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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).

CORMIER, Kearsy, Sandra Smith & Zed Sevcikova Sehyr (2015). Rethinking constructed action. *Sign Language & Linguistics* 18:2, 167–204. doi 10.1075/sll.18.2.01cor

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



”snowman pulls back”

Reduced

Many articulators,
Partial character perspective



”snowman” LOOK-AT

Subtle

Few articulators,
Partial character perspective



WAKE-UP (”eyes”)

CORMIER, Kearsy, Sandra Smith & Zed Sevcikova Sehyr (2015). Rethinking constructed action. *Sign Language & Linguistics* 18:2, 167–204. doi 10.1075/sll.18.2.01cor – JANTUNEN, Tommi (forthcoming). Viittomakielet hybridisysteeminä: hämääräjäisyys ja epäkonventionaalisuus osana viittomakielten rakennetta [Sign languages as hybrid systems: Gradience and unconventionality as a part of the structure of sign languages]. *Puhe ja kieli*.

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.

CORMIER, K., S. Smith & Z. Sevcikova Sehyr (2015). Rethinking constructed action. *Sign Language & Linguistics* 18:2, 167–204. – FERRARA, L. & T. Johnston (2014). Elaborating who's what: A study of constructed action and clause structure in Auslan (Australian Sign Language), *Australian Journal of Linguistics* 34:2, 193–215. – HERRMANN, A. & M. Steinbach (2012). Quotation in sign languages: A visible context shift. In I. van Alphen & I. Buchstaller (eds.), *Quotatives: Cross-linguistic and cross-disciplinary perspectives*, 203–230. Amsterdam: John Benjamins. – JANTUNEN, T. (2017). Constructed action, the clause and the nature of syntax in Finnish Sign Language. *Open Linguistics*, 3, 65–85.

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 $0.5 \leq 1.5$ frames

5. Processing in ELAN

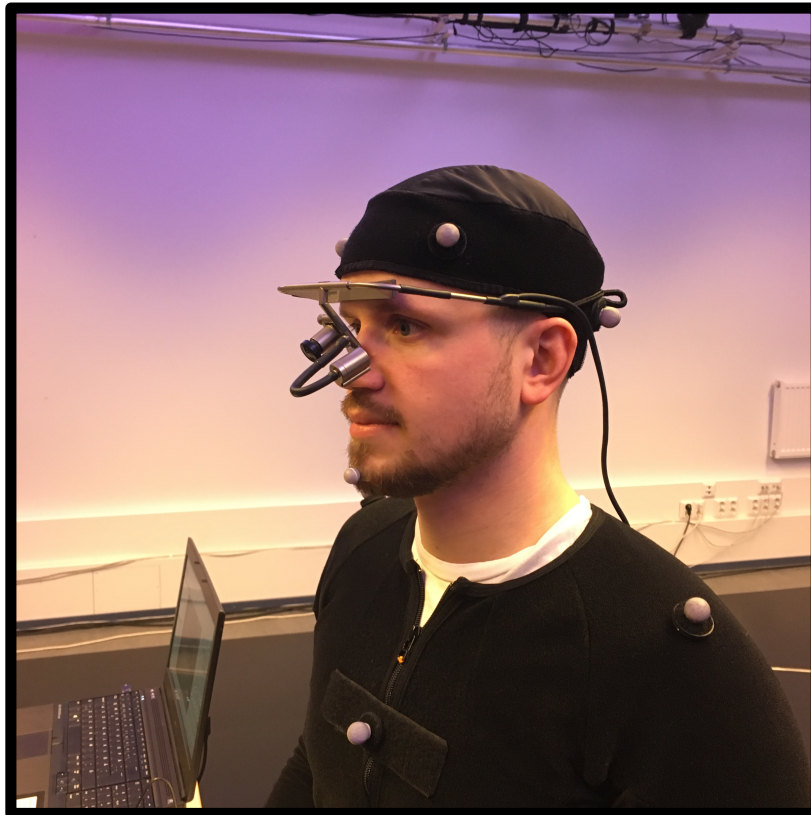
- Basic annotation of signs and translations
- Annotation of CA (Cormier & al. 2015)
- ET data visualized with descriptors
- Closures, saccades, gaze direction (x, y)

6. Samples & analysis

- The first CA of each story (n=25) and ...
- ... all the CA in all stories (n=274)
- The beginning of CA

BURGER, B., T. Jantunen & A. Puupponen (2018). Synchronizing eye tracking and optical motion capture: How to bring them together. *Journal of Eye Movement Research* 11(2):5. doi 10.16910/jemr.11.2.5 – CORMIER, Kearsy, Sandra Smith & Zed Sevcikova Sehyr (2015). Rethinking constructed action. *Sign Language & Linguistics* 18:2, 167–204. doi 10.1075/sll.18.2.01cor

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

Tier	Description (and annotation cell values)
Translation	Sentence level translation.
Gloss	A gloss identifying the sign.
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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)
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Story	The duration of the story (story).

Annotations and visual descriptors in ELAN

The screenshot displays the ELAN 5.0.0-alpha interface for a video file named "MoCap_ET_2017_subject4_task2.eaf". The interface includes a menu bar (File, Edit, Annotation, Tier, Type, Search, View, Options, Window, Help) and a toolbar with various playback and editing controls. A selection box is active over a video frame, with the time range "00:00:08.153 - 00:00:09.023 870" displayed below it.

Below the video, three eye-tracking plots are visible: "Saccades_angle", "Gaze_x", and "Gaze_y". The "Saccades_angle" plot shows a sharp peak at 6.8625. The "Gaze_x" plot shows a peak at 131.55. The "Gaze_y" plot shows a peak at 237.393. A vertical red line marks the current selection time.

The bottom section of the interface shows a timeline with various annotations. The "Glossi" tier contains the following text: "OS:minä · YMMÄRTÄÄ · OIKEIN · KYLLÄ · SARJA · TIETÄÄ-EI(5c5c) · MUTTA · KUITENKIN · KÄMMEN-ALAS_ele · AVIOMIES · VAIMO · SYÖDÄ(HH) · VALMIS · LOPPU(BB) · SITTEN · MIES · MITÄ · VAIMO · SANOA · Täytyä(AA) · OS: · PESTÄ-HAMPAAT · KÄSKEÄ-MENEMÄÄN_ele · KOSKA". Other tiers include "CA-type", "Role1", "Role2", "CA-summary", "CA-eyegaze", "CA-head", "CA-face", "CA-torso", "CA-dom-arm/hand", "CA-ndom-arm/han", "CA-legs", and "Story".

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**

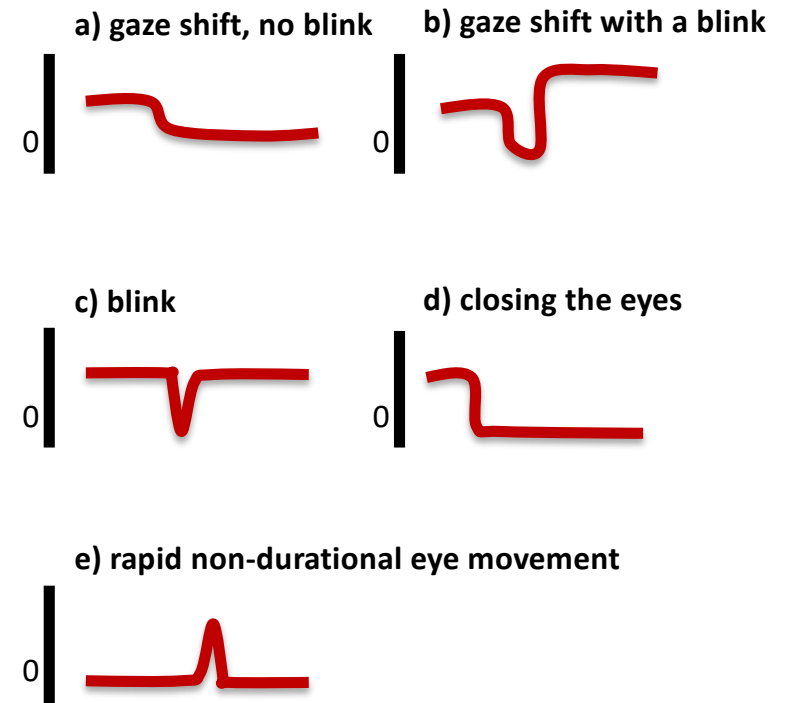
A displacement to zero in the ELAN graph describing eye gaze (c, d).

- **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)

Numerical ET data*

	Overt (n=5)	Reduced (n=14)	Subtle (n=6)
Eye gaze shift at the beginning of CA	100%	71%	33%
Eyes closing before CA	100%	57%	17%
Saccade before CA	0%	29%	50%

Annotation cell values

CA involves enacting eye gaze	100%	93%	33%
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* 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)

Numerical ET data*

	Overt (n=105)	Reduc. (n=109)	Subtle (n=60)
Eye gaze shift at the beginning of CA	81%	72%	58%
Eyes closing before CA	61%	50%	30%
Saccade before CA	19%	28%	42%

Annotation cell values

CA involves enacting eye gaze	100%	94%	50%
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* 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.

CORMIER, K., S. Smith & Z. Sevcikova Sehyr (2015). Rethinking constructed action. *Sign Language & Linguistics* 18:2, 167–204.

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).

BAHAN, B. & S. Supalla (1995). Line segmentation and narrative structure: A study of eyegaze behavior in American Sign Language. In K. Emmorey & J. Reilly (eds.), *Language, gesture, and space*, 171-191. Hillsdale, NJ: LEA. – HANSEN, M. & J. Hessmann (2007). Matching propositional content and formal markers: Sentence boundaries in a DGS text. *Sign Language & Linguistics* 10(2), 145-175.– METZGER, M. (1998). Eye gaze and pronominal reference in American Sign Language. In C. Lucas (ed.), *Pinky extension and eye gaze: Language use in deaf communities*, 170-181. Washington, DC: GUP. – THOMPSON, R., K. Emmorey & R. Kluender (2006). The relationship between eye gaze and verb agreement in American sign Language: An eye-tracking study. *Natural Language and Linguistic Theory* 24:2, 571-604.

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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