Constructed action types and eye behavior in Finnish Sign Language

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Definition of constructed action (CA)

• CA is a form of gestural enactment in which the signers use their hands, face and other parts of the body to represent the actions, thoughts, feelings or sayings of someone they are referring to in the discourse (Cormier & al. 2015).

Example of CA

He gets an idea, walks to the oven and picks up some coal with him. He puts the pieces of coal on the snowman as eyes and mouth. He looks at what he has done and is very satisfied.
Types of CA

- CA has degrees (Cormier & al. 2015):

**Overt**
- Many articulators,
- Full character perspective

**Reduced**
- Many articulators,
- Partial character perspective

**Subtle**
- Few articulators,
- Partial character perspective

"snowman pulls back"  "snowman" LOOK-AT  WAKE-UP ("eyes")

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Motivation

• Eye behavior – eye gaze shift away from the addressee in particular – is considered to be the most important articulatory cue of the beginning of CA (e.g. Herrmann & Steinbach 2012; Ferrara & Johnston 2014; Cormier & al. 2015; Jantunen 2017).
• Some works treat eye gaze shift even as a formal marker of CA.
• But there is very little frequency-based information about the topic of eye behavior and CA available and, moreover, eye behavior has not been investigated at all with respect to the three CA types.
• In order to better understand this relationship, the present work looks at eye behavior at the beginning of CA and its three types in Finnish Sign Language (FinSL) narrations.

Data

1. Signers
   • 5 native FinSL signers (2 female)
   • Ages between 30–60 years
   • Head-mounted eyetracker (ET)

2. Content
   • Textless *Ferdinand* comic strips
   • 5 strips per a signer
   • ”Sign as vividly as you can.”

3. Statistics
   • Altogether 25 stories
   • Total video duration 13 min and 32 sec.
   • Ca. 5 million characters of numerical ET data

4. Synchronization (see Burger & al. forthc.)
   • Video-based synchronization in ELAN
   • Accuracy 0.5≤1.5 frames

5. Processing in ELAN
   • Basic annotation of signs and translations
   • Annotation of CA (Cormier & al. 2015)
   • ET data visualized with descriptors
   • Closures, saccades, gaze direction (x, y)

6. Samples & analysis
   • The first CA of each story (n=25) and ...
   • ... all the CA in all stories (n=274)
   • The beginning of CA

Eyetracking

- Head-mounted Ergoneers Dikablis eyetracking system
- 2 video cameras, recording speed 50 fps (H.264, mp4)
- Tracking the pupil activity and gaze direction of the left eye
- For more info, visit http://www.ergoneers.com/eye-tracking/dikablis-glasses/
# Tiers in ELAN

<table>
<thead>
<tr>
<th>Tier</th>
<th>Description (and annotation cell values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Translation</td>
<td>Sentence level translation.</td>
</tr>
<tr>
<td>Gloss</td>
<td>A gloss identifying the sign.</td>
</tr>
</tbody>
</table>

**Cormier & al. (2015)**

- **CA-type**: The type of CA based on the annotations on the CA-summary and role tiers (overt, reduced, subtle).
- **Role1**: The primary role the signer is taking on when using CA (narrator, "character").
- **Role2**: The secondary role the signer is taking on when using CA ("none", narrator, "character").
- **CA-summary**: A stretch of discourse where CA is continuously used with one or more articulator to represent the same referent (i.e. within the same character role) (enacting).
- **CA-eyegaze**: Break of eyegaze with addressee for purpose of enacting referent (enacting).
- **CA-head**: Signer’s use of his/her head to represent head movement/posture of referent (enacting).
- **CA-face**: Signer’s use of his/her facial expression to represent face of referent (enacting).
- **CA-torso**: Signer’s use of his/her torso to represent torso movement/posture of referent (enacting).
- **CA-dom-arm/hand**: Signer’s use of his/her dominant arm/hand to represent arm/hand of referent (enacting, instrument).
- **CA-ndom-arm/hand**: Signer’s use of his/her non-dominant arm/hand to represent arm/hand of referent (enacting, instrument).
- **CA-legs**: Signer’s use of his/her legs to represent legs of referent (enacting). **NB! Not included in Cormier & al. (2015)**
- **Story**: The duration of the story (story).

Annotations and visual descriptors in ELAN
Features

- **Eye gaze shift at the beginning of CA**
  A prominent displacement in the ELAN graph describing eye gaze in x and/or y dimension (a, b).

- **Eyes closing before CA**
  A displacement to zero in the ELAN graph describing eye gaze (c, d).

- **Saccade before CA**
  A peak in the ELAN graph describing saccade angle (e).

- **CA involves enacting eye gaze**
  A *CA-type* annotation cell overlaps with *CA-eyegaze* cell.
Summary of results

- The three CA types are associated with different kinds of eye behavior.
- **Overt CA**: The eye gaze is always *enacting*. It is almost obligatory to have a prominent break in eye gaze – a shift in the eye gaze direction and/or a closing of the eyes – at the beginning of the CA.
- **Reduced CA**: The eye gaze is *enacting* most of the time. There tends to be a some sort of break in eye gaze – most typically a shift in the eye gaze direction – at the beginning of the CA.
- **Subtle CA**: The eye gaze is sometimes *enacting*. There is often no prominent break in eye gaze – at least no closing of the eyes – at the beginning of CA, and in general eye behavior is not a reliable cue of CA.
Results 1 – the first CA of each story (total n=25)

<table>
<thead>
<tr>
<th>Numerical ET data*</th>
<th>Overt (n=5)</th>
<th>Reduced (n=14)</th>
<th>Subtle (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye gaze shift at the beginning of CA</td>
<td>100%</td>
<td>71%</td>
<td>33%</td>
</tr>
<tr>
<td>Eyes closing before CA</td>
<td>100%</td>
<td>57%</td>
<td>17%</td>
</tr>
<tr>
<td>Saccade before CA</td>
<td>0%</td>
<td>29%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Annotation cell values

<table>
<thead>
<tr>
<th>CA involves enacting eye gaze</th>
<th>Overt (n=5)</th>
<th>Reduced (n=14)</th>
<th>Subtle (n=6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
<td>93%</td>
<td>33%</td>
</tr>
</tbody>
</table>

* The analysis window of numerical ET data is +/- 3 video frames counted from the beginning of the CA-type annotation cell.
Results 2 – all the CA in all stories (total n=274)

<table>
<thead>
<tr>
<th>Numerical ET data*</th>
<th>Overt (n=105)</th>
<th>Reduc. (n=109)</th>
<th>Subtle (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye gaze shift at the beginning of CA</td>
<td>81%</td>
<td>72%</td>
<td>58%</td>
</tr>
<tr>
<td>Eyes closing before CA</td>
<td>61%</td>
<td>50%</td>
<td>30%</td>
</tr>
<tr>
<td>Saccade before CA</td>
<td>19%</td>
<td>28%</td>
<td>42%</td>
</tr>
</tbody>
</table>

Annotation cell values

| CA involves enacting eye gaze | 100% | 94% | 50% |

* The analysis window of numerical ET data is +/- 3 video frames counted from the beginning of the CA-type annotation cell.
Discussion (1)

- The eye behavior characteristics provide support for the present CA typology (Cormier & al. 2015).
- Moreover, the eye behavior characteristics may be used to further define the three CA types.
- Eye gaze shift away from the addressee is not a marker of CA: it is an important cue of overt and often even reduced CA but does not occur reliably with subtle CA.
- Rather, the data suggests that eye gaze shift away from the addressee is linked to the enacting role of the eyes in CA.

Discussion (2)

- The type of data matters: the eye behavior in the transitions from regular narration to CA (results 1) is more systematic than that in the transitions between CA types (cf. results 2).
- The differences between results 1 and 2 can be explained by the fact that in the middle of discourse (results 2) eye behavior has several competing functions (see e.g. Bahan & Supalla 1995, Metzger 1998, Thompson & al. 2006, Hansen & Hessmann 2007).

Conclusion

• We investigated the relation between eye behavior and CA types with the help of eyetracking technology.
• We found that the lower the CA, the more unreliable is eye behavior as an articulatory cue of CA.
• We interpret the results to support the current CA typology.
• We will be next in SLE 2018 (Tallin, Estonia, August 29–September 1, 2018) where we will be presenting on the topic *The kinematics of constructed action in sign language narration – A motion capture study.*
Thank you!

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