2
experiencer
3

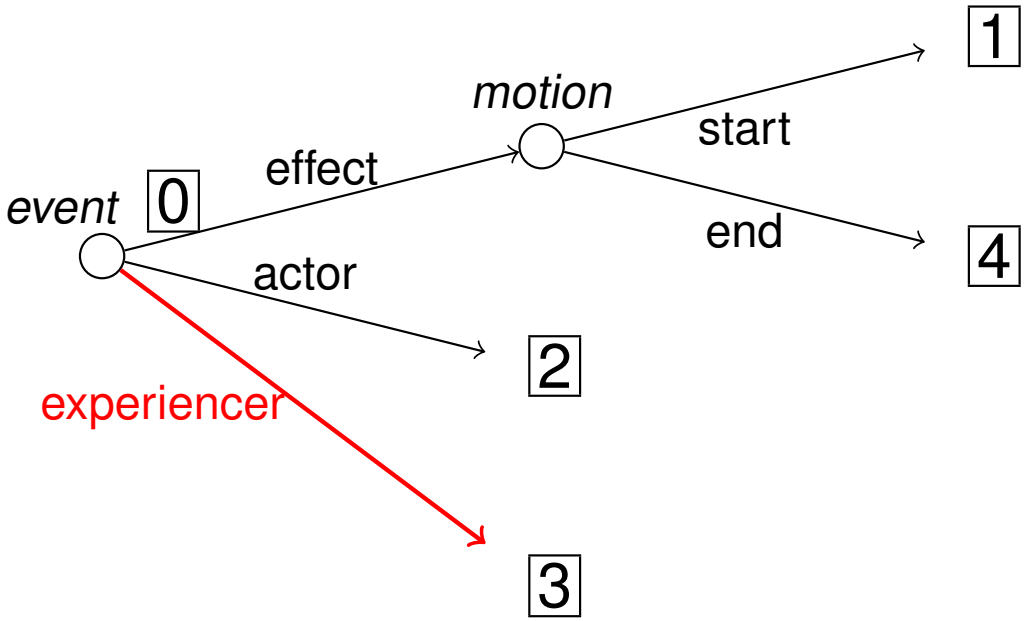
Paths in AVM


event
EFFECT
motion
START: 1
END: 4
0
ACTOR 2
EXPERIENCER 3


event
0
effect
motion
start
end
1
4
actor
2
experiencer
3

Paths in AVM


event
EFFECT
motion
START: 1
END: 4
0
ACTOR 2
EXPERIENCER 3


event
0
effect
motion
start
end
1
4
actor
2
experiencer
3

An abstraction for *ment*: underspecified rule

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

$$\begin{bmatrix} \textit{ment lexeme} & \\ \textbf{M-BASE} & \begin{bmatrix} \textit{event} & \\ \textbf{SEM:} & \boxed{0} \end{bmatrix} \\ \textbf{REF} & \boxed{R} \\ \boxed{0} \geqslant \boxed{R} & \end{bmatrix}$$

An abstraction for *ment*: underspecified rule

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

$$\begin{bmatrix} \textit{ment lexeme} & \\ \textsc{m-base} & \begin{bmatrix} \textit{event} & \\ \textsc{sem}: & \boxed{0} \end{bmatrix} \\ \textsc{ref} & \boxed{R} \\ \boxed{0} \geqslant \boxed{R} & \end{bmatrix}$$

→ Monosemy without constraints: overgeneration

$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem}: & \boxed{0}
\end{array}\right] \\
\textsc{ref} & \boxed{R}
\end{array}\right]
$$

$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{R} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{R}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{R}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{R}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem}: & \boxed{0}
\end{array}\right] \\
\textsc{ref} & \boxed{R}
\end{array}\right]
$$

$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{R}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem}: & \boxed{0}
\end{array}\right] \\
\textsc{ref} & \boxed{R}
\end{array}\right]
$$

An abstraction for *ment*: underspecified rule with constraints

```
<frame>{
 [ment-lexeme,
        m-base:[event,
                sem:?Root]
        ref:?Ref
 ]
        ;
        ?Root >* ?Ref;
        { ?Ref[result_state]  | ?Ref[event]
        | ?Ref[entity, animacy:[inanimate]] }
  }
```

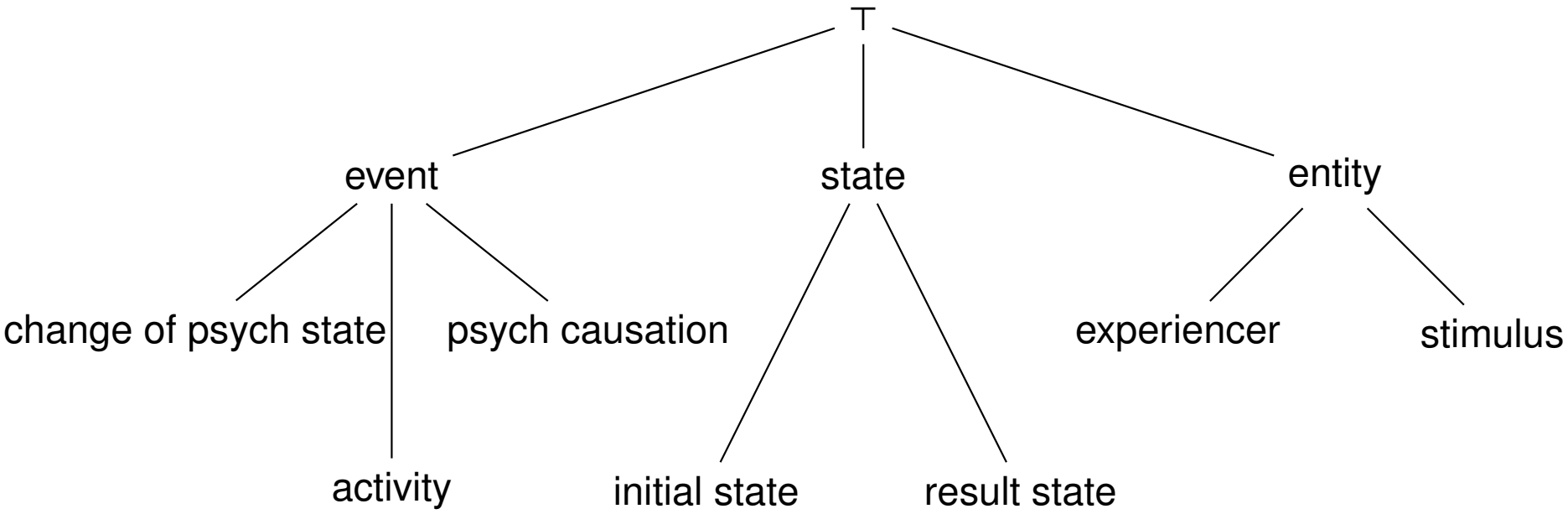
$$\left[\begin{array}{ll} \textit{ment lexeme} & \\ \textsc{m-base} & \left[\begin{array}{ll}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{array}\right] \\ \textsc{ref} & \boxed{R} \\ \boxed{0} \geqslant \boxed{R} & \end{array}\right] \wedge \left\{ \boxed{R}\left[\textit{result state}\right] \vee \boxed{R}\left[\textit{event}\right] \vee \boxed{R}\left[\begin{array}{ll}\textit{entity} & \\ \textsc{animacy} & \left[\textit{inanimate}\right]\end{array}\right] \right\}$$

XMG modeling: the type hierarchy

```
frame-constraints = {
 state  event -> -,
 ...
 psych_causation -> event,
 experiencer -> entity,
 stimulus -> entity,
 experiencer  stimulus -> -,
 ...
 entity -> animacy:animacy,
 ...
}
```

XMG modeling: the type hierarchy

```
frame-constraints = {
 state event -> -,
 ...
 psych_causation -> event,
 experiencer -> entity,
 stimulus -> entity,
 experiencer stimulus -> -,
 ...
 entity -> animacy:animacy,
 ...
}
```



$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{lll}
\textit{ment lexeme} & & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem:} & \boxed{0}
\end{array}\right] & \\
\textsc{ref} & \boxed{R} &
\end{array}\right] \wedge \left\{\begin{array}{l}
\boxed{R}\left[\textit{result state}\right] \vee \boxed{R}\left[\textit{event}\right] \vee \boxed{R}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{inanimate}\right]
\end{array}\right]
\end{array}\right\}
$$

$$
\boxed{R}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{animate}]\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{4}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

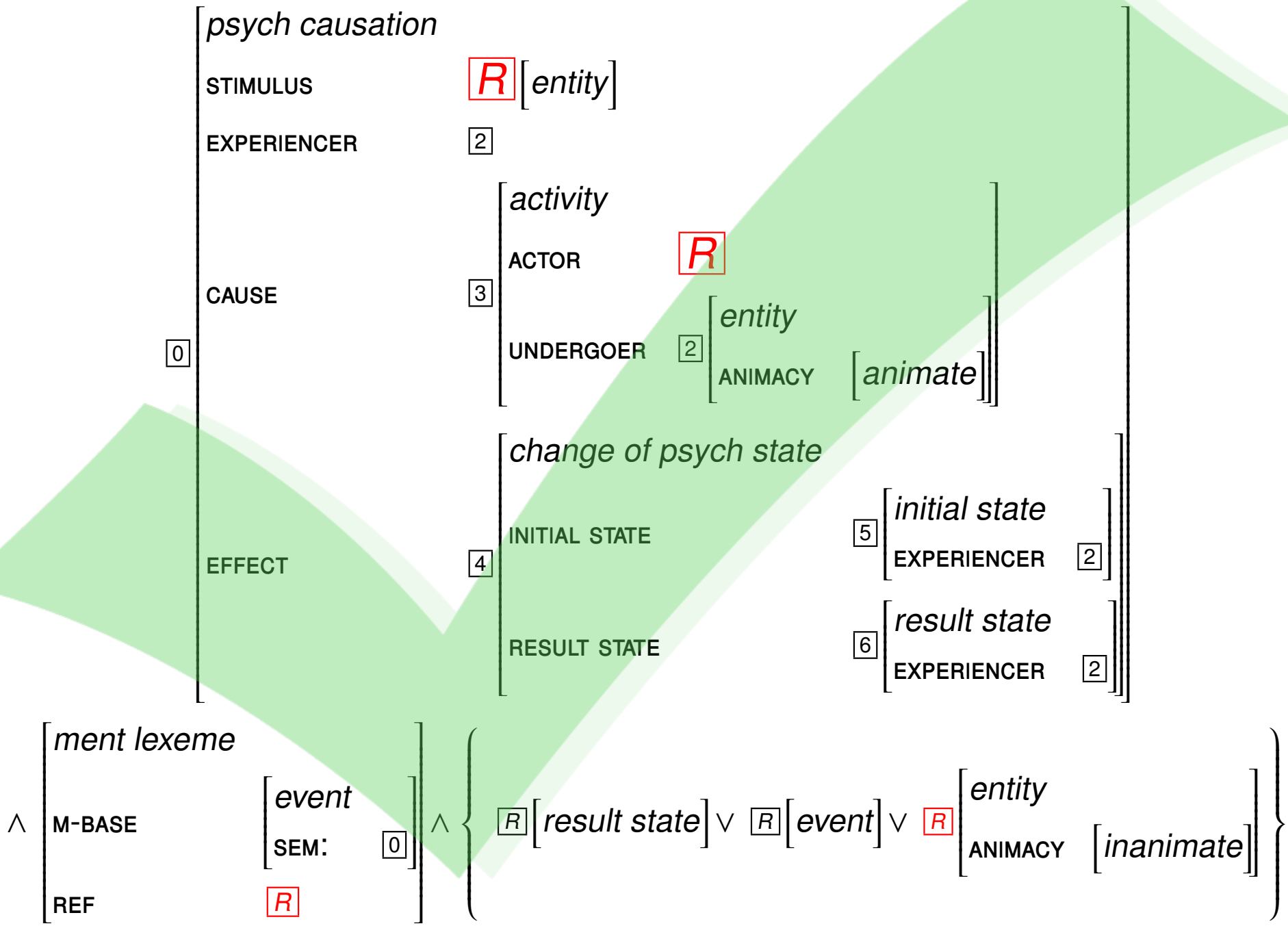
$$
\wedge \begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}[\textit{result state}] \vee \boxed{R}[\textit{event}] \vee \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{inanimate}]\end{bmatrix} \right\}
$$

$$
R \left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge \left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem:} & \boxed{0}
\end{array}\right] \\
\textsc{ref} & \boxed{R}
\end{array}\right] \wedge \left\{ \boxed{R}\left[\textit{result state}\right] \vee \boxed{R}\left[\textit{event}\right] \vee \boxed{R}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{inanimate}\right]
\end{array}\right] \right\}
$$

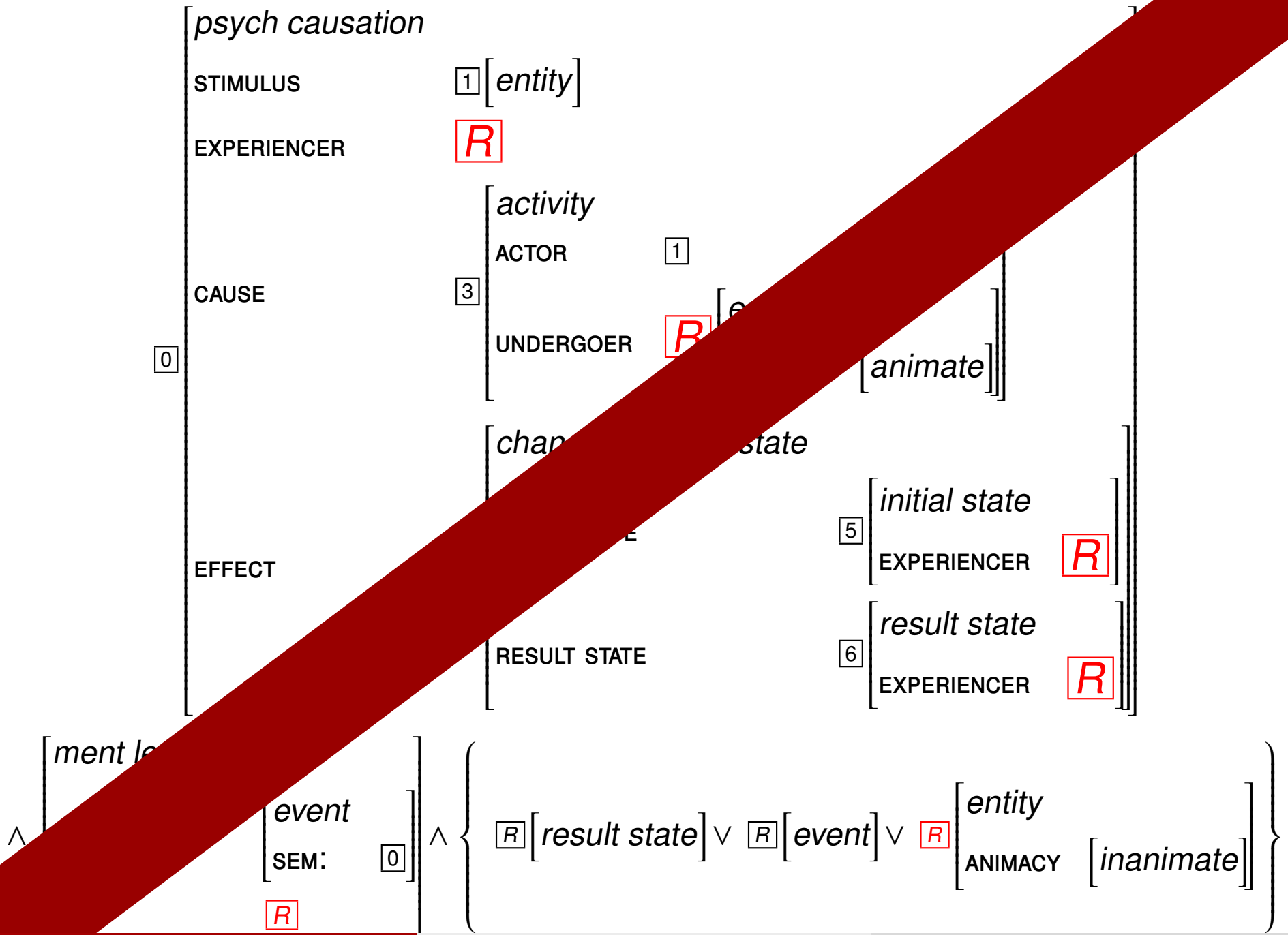
$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{R}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{R} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem:} & \boxed{0}
\end{array}\right] \\
\textsc{ref} & \boxed{R}
\end{array}\right] \wedge \left\{ \boxed{R}\left[\textit{result state}\right] \vee \boxed{R}\left[\textit{event}\right] \vee \boxed{R}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{inanimate}\right]
\end{array}\right] \right\}
$$


psych causation
STIMULUS
R
entity
EXPERIENCER
2
CAUSE
3
activity
ACTOR
R
UNDERGOER
2
entity
ANIMACY
animate
0
EFFECT
4
change of psych state
INITIAL STATE
5
initial state
EXPERIENCER
2
RESULT STATE
6
result state
EXPERIENCER
2
∧
ment lexeme
M-BASE
event
SEM:
0
REF
R
∧
R
result state
∨
R
event
∨
R
entity
ANIMACY
inanimate

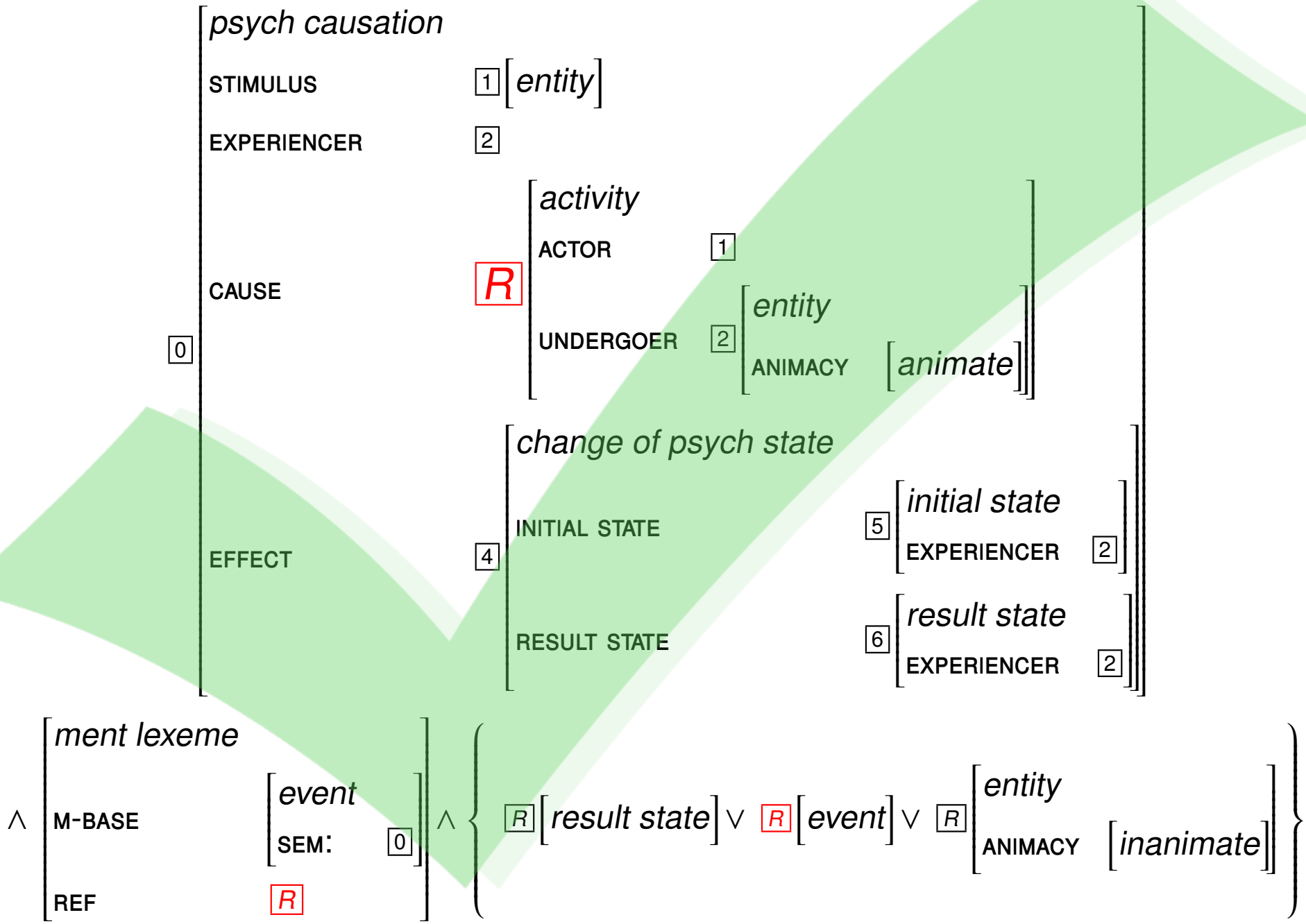
$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{R} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{animate}\end{bmatrix}\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{4}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{R}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{R}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
\wedge\begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem}: & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}\begin{bmatrix}\textit{result state}\end{bmatrix} \vee \boxed{R}\begin{bmatrix}\textit{event}\end{bmatrix} \vee \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{inanimate}\end{bmatrix}\end{bmatrix} \right\}
$$


psych causation
STIMULUS
1
entity
EXPERIENCER
R
CAUSE
3
activity
ACTOR
1
UNDERGOER
R
animate
0
EFFECT
initial state
5
EXPERIENCER
R
RESULT STATE
result state
6
EXPERIENCER
R
event
SEM:
0
R
result state
event
entity
ANIMACY
inanimate

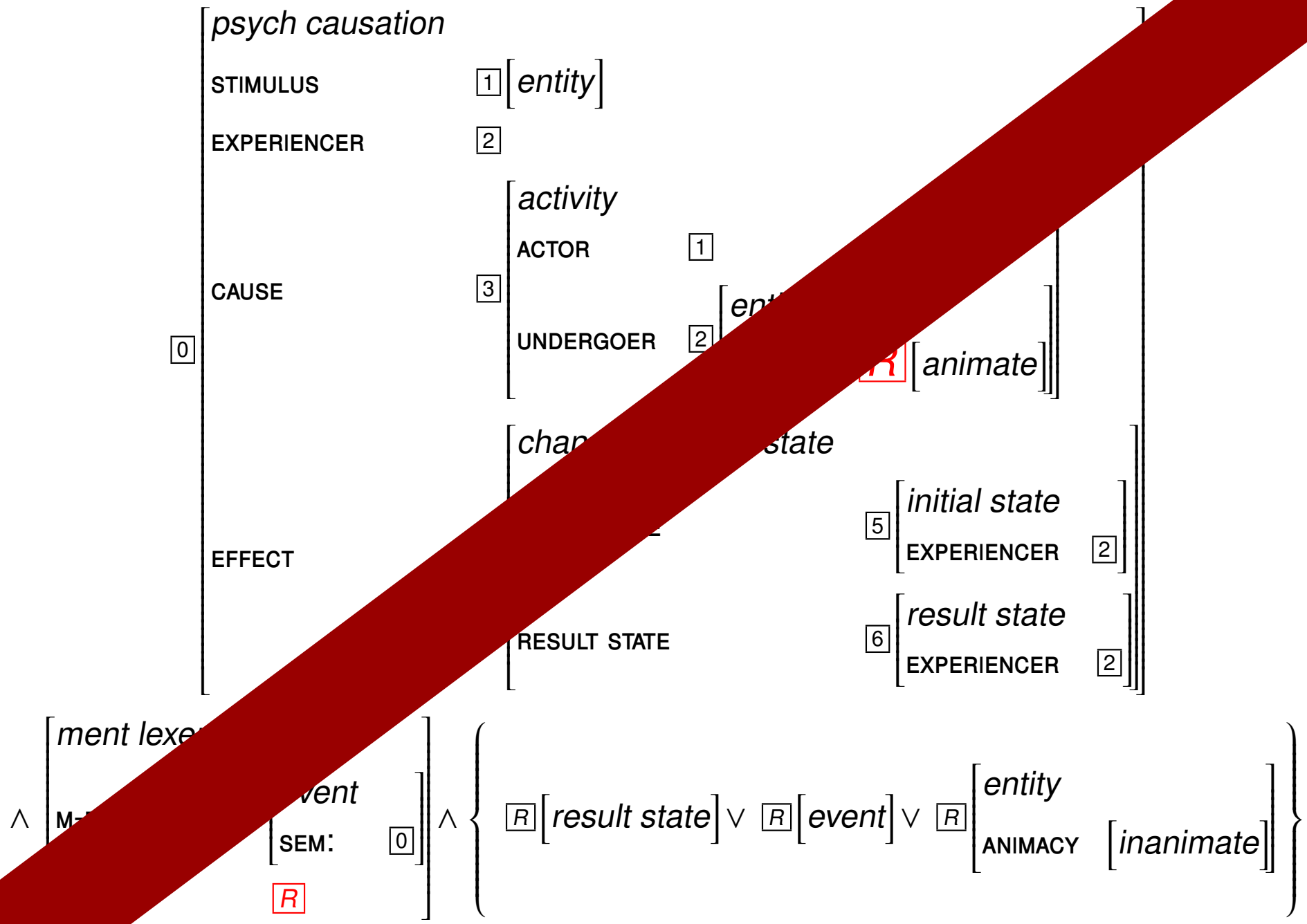
$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{R}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{animate}\end{bmatrix}\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{4}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
\wedge\begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix}\wedge\left\{\boxed{R}\begin{bmatrix}\textit{result state}\end{bmatrix}\vee\boxed{R}\begin{bmatrix}\textit{event}\end{bmatrix}\vee\boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{inanimate}\end{bmatrix}\end{bmatrix}\right\}
$$


psych causation
STIMULUS 1 entity
EXPERIENCER 2
CAUSE
R
activity
ACTOR 1
UNDERGOER 2
entity
ANIMACY animate
0
EFFECT
4
change of psych state
INITIAL STATE
5
initial state
EXPERIENCER 2
RESULT STATE
6
result state
EXPERIENCER 2
∧
ment lexeme
M-BASE
event
SEM: 0
REF R
∧
R result state ∨ R event ∨ R
entity
ANIMACY inanimate

$$
\boxed{0}\left[\begin{array}{ll}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\left[\textit{entity}\right] \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\left[\begin{array}{ll}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & R\left[\textit{animate}\right]
\end{array}\right]
\end{array}\right] \\
\textsc{effect} & \boxed{4}\left[\begin{array}{ll}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\left[\begin{array}{ll}
\textit{initial state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right] \\
\textsc{result state} & \boxed{6}\left[\begin{array}{ll}
\textit{result state} & \\
\textsc{experiencer} & \boxed{2}
\end{array}\right]
\end{array}\right]
\end{array}\right]
$$

$$
\wedge\left[\begin{array}{ll}
\textit{ment lexeme} & \\
\textsc{m-base} & \left[\begin{array}{ll}
\textit{event} & \\
\textsc{sem}: & \boxed{0}
\end{array}\right] \\
\textsc{ref} & R
\end{array}\right] \wedge \left\{ R\left[\textit{result state}\right] \vee R\left[\textit{event}\right] \vee R\left[\begin{array}{ll}
\textit{entity} & \\
\textsc{animacy} & \left[\textit{inanimate}\right]
\end{array}\right] \right\}
$$


psych causation
STIMULUS 1 entity
EXPERIENCER 2
CAUSE 3 activity
ACTOR 1
UNDERGOER 2
animate
EFFECT
initial state
EXPERIENCER 2
result state
EXPERIENCER 2
SEM: 0
R
result state
event
entity
ANIMACY inanimate

$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{animate}]\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{R}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

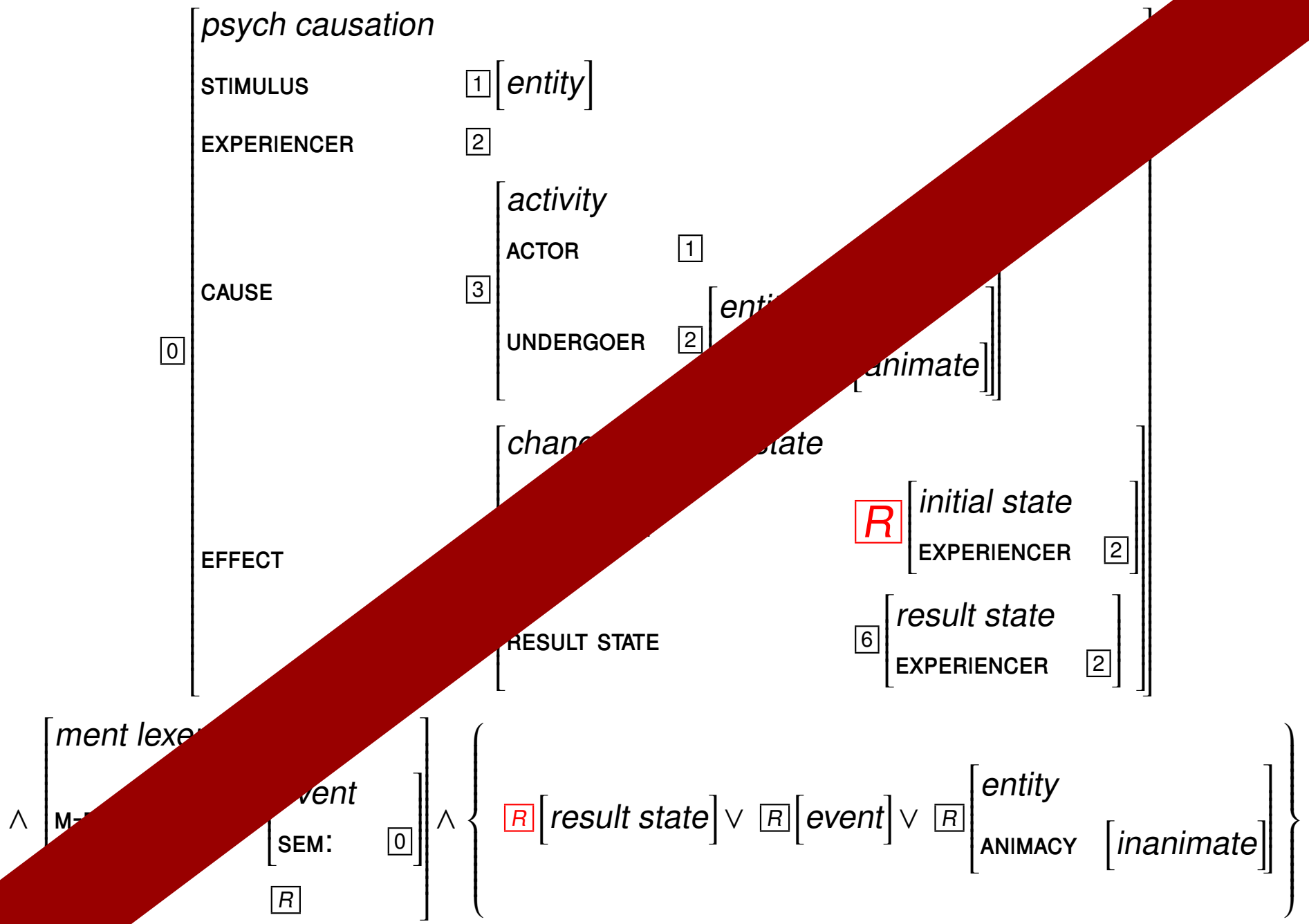
$$
\wedge\begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}[\textit{result state}] \vee \boxed{R}[\textit{event}] \vee \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{inanimate}]\end{bmatrix} \right\}
$$

$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} \\ \textsc{animacy} & [\textit{animate}]\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{R}\begin{bmatrix}
\textit{change of psych state} \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
\wedge\begin{bmatrix}
\textit{ment lexeme} \\
\textsc{m-base} & \begin{bmatrix}\textit{event} \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}[\textit{result state}] \vee \boxed{R}[\textit{event}] \vee \boxed{R}\begin{bmatrix}\textit{entity} \\ \textsc{animacy} & [\textit{inanimate}]\end{bmatrix} \right\}
$$

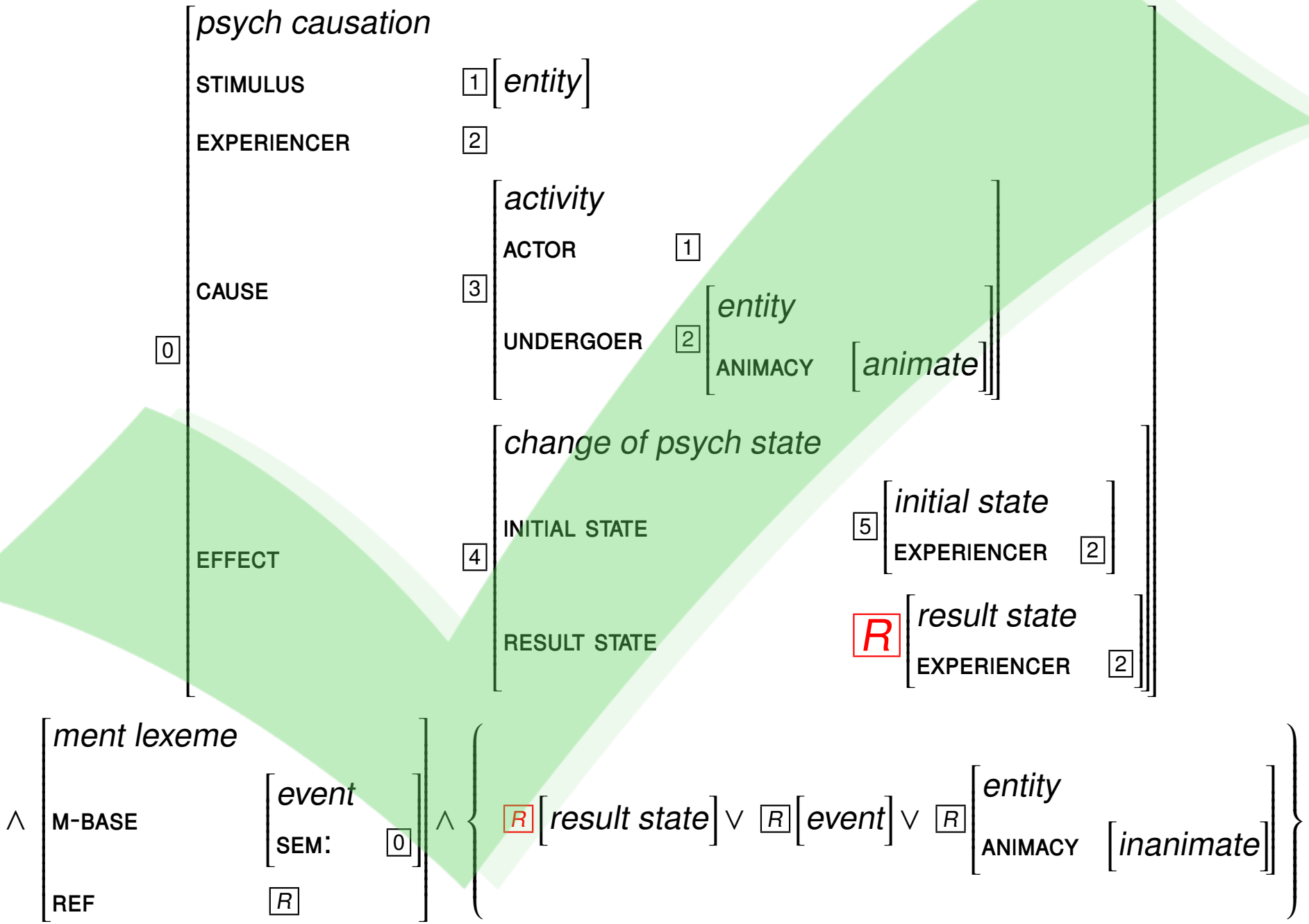
$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{animate}\end{bmatrix}\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{4}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{R}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{6}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
\wedge\begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}\begin{bmatrix}\textit{result state}\end{bmatrix} \vee \boxed{R}\begin{bmatrix}\textit{event}\end{bmatrix} \vee \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & \begin{bmatrix}\textit{inanimate}\end{bmatrix}\end{bmatrix} \right\}
$$


psych causation
STIMULUS 1 entity
EXPERIENCER 2
CAUSE 3 activity
ACTOR 1
UNDERGOER 2
0
EFFECT
R initial state
EXPERIENCER 2
6 result state
EXPERIENCER 2
RESULT STATE
SEM: 0
R
R result state ∨ R event ∨ R entity
ANIMACY inanimate

$$
\boxed{0}\begin{bmatrix}
\textit{psych causation} & \\
\textsc{stimulus} & \boxed{1}\begin{bmatrix}\textit{entity}\end{bmatrix} \\
\textsc{experiencer} & \boxed{2} \\
\textsc{cause} & \boxed{3}\begin{bmatrix}
\textit{activity} & \\
\textsc{actor} & \boxed{1} \\
\textsc{undergoer} & \boxed{2}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{animate}]\end{bmatrix}
\end{bmatrix} \\
\textsc{effect} & \boxed{4}\begin{bmatrix}
\textit{change of psych state} & \\
\textsc{initial state} & \boxed{5}\begin{bmatrix}\textit{initial state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix} \\
\textsc{result state} & \boxed{R}\begin{bmatrix}\textit{result state} & \\ \textsc{experiencer} & \boxed{2}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

$$
\wedge \begin{bmatrix}
\textit{ment lexeme} & \\
\textsc{m-base} & \begin{bmatrix}\textit{event} & \\ \textsc{sem:} & \boxed{0}\end{bmatrix} \\
\textsc{ref} & \boxed{R}
\end{bmatrix} \wedge \left\{ \boxed{R}[\textit{result state}] \vee \boxed{R}[\textit{event}] \vee \boxed{R}\begin{bmatrix}\textit{entity} & \\ \textsc{animacy} & [\textit{inanimate}]\end{bmatrix} \right\}
$$


psych causation
STIMULUS
1
entity
EXPERIENCER
2
CAUSE
3
activity
ACTOR
1
UNDERGOER
2
entity
ANIMACY
animate
0
EFFECT
4
change of psych state
INITIAL STATE
5
initial state
EXPERIENCER
2
RESULT STATE
R
result state
EXPERIENCER
2
∧
ment lexeme
M-BASE
event
SEM:
0
REF
R
∧
R
result state
∨
R
event
∨
R
entity
ANIMACY
inanimate

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

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