

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

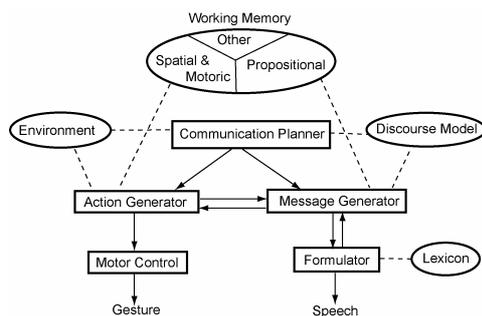
- How do gestures shape the gesturer’s own mental representations and processes?
- **Gesture-for-Conceptualization Hypothesis** (Kita, Alibali, Chu, in press, *Psychological Review*)

Mechanism & Function

- Theories of mechanism and function should constrain each other

Mechanism

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

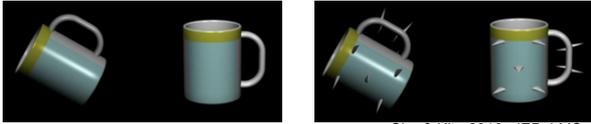
- Chu & Kita, 2016, *Journal of Experimental Psychology:LMC*

Gesture and the Action Generator

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

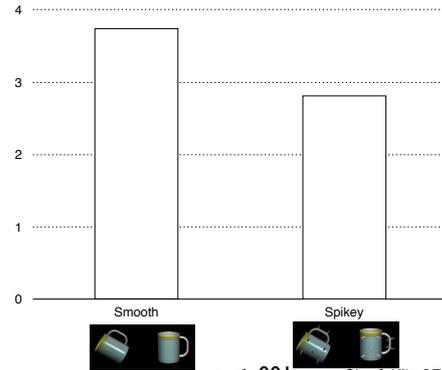
Methods

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



Chu & Kita 2016, *JEP: LMC*

Num. of gestures per min.

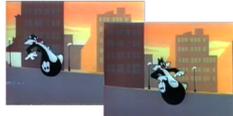


$p < .001$

Chu & Kita 2016, *JEP: LMC*

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

(Kita & Özyürek, *JML*, 2003)

Example: Manner-Path Conflated Gesture (English)

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



(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)

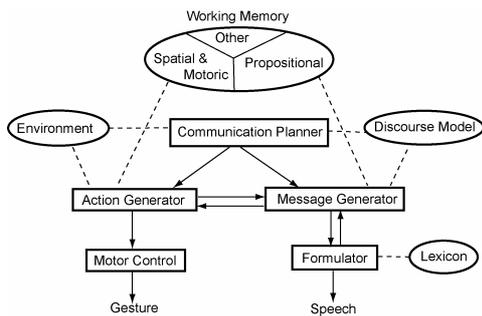
Example: Manner gesture and Path gesture (Turkish)

- "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.

I. Four functions

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

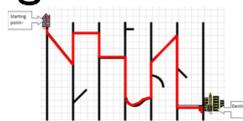
2. Schematization

- 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

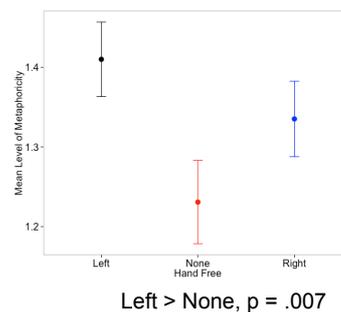
- Explain the meaning and motivation for “Spill the beans”
 - beans => secrets
 - spilling => telling
- Quality of explanation rated
 - the number and clarity of metaphorical mappings
 - 0 (worst), 1, 2 (best)

Manipulation of hands

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



Effect of gesturing



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

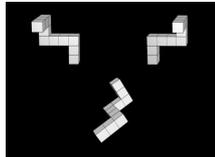
- Schematised representation is *light weight* and can easily be activated.

Gesture manipulates

- Gesture helps manipulate spatio-motoric representations.

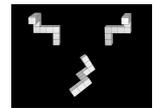
Evidence for manipulating

- 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

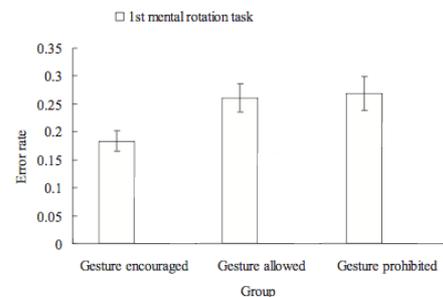
- The classical mental rotation task (Shepard & Metzler, 1971), but with foot pedals.
- Participants were alone in the room, filmed by a hidden camera.



(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



- 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.

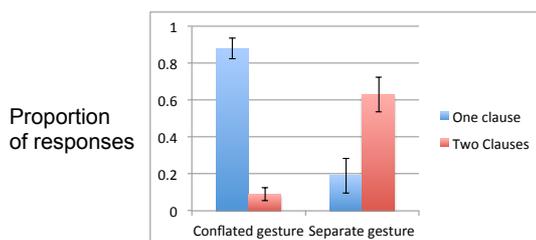
Evidence for Packaging

- 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



Mol & Kita, *Cog. Sci. Proceedings*, 2012

Result



Mol & Kita, *Cog. Sci. Proceedings*, 2012

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.

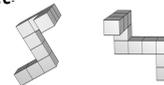
Evidence for exploration

- 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.



Kita, Chu, & Alibali, in press, *Psych Rev*

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.

Kita, Chu, & Alibali, in press, *Psych. Rev.*

Schematization

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

Summary of Functions

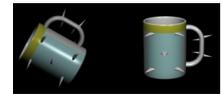
- Gesture activates, manipulates, packages and explores spatio-motoric representations.
- The schematic nature of representation plays a key role.
- Gesture affects our conceptualization for speaking and thinking.

Overall Conclusions

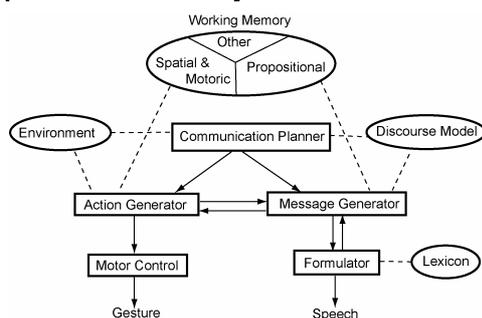
Mechanism & Functions

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

- Asli Özyürek
- Martha Alibali
- Mingyuan Chu

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)