Interfacing Speech and Co-Verbal Gesture: Exemplification

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Exemplification

Some Observations (Lücking [2011]2013:103)

- Suppose this to be a gesture trajectory:

  What does it mean?  

  „Rolling“?

- Maybe iconic gestures are not driven by an iconographic (isomorphic) mapping of some property or event.
- Iconic gestures could rather be connected to (mis-)conceptions we have (cf. the notion of interpretant gesture (Fricke 2012)).
Examples from the SaGA-Korpus
(Lücking, Bergmann, Hahn, Kopp & Rieser 2010)

1. Bus ride through VR SaGA town
2. Giving direction & describing sights

SaGA: Bielefeld Speech-and-Gesture Alignment Corpus
Exemplification

Some Observations

- Who cares about the course of the road?

Outline of Street 1:

an so einer geschlängelte Straße lang

Das ist so eine geschlängelte Straße
Exemplification

Goodmanian Approach (Goodman 1976)

- The gestures, although not literally representing their referent, match quite well their affiliates: *winded* [street].

- Gesture performance is not so much driven by iconicity (as resemblance), but rather by suiting the accompanying verbal expression: Exemplification.

*an so einer geschlängelte Straße lang*  
*Das ist so eine geschlängelte Straße*
Exemplification

Agenda

1. Exemplifying Exemplification
2. A Problem for Set-Nominalism
3. Representing Conceptual Representations Explicitly
4. Interfacing Speech and Gestures
Exemplification

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Exemplifying exemplification

- The color predicate *green* denotes (at least in English and German) wavelengths in the range of 497 to 530 nm.

\[
\begin{array}{c|c}
\text{color} & \hline \\
\text{RELN} & \text{green} \\
\text{NM} & 497–530 \\
\end{array}
\]
Exemplification

Exemplifying exemplification

- The color predicate green denotes (at least in English and German) wavelengths in the range of 497 to 530 nm.
- Suppose entity $x$ reflects light on a wavelength of 511 nm.

\[
\begin{pmatrix}
\text{color} \\
\text{RELN} \quad \text{green} \\
\text{NM} \quad 497–530
\end{pmatrix}
\quad \begin{pmatrix}
\text{entity} \\
\text{IND} \quad x \\
\text{SR} \quad 511
\end{pmatrix}
\]
Exemplification

Exemplifying exemplification

- The color predicate *green* denotes (at least in English and German) wavelengths in the range of 497 to 530 nm.
- Suppose entity \( x \) reflects light on a wavelength of 511 nm.
- Then \( x \) can exemplify the predicate *green*.

- Presupposed: wavelength hierarchy:
  
  497–530
  
  497 498 499 ... 529 530
Exemplification

Exemplifying exemplification

- Likewise, a spatial predicate like *semicircle* is bound up with a certain path, namely 180°.

\[
\begin{array}{l}
\text{form} \\
\text{RELN} \quad \text{semicircle} \\
\text{PATH} \quad 180°
\end{array}
\]
Exemplification

Exemplifying exemplification

- Likewise, a spatial predicate like *semicircle* is bound up with a certain path, namely 180°.
- The predicate *semicircle* can be exemplified by a gesture that performs a trajectory of 180°.

\[
\begin{bmatrix}
\textit{form} \\
\text{RELN} & \text{semicircle} \\
\text{PATH} & 180°
\end{bmatrix}
\quad \begin{bmatrix}
\textit{gesture} \\
\text{IND} & \times \\
\text{TRAJ} & 180°
\end{bmatrix}
\quad \begin{bmatrix}
\textit{sem-struc} \\
\text{MODE} & \text{exemplification} \\
\text{GEST} & \begin{bmatrix}
\text{IND} & \times \\
\text{TRAJ} & 180°
\end{bmatrix} \\
\text{PRED} & \begin{bmatrix}
\text{RELN} & \text{semicircle} \\
\text{PATH} & 3
\end{bmatrix}
\end{bmatrix}
\]
Likewise, a spatial predicate like *semicircle* is bound up with a certain path, namely 180°.

The predicate *semicircle* can be exemplified by a gesture that performs a trajectory of 180°.

A respective speech-gesture ensemble can indeed be found in V20, video time 6:37, in the SaGA corpus.

```
form
RELN  semicircle
PATH  180°

gesture
IND  x
TRAJ  180°

sem-struc
MODE  exemplification
GEST
IND  x
TRAJ  180°
PRED
RELN  semicircle
PATH  3
```

*oben haben die so’n Halbkreis*
Exemplification

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Model-Theory (following Armstrong 1989)

\[\text{[round']}_M = \{\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc\} \quad \text{[square']}_M = \{\square \square \square \square \square \square \square\}\]

\[\text{[round2']}_M = \{\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \square\}\]

What distinguishes a set of tokens that make up a type from a set of tokens that do not make up a type? (cf. Armstrong 1989:13)
Exemplification

Model-Theory  (following Armstrong 1989)

Model $\mathcal{M}$

\[
[\text{round}']_{\mathcal{M}} = \{\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \} \\
[\text{round2}']_{\mathcal{M}} = \{\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \bigcirc \}
\]

Outline path = 360°

Possible answer: commonality
Exemplification

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Why Vectors?

- We use vectors and vector sequences to represent spatial concepts.
- Why vectors?
  - Vector models are an established account for motion perception.
  - Vector semantics provide a linguistic framework for dealing with spatial predicates.
  - Vectors are a flexible representation tool ("drawing with vectors").
Exemplification

Vector analysis of biological motion (Johansson 1973)

- Motion perception can be captured by means of a vector model.
- Rotation and translation Carriers are the basis for the vector model.

Vector model: factoring out common movement shares
Exemplification


- Axis and location vectors as spatial denotations (e.g., “near”, “along”):

  location vector: \( \text{loc}(v, x) \)  
  axis vector: \( \text{axis}(x, v) \)

- Additionally, four-dimensional (spatial + temporal) vector sequence variants of axis and loc cover the changing of location or shape.

  shape vector: \( \text{shape}(\Phi, x) \)  
  motion vector: \( \text{motion}(\Phi, x) \)
Exemplification

Spatial Predicates and CVM

- We assume vectorial representations to be appropriate only for space-related predicates.

- Sorting predicates:

  \[ \text{pred} \]
  \[ \text{spatial-pred} \]
  \[ \text{nonspatial-pred} \]
  \[ \text{form-pred} \]
  \[ \text{handle-pred} \]
  \[ \text{loc-pred} \]
  \[ \text{col-pred} \]
  \[ \text{weight-pred} \]
  \[ \text{olfac-pred} \]
  \[ \ldots \]

- A constraint for the type \textit{spatial-pred} introduces conceptual vector meaning:

  \[
  \begin{bmatrix}
    \text{spatial-pred} \\
    \text{CONT} \\
    \text{RESTR}
  \end{bmatrix}
  \begin{bmatrix}
    \text{CVM} \\
    \text{VEC} \\
    \text{PATH} \\
    \text{vec.type} \\
    \text{vec}
  \end{bmatrix}
  \]
Exemplification

Vectorizing Gestures

- The (potential) carriers of a gesture performance are the gesture’s “morphological” feature of handshape, and wrist, palm and back of hand movement and direction.

- The basic representation format of a gesture is the following:

\[
\text{gesture-vec} \\
\text{TRAJ} \quad [\text{PATH vec}] \\
\text{CARRIER} \quad \text{MORPH} \\
\text{gesture} \\
\text{morph-struc} \\
\text{HANDSHAPE} \quad \text{shape.feat} \\
\text{WRIST.MOV} \quad \text{move.feat} \\
\text{PALM.MOV} \quad \text{move.lr.feat} \\
\text{PALM.DIR} \quad \text{dir.feat} \\
\text{BOH.MOV} \quad \text{move.udlr.feat} \\
\text{BOH.DIR} \quad \text{dir.feat}
\]

- The feature values are derived from gesture annotation (SaGA).
Exemplification

Vectorizing Gestures

1. Translating basic movement predicates into orienting vectors of three-dimensional vector space.

\[
\begin{align*}
mf & \in FT \\
mb & \in -FT \\
mu & \in UP \\
md & \in -UP \\
ml & \in -RT \\
mr & \in RT
\end{align*}
\]

2. Building complex motion paths by two kinds of concatenations of basic predicates.

- line-Trajektorie
- arc-Trajektorie
Exemplification

Example: *winded* gesture

\[
\begin{align*}
\text{AFF} & \quad \left\langle \left[ \text{PHON [ACCENT marked]} \right] \right \rangle \\
\text{TRAJ} & \quad \left[ \text{PATH V(1) = RT>FT>LT>FT>RT} \right] \\
\text{CARRIER} & \quad \left[ \text{MORPH [WRIST.MOV mr>mf>ml>mr]} \right] \\
\text{CONT} & \quad \left[ \text{MODE exemplification EX-PRED predicate} \right]
\end{align*}
\]
Exemplification

Example: *winded*

```
verbatim-sign
CAT [HEAD adj]
INDEX j
CONT [RESTR [RELN [CVM [VEC shape.vec(j, \(\Phi\))]
PATH sin(\(\Phi\))]]]
```

```
\[
\text{sin} \quad \text{RT} \rightarrow \text{FT} \rightarrow \text{LT} \\
\text{RT} \rightarrow \text{FT} \rightarrow \text{LT} \rightarrow \text{FT} \rightarrow \text{RT} \\
\text{UP} \rightarrow \text{BT} \rightarrow \text{FT} \quad \ldots
\]
```
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Interfacing speech and gesture

- A construction where speech and gesture can meet:

  - Contact point is phonology/information structure (cf. Alahverdzhiieva & Lascarides 2010).

  - Semantic integration happens in the exemplification interface.

  - Note, that integration can fail if the gesture vectors does not fit to the predicates CVM value.
Exemplification

Combining *winded* + *winded gesture*

```
sg-ensemble
CAT  [2][HEAD  adj]
  INDEX  j
CONT  3
  RESTR
    [4][form-pred
       RELN  winded
       INDEX  j
       CVM  [5][VEC  shape.vec(j, Φ)]
]
S-DTR  6
  CAT  [2]
  CONT  [3]
    [AFF  6]
    [TRAJ  5][PATH  V(1) = RT>FT>LT>RT]
G-DTR
  CARRIER
    [MORPH  [1][WRIST.MOV  mr>mf>ml>mf>mr]]
  CONT
    [MODE  exemplification]
```

\sin
RT>FT>LT  RT>FT>LT>FT>RT  UP>BT>FT
Exemplification

Conclusion

- The exemplification account claims that iconic gestures exemplify conceptual structures of verbal predicates.

- The account draws on an explicit representation of spatial meaning.

- The account, *inter alia*, provides
  - a view on speech-gesture redundancy vs. complementarity;
  - a framework for multimodal subcategorization.

- Unification is probably too strong to cover more complex vector path constraints. For example, the path for “drive towards x” can not be enumerated in terms of vector concatenations (*Lücking [2011]2013*).
References


