A model of speech-gesture production: Linking gesture to thinking and speaking

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Gesture

- When we speak or when we silently think, we often spontaneously produce gestures.

Representational gestures

- Depict and indicate
- "iconic","metaphoric","deictic" (McNeill, 1992)

Gesture’s relation to thinking and speaking

- Mechanism
- Function

Mechanism

- What cognitive and linguistic factors trigger and shape gesture production?
- The Interface Hypothesis (Kita & Özyürek, 2003, JML).

Function

- How do gestures shape the gesturer’s own mental representations and processes?
- Gesture-for-Conceptualization Hypothesis (Kita, Alibali, Chu, in press, Psychological Review)
Mechanism & Function

- Theories of mechanism and function should constrain each other.

The Interface Model (Kita & Özyürek, 2003)

Two key features

- Gestures are generated from the Action Generator
- Outside of the speech production process
- Also responsible for practical actions

Speech formulation can shape gesture generation, via the conceptual-level link.

Common property of co-speech gestures and practical actions

- Chu & Kita, 2016, *Journal of Experimental Psychology: LMC*

Gesture and the Action Generator

- Gestures should exhibit properties of practical actions.
- Is gesture production affected by the affordance of referent objects?
Methods

• Participants described how to rotate one of the mugs to align the two.
• Mugs either afforded touching or not.

Speech-to-gesture influence

• Information packaging in speech shapes information packaging in gesture.
• Clausal packaging of info.
• Crosslinguistic variation (English vs. Japanese and Turkish) in the syntax of motion event expression.
  • “Rolling down”
  • Manner = Roll
  • Path = Down

Syntactic packaging of Manner and Path

• In line with linguistic typology by Talmy (1985)...
• English
  • He rolls down the street
• Turkish and Japanese
  • a. Japanese
    • korogat-te saka-o kudaru
      roll-Connective slope-Accusative descend:Present
      “(s/he) descends the slope, as (s/he) rolls.”
  • b. Turkish
    • yuvarlan-arak cadde-den iniyor
      roll-Connective street-Ablative descend:Present
      “(s/he) descends on the street, as (s/he) rolls.”
    (Kita & Özyürek, JML, 2003)

• Gestures depicting the Rolling Down Event were classified into three:
  • Manner gesture
  • Path gesture
  • Manner-Path Conflated gesture

Example: Manner-Path Conflated Gesture (English)

"He rolls down a street into a bowling alley."

Results

• English => Manner-Path Conflated gestures
• Japanese, Turkish => Manner gestures, Path gestures.

(Kita & Özyürek, JML, 2003)
Example: Manner gesture and Path gesture (Japanese)

• "As (he) somehow rotates like a ball, he rolls, descends."

(Kita & Özyürek, JML, 2003)

Example: Manner gesture and Path gesture (Turkish)

• "As it keeps rolling, it goes."

(Kita & Özyürek, JML, 2003)

The Interface Model
(Kita & Özyürek, 2003)

Function

Gesture for Conceptualization Hypothesis

(Kita, Alibali & Chu, in press, Psychological Review)

Given the assumptions about the mechanism…

• Action Generator
• Not just for speaking, but also for thinking
• Same functions for co-speech and co-thought gestures
Given the assumptions about the mechanism...

- Conceptual level linkage between gesture and speaking
- Gesture can influence conceptualisation not only for speaking, but also for thinking in general.

1. Four functions

- Gesture activates, manipulates, packages and explores spatio-motoric representations for the purpose of speaking and thinking.

2. Schematization

- Gesture schematizes information, and schematization shapes the four functions.

Gesture activates

- Gesture maintains spatio-motoric representations that are already active (e.g., de Ruiter, 1998; Wesp et al., 2001)
- Gesture generates new spatio-motoric representations and changes the content of speech or thought (e.g., Alibali & Kita, 2010).

Evidence for maintaining

- A route recall task
- Better recall when gesturing than visualising during the rehearsal period (So et al., 2014, Plos One).

Evidence for activating anew

- Gesture activates image schemas underlying linguistic metaphor.
- Metaphor allow us to understand abstract concepts based on concrete spatio-motoric imagery (Lakoff & Johnson, 1980).
- “spill the beans” = “disclose something confidential”
The question and the basic idea

- Does gesture lead to better metaphor processing?
- Especially left hand gestures, given the right-hemisphere metaphor processing?
- (Argyriou, Mohr, & Kita, in press, JEP: LMC)
- Manipulated which hand is available for spontaneous gesturing.
- Measured quality of metaphor explanation.

Scoring quality of metaphor processing

- Explain the meaning and motivation for “Spill the beans”
  - beans => secrets
  - spilling => telling
- Quality of explanation rated
  - the number and clarity of metaphoric mappings
  - 0 (worst), 1, 2 (best)

Manipulation of hands

- One hand immobilization + encouraged to gesture in the right hand and left hand condition.

Effect of gesturing

![Graph showing effect of gesturing]

Left > None, p = .007

Conclusion

- Metaphor processing is better when producing gestures.
- Only for the left hand.
- Left hand gesturing activates spatio-motoric imagery in the right hemisphere.
- This facilitates metaphor processing in the right hemisphere.

Conclusion

- Gesture activates new spatio-motoric representations, and changes the content of our thought.
Schematization

- Schematised representation is lightweight and can easily be activated.

Gesture manipulates

- Gesture helps manipulate spatio-motoric representations.

Evidence for manipulating

- Mentally manipulating spatial representation
- We investigated if gesture improves performance of mental rotation (Chu & Kita, 2011, JEP: General).

“Co-thought gestures” during a mental rotation task

- The classical mental rotation task (Shepard & Metzler, 1971), but with foot pedals.
- Participants were alone in the room, filmed by a hidden camera.

(Chu & Kita, JEP: General, 2008, 2011)

Design

- Participants solved mental rotation
  - Gesture encouraged
  - Gesture allowed (but not mentioned)
  - Gesture prohibited
  - Fixed time for thinking
  - Error rate as the DV
  - Prediction
    - Encouraged should be the best

![Graph showing performance differences between gesture conditions]

- Group difference $p < .05$
- Encouraged < Allowed, Prohibited, $p < .05$
Conclusion

- Gesture helps mentally manipulate spatial representations.

Schematization

- Representation is flexible and more open to change.
- “Light-weight” representation reduces processing load.

Gesture packages

- Gesture packages information into units that are appropriate and useful for speaking or thinking.

Evidence for Packaging

- Dutch speakers described motion events with manner and path.
- Instructed to produce
  - separate gestures for manner and path
  - conflated gestures
- Observed the syntactic structures used
  - one clause vs. two clauses

Result

- Proportion of responses

<table>
<thead>
<tr>
<th>Conflated gesture</th>
<th>Separate gesture</th>
</tr>
</thead>
<tbody>
<tr>
<td>One clause</td>
<td>0.8</td>
</tr>
<tr>
<td>Two Clauses</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Conclusion

- Gesture packages information into units useful for speaking.
Schematization

• “Stripped down” representation
• makes it easier to zero in on a relevant package of information
• reduces processing load

Gesture explores

• When solving a problem (including speaking), one needs to select the information useful for the task, among many pieces of information.
• Gesture can help explore information useful for speaking or thinking.

Evidence for exploration

• The Alternative Use Test (Guilford, 1967)
• “list all nonconventional uses of newspaper”
• More uses are generated when gesturing than not gesturing (Kirk & Lewis, in press, Psych. Sci.)

Evidence for gestural trial-and-errors

• Exploration requires trial-and-errors
• Trial-and-errors entail unsuccessful exploration
• “Abandoned gestures”
• Participants described rotation of an object.

Unsuccessful exploration

• When participants produce both abandoned and normal gestures within a trial,
• Abandoned gestures are produced earlier than normal gestures.
• Participants produced abandoned gestures more often in more difficult problems.
• Gestures are used for exploration of ideas.

Schematization

• “Light-weight” representation makes it easier to go through and evaluate possible solutions.
Summary of Functions

- Gesture activates, manipulates, packages and explores spatio-motoric representations.
- The schematic nature of representation plays a key role.
- Gesture affects our conceptualization for speaking and thinking.

Overall Conclusions

Mechanism & Functions

Mechanism

- Action generator
- Feedback from the Speech Formulator, via the Conceptualizer.

The Interface Model (Kita & Özyürek, 2003)

Functions

- Gesture-for-Conceptualization Hypothesis
  (Kita, Chu, Alibali, in press, Psych. Rev.)
Gesture….

- activates
- manipulates
- packages
- explores

Gestural representations are schematic.
- focused, light-weight and flexible.
- This nature of representation shapes the four functions.

Take home message

- Gestures, generated at the interface of action and language, shape the way we think and we speak.

Acknowledgment

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End
Other Components of the Hypothesis

- Both co-speech and co-thought gestures are generated from the process that also generates practical actions (e.g., grasping a cup to drink) (Kita, 2000; Kita & Özyürek, 2003; Hostetter & Alibali, 2008)
- Gesture shapes thinking more strongly than practical action due to schematization.

Theoretical advance

- Gesture for Conceptualization Hypothesis provides a coherent and novel account for gesture’s self-oriented functions.
- Synthesizes theoretical discussions on
  - self-oriented functions
  - mechanism of speech-gesture co-production
  - action vs. gesture
  - gestural representation (schematization)