Architectural issue in the model of speech-gesture production: Gesture, Action Language

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(Univ. of Warwick, as of August 2013)

Co-speech gesture

- When we speak, we often spontaneously gesture.

- Where there is speech, there is gesture
  - When talking on the phone.
  - No report of a culture without gesture.
  - Infants in the one-word stage (e.g., Iverson & Goldin-Meadow, 2005)
  - Congenitally blind children (Iverson & Goldin-Meadow, 1997).

- How are speech production and gesture production related?

Representational gestures

- There are different types of gestures.

- "Representational gestures"
  - They refer to objects and events, based on iconicity ("depicting") and abstract deixis ("pointing")

Issues concerning speech-gesture production

- How are contents of gestures determined?
  - The role of speech production
- What process generates gesture?
- How are speech and gesture synchronised with each other?
- What are cognitive consequences of gesture production?

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Cognitive Consequences

- The "Information Packaging Hypothesis" (Kita, 2000)
- Representational gesture activates, manipulation, explore and packages spatio-motoric information into units suitable for speaking (Alibali, Kita & Young, 2000; Alibali & Kita, 2010; Chu & Kita, 2011).

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Gestural Contents & Gesture generation

- Gestural contents are determined by various processes.

- What process generates gestures.

- The "Interface Model"
  - Kita & Özyürek, 2003

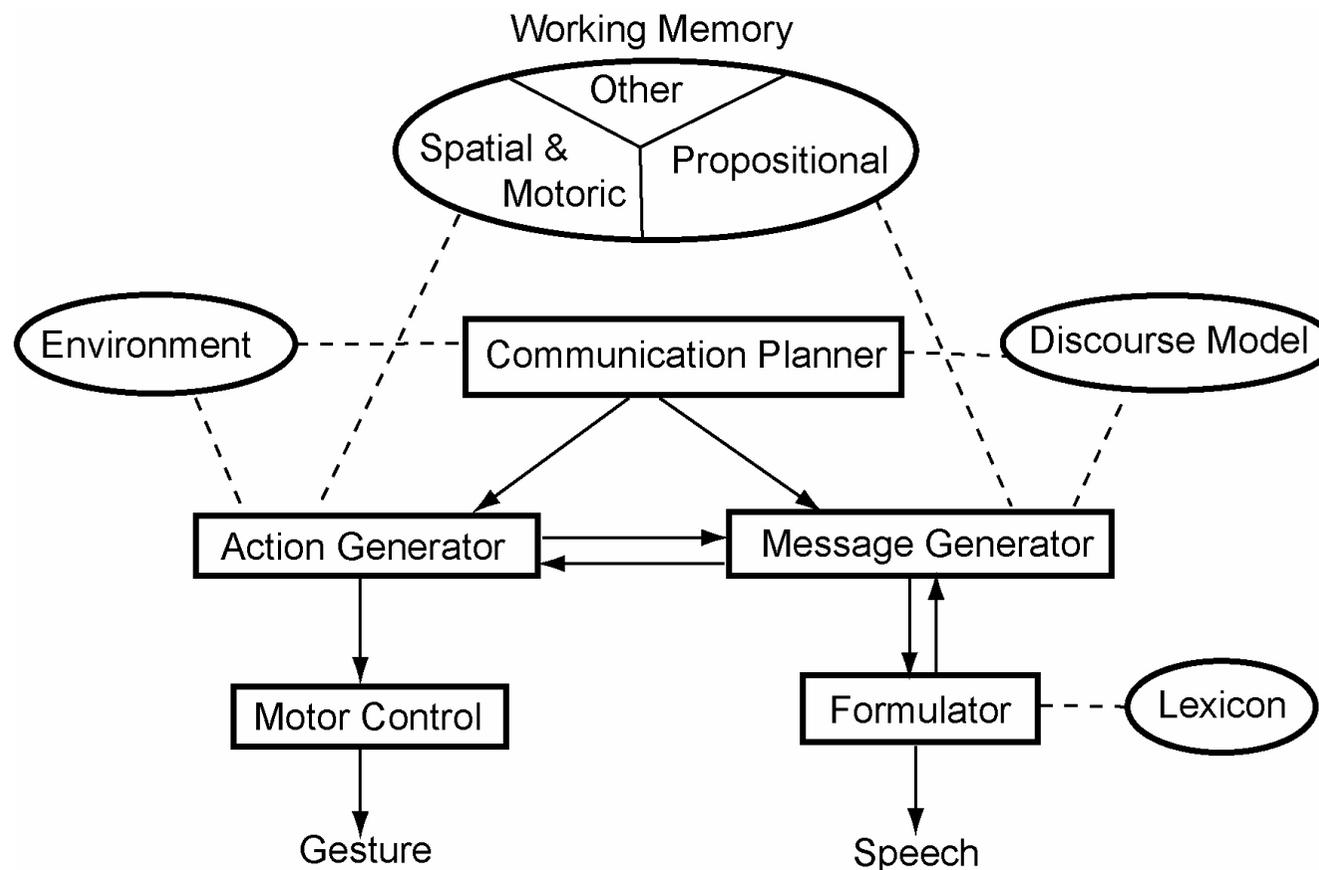# The Interface Model (Kita & Özyürek, 2003)
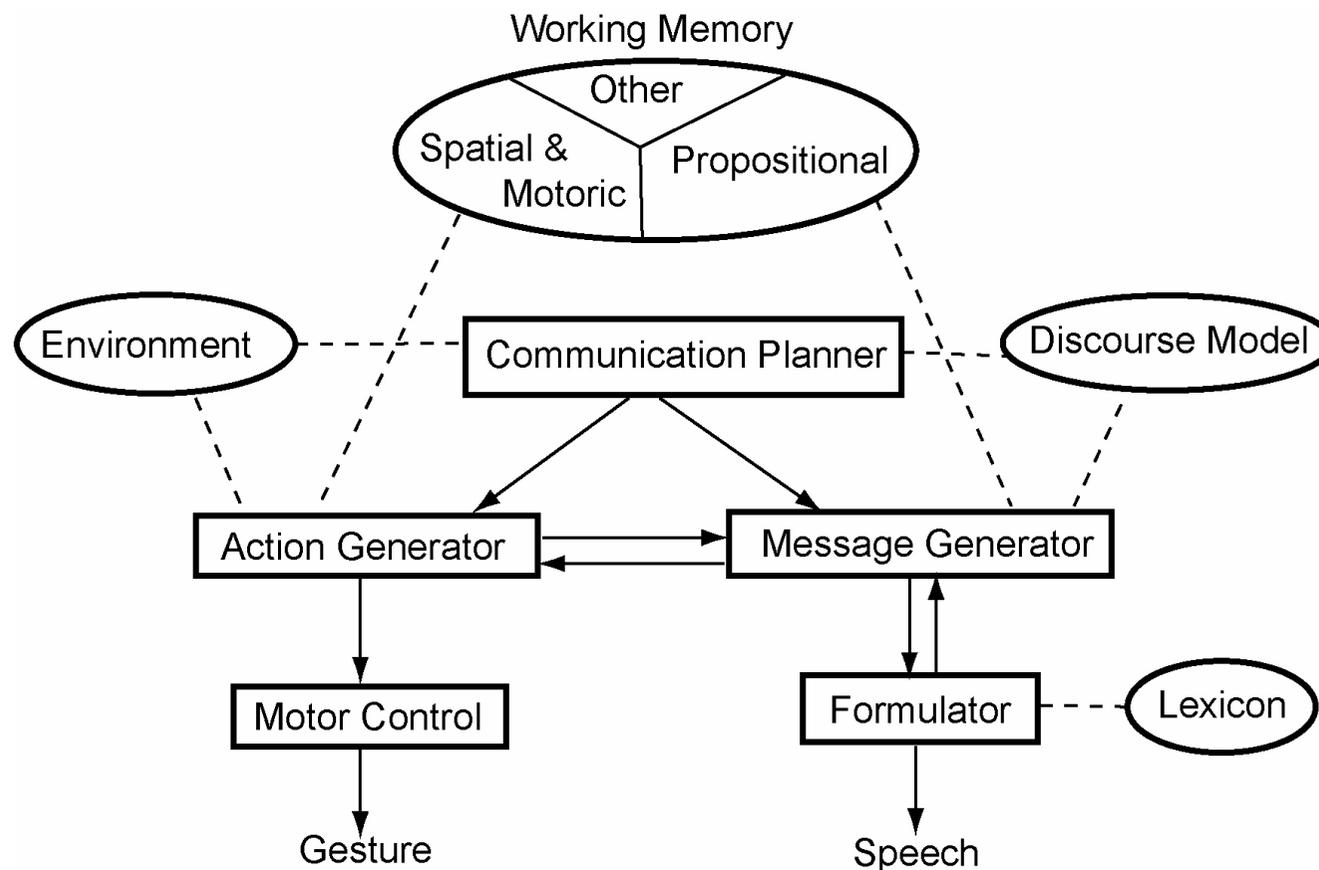
Two key features

- Representational gestures are generated from the Action Generator

  - Outside of the speech production process

  - Also responsible for practical actions

- Bidirectional links among the Action Generator, Message Generator, Formulator.

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Bi-directional links

Speech-to-gesture influence

- Kita & Özyürek, 2003, *Journal of Memory and Language*

The Interface Model (Kita & Özyürek, 2003)

Working Memory

Other

Spatial & Motoric

Propositional

Environment

Communication Planner

Discourse Model

Action Generator

Message Generator

Motor Control

Formulator

Lexicon

Gesture

Speech

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. <u>Japanese</u>
    - korogat-te   saka-o   kudaru
      roll-Connective slope-Accusative descend:Present
      "(s/he) descends the slope, as (s/he) rolls."
  - b. <u>Turkish</u>
    - yuvarlan-arak   cadde-den   iniyor
      roll-Connective   street-Ablative descend:Present
      "(s/he) descends on the street, as (s/he) rolls."

(Kita & Özyürek, *Journal of Memory and Language*, 2003)

Cross-linguistic difference in gesture

- 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, *Journal of Memory and Language*, 2003)

Example: Manner-Path Conflated Gesture (English)

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

Example: Manner gesture and Path gesture (Japanese)

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

(Kita & Özyürek, *Journal of Memory and Language*, 2003)

Example: Manner gesture and Path gesture (Turkish)

- "As it keeps rolling, it goes."

(Kita & Özyürek, *Journal of Memory and Language*, 2003)

- Gestural representation is shaped by the on-line interaction with the speech formulation process.

Kita & Özyürek, 2003
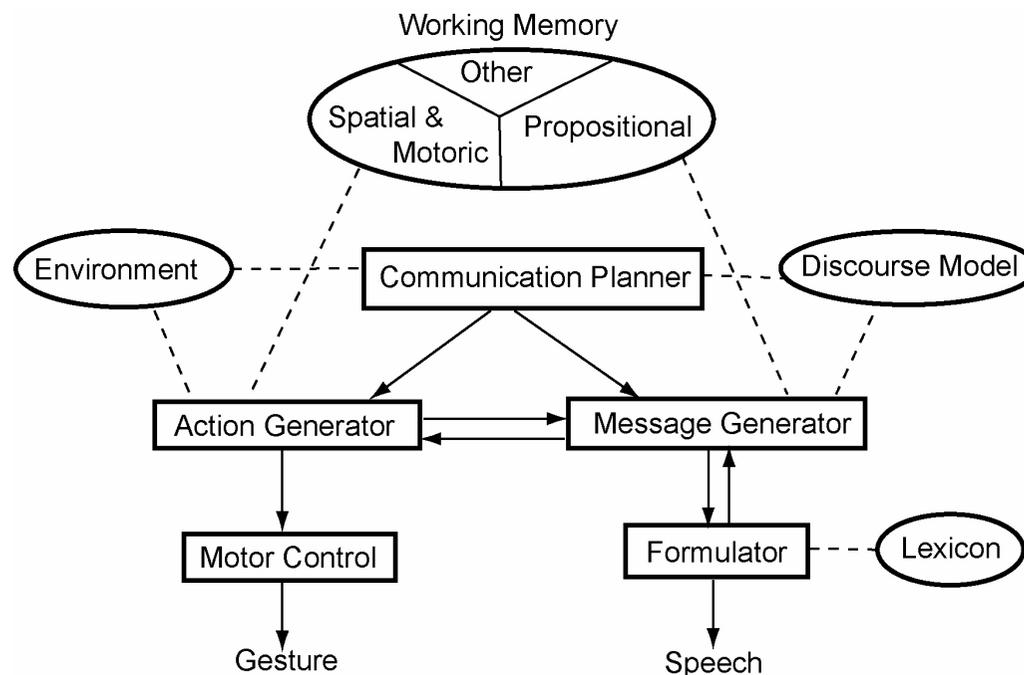
Gesture-to-speech influence

- Mol & Kita, 2012, *Cognitive Science Proceedings*

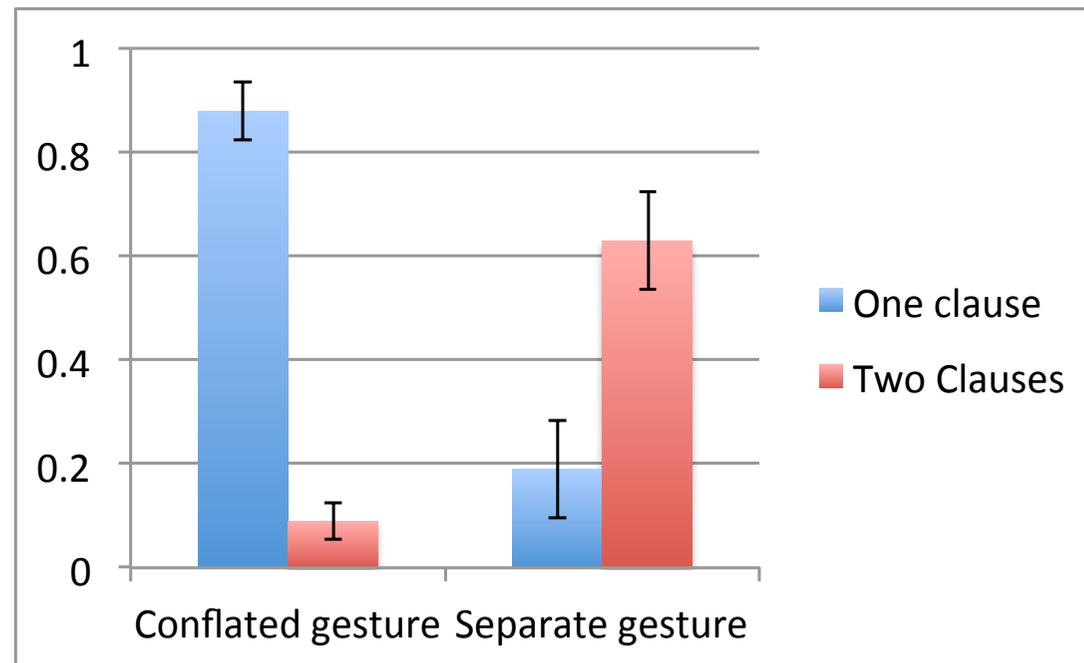- Information packaging in gesture shapes information packaging in speech.

Methods
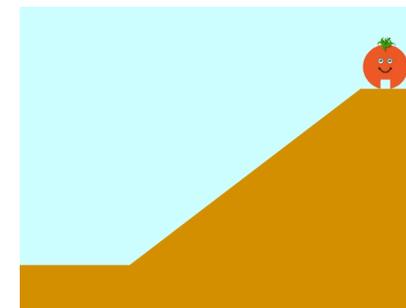
- Dutch speakers described motion events with manner and path.

- 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

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

Conclusion

- Bidirectional links between Action Generator, Message Generator, and Formulator.

- No other models account for these findings.
  - Sketch Model (de Ruiter 2000)
  - Image Maintenance Hypo. (de Ruiter, 1998; Wesp et al. 2001)
  - Lexical Retrieval Hypo. (Rauscher, et al., 1998)
  - Lightening Load Hypo. (Goldin-Meadow, et al. 2001)

The Interface Model (Kita & Özyürek, 2003)
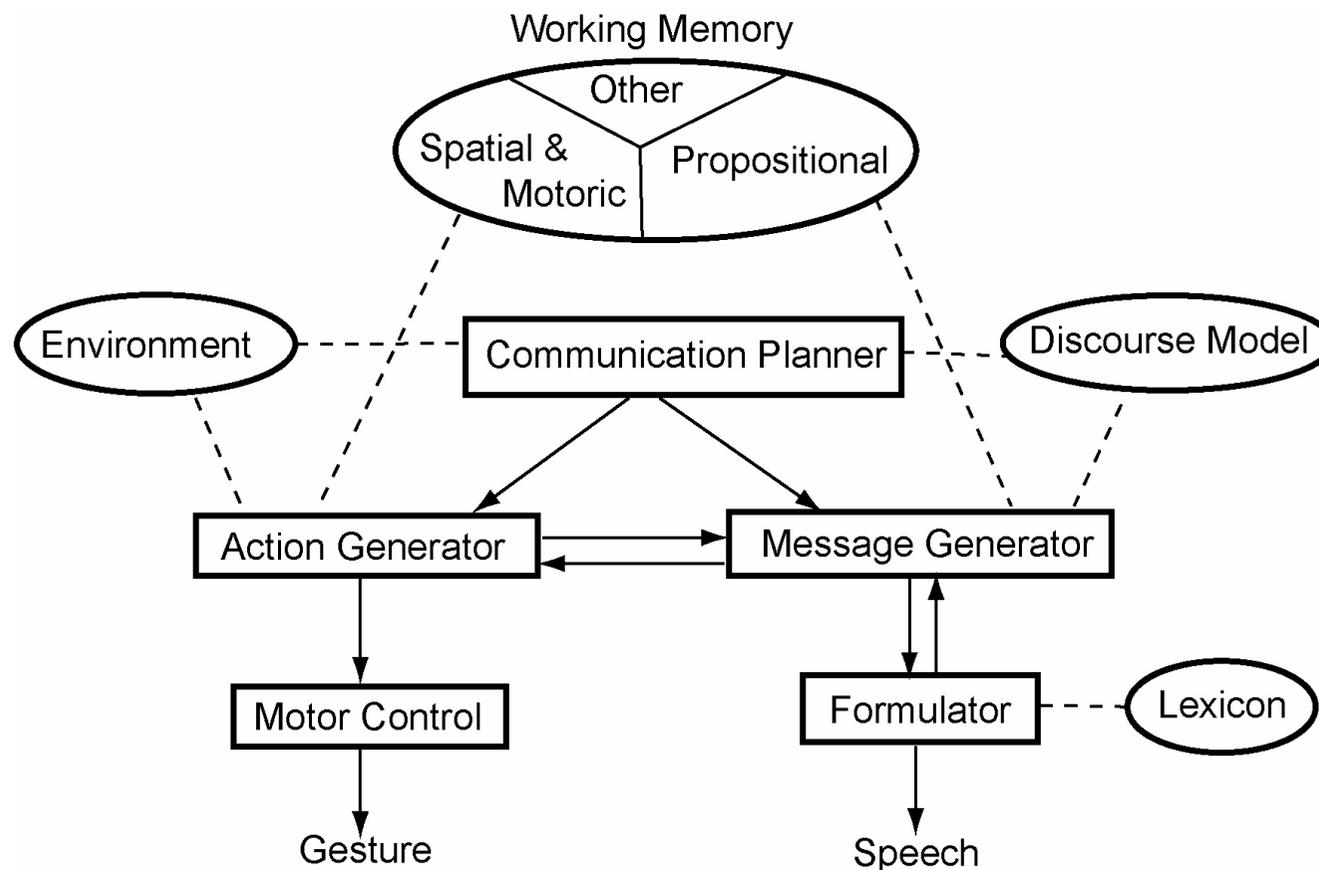
Gestures are generated from the Action Generator

The Interface Model (Kita & Özyürek, 2003)
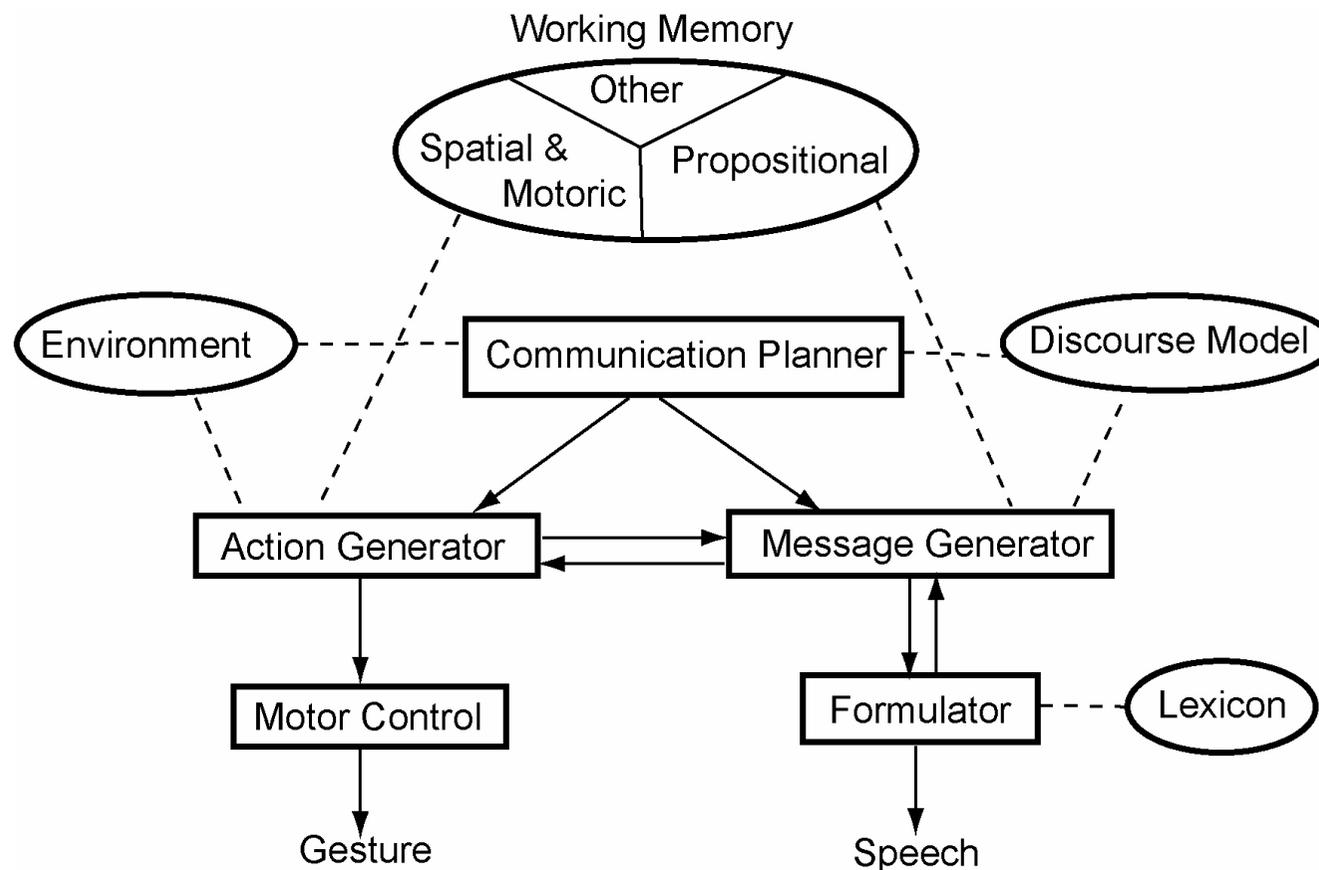
# Common property of co-speech gestures and practical actions

- Chu & Kita, in prep
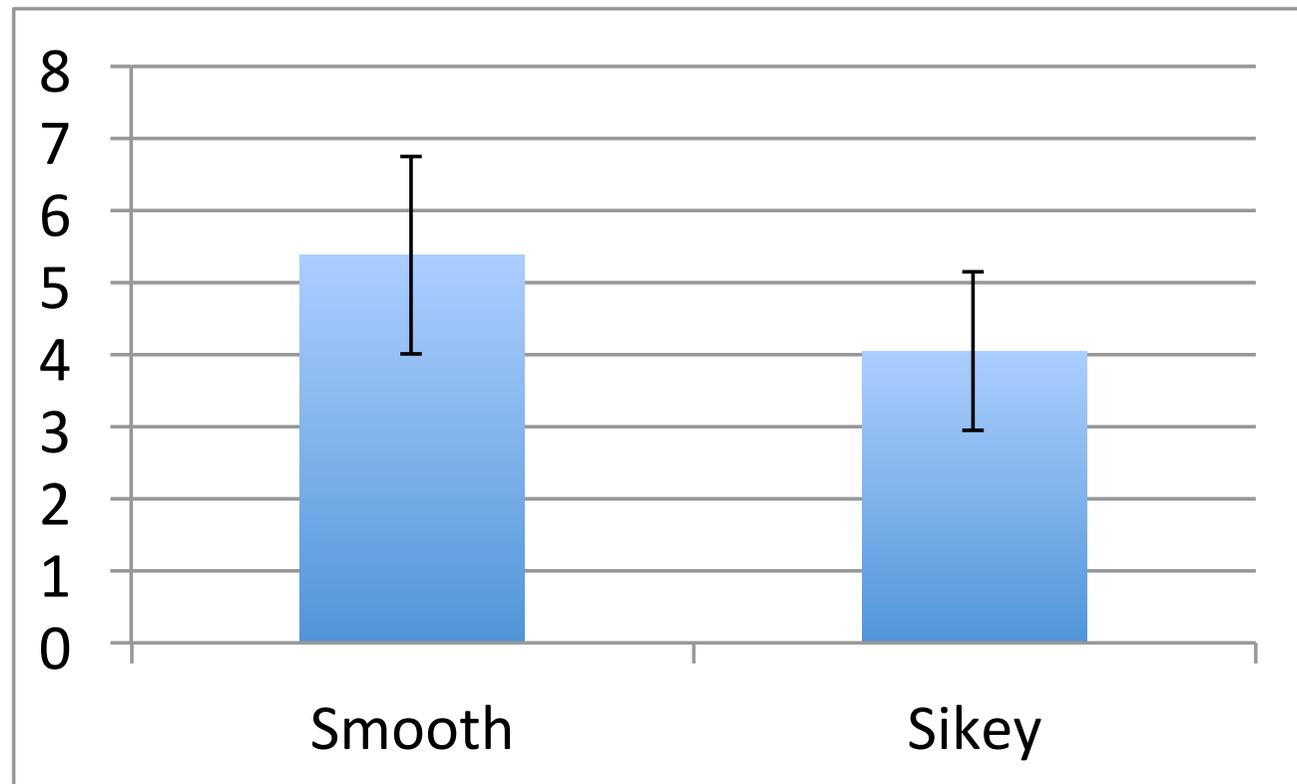
Gesture and practical action

- If gestures are generated from the Action Generator, then 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.
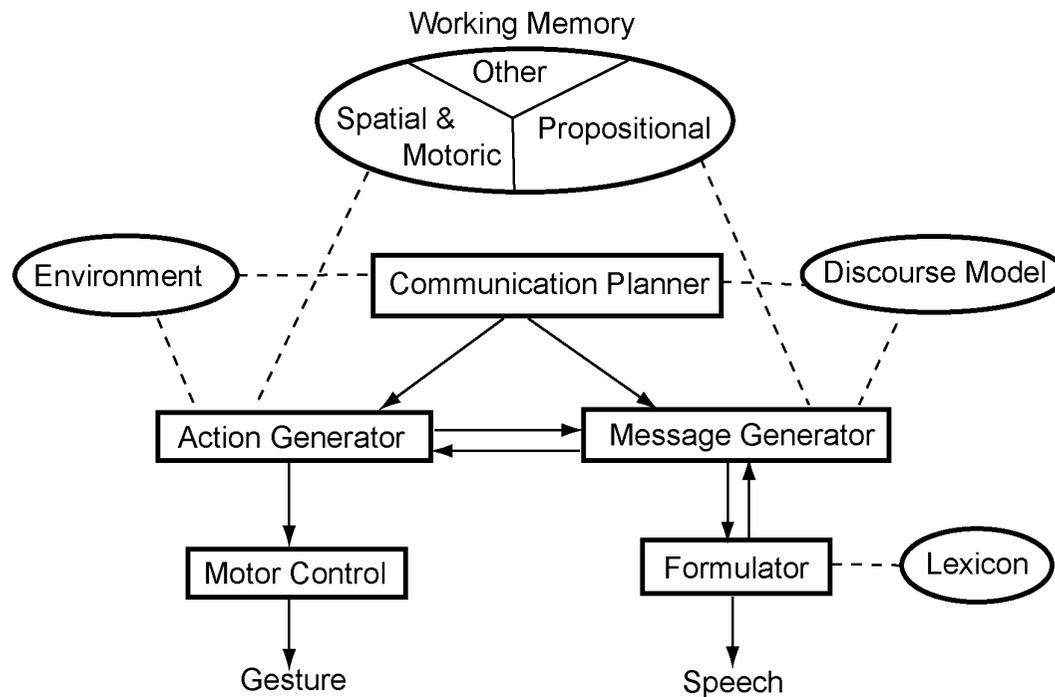
- Mugs either afforded touching or not.
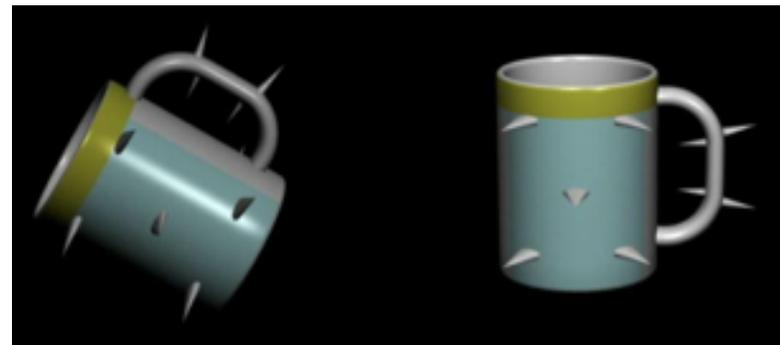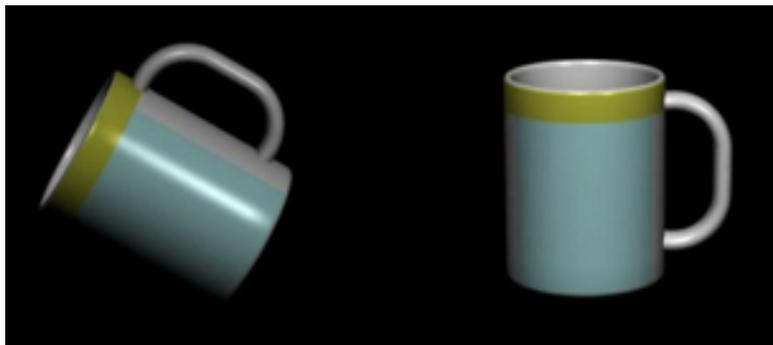
Num. of representatio nal gestures per 100 words

Smooth   Sikey

Chu & Kita in prep

- Similarly to practical action, objects that afford actions elicit more representational gestures.

The Interface Model (Kita & Özyürek, 2003)

Neuroanatomical independence between co-speech gesture production and speech production

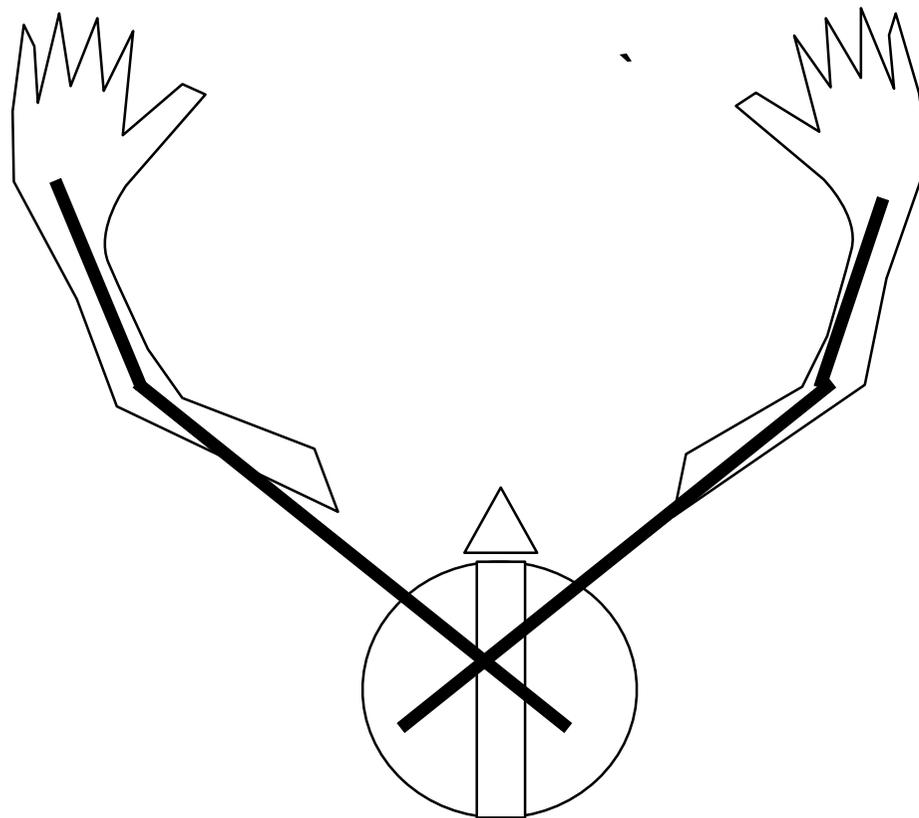- Kita & Lausberg (2008). *Cortex*.

- If Action Generator generates co-speech gestures, then co-speech gestures should be generated by different brain areas from speech production areas.

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Split brain patients

- In split-brain patients, the corpus callosum, which connects cortices of the left and right hemispheres, is surgically severed.

- This allows us to infer the hemisphere that has generated a gesture from the hand that is used.
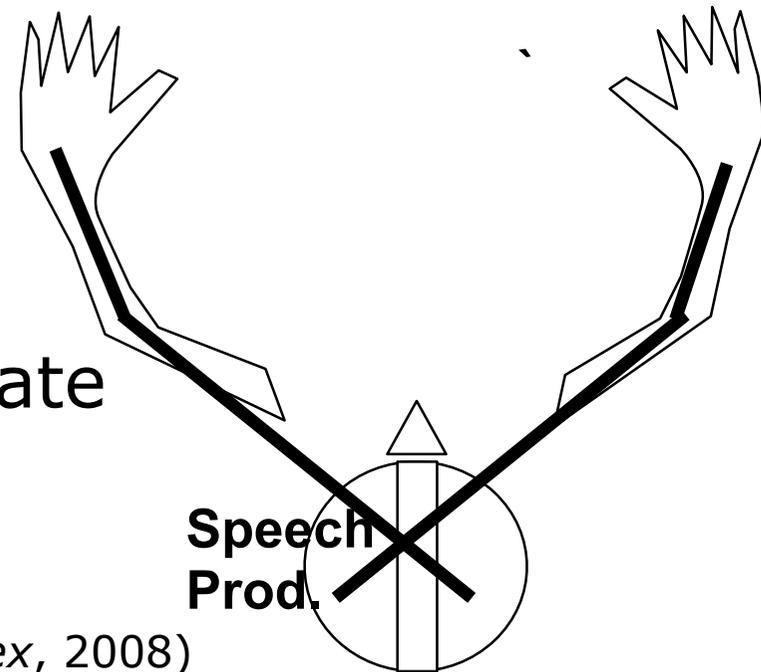
(Kita & Lausberg, *Cortex*, 2008)

- The hands are innervated by the contra-lateral hemisphere.

Question

- In a large majority of right handers, the left hemisphere produces speech.

- Can the right hemisphere (without speech production abilities) alone generate representational gestures?

**Speech Prod.**

(Kita & Lausberg, *Cortex*, 2008)

Method: Participants

- 2 split-brain patients: NG, AA
  - The Vogel & Bogen patients.
  - Right handed

- AA and NG have left-hemisphere language dominance (e.g., Zaidel et al. 2003), and shows no evidence for the right-hemisphere speech production.

(Kita & Lausberg, *Cortex*, 2008)

Method

- The participants verbally described animated cartoons to the experimenter.
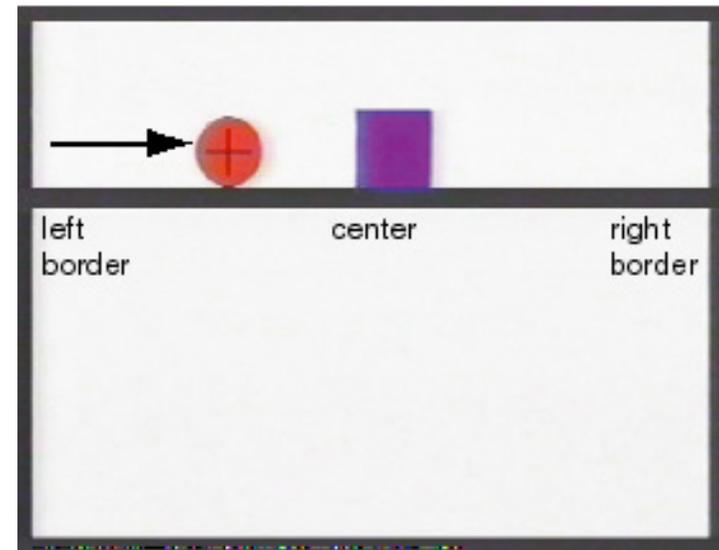
(Kita & Lausberg, *Cortex*, 2008)

Hand choice for their co-speech gestures

- Total number of gestures produced

	Left hand	Right hand
AA	44	36
NG	12	157

(Kita & Lausberg, *Cortex*, 2008)

Conclusion

- The right hemisphere alone can generate representational gestures even in the patients with left-hemisphere language.

(Kita & Lausberg, *Cortex*, 2008)

Discussion

- NG and AA's co-speech gestures with the left hand could not have arisen from a process embedded in the speech production process.

Gesture generation by the Action Generator

- Not compatible with models that assume co-speech gestures are produced within the speech-production process.
    - Sketch Model (de Ruiter, 2000)
    - Butterworth and Hadar (1989)
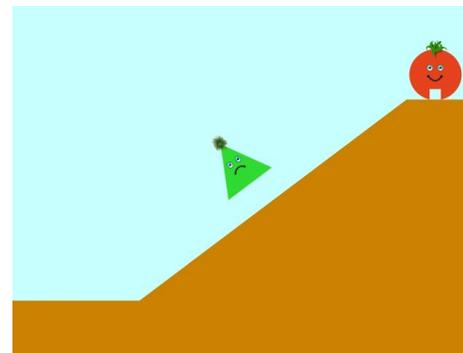
Overall Conclusions

Bidirectional links

- Gesture production processes are interlinked with speech production processes.
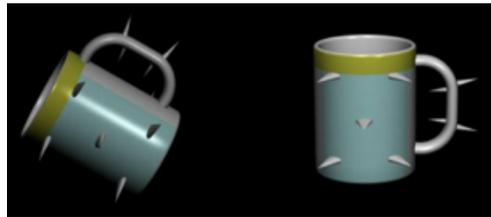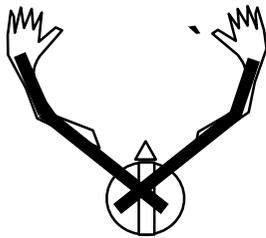
S to G
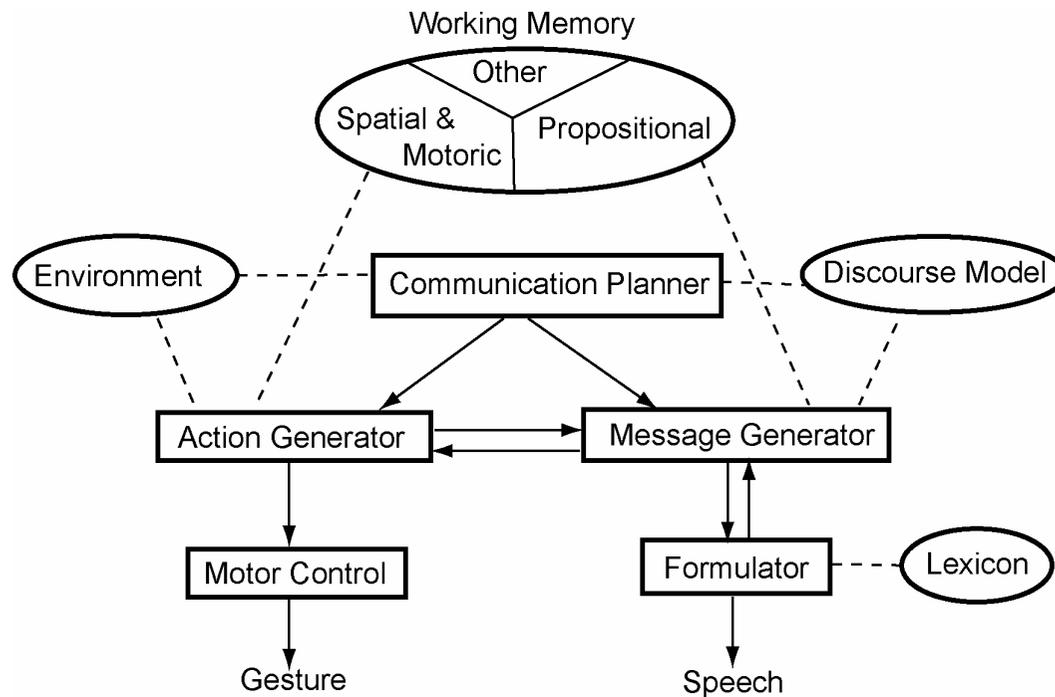
G to S

Gesture generation from the Action Generator

- Gestures and practical actions share sensitivity to object affordance.

- The right-hemisphere without speech production capabilities alone can generate co-speech gestures.

The Interface Model (Kita & Özyürek, 2003)

New development on self-oriented functions

- Gestures *activate* and *manipulate* spatio-motoric information

  - Piagetian Conservation explanation, Alibali & Kita (2010), *Gesture*

  - Problem solving, Alibali, Spencer, Knox, & Kita (2011), *Psychological Science*

  - Mental rotation, Chu & Kita (2012), *JEP: General*

- More than just maintaining imagery

  - de Ruiter, 1998; Wesp et al., 2001).

- Gestures activate processes in the contra-lateral hemisphere (Argyriou & Kita, in press, *Cog Sci Proceedings; TIGER 2013 Proceedings*).

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Relation between production and comprehension

- Relevant questions
  - Is the Action Generator involved in gesture comprehension?
    - Mirror Neuron System
  - Is the Message Generator involved in speech comprehension?
- If they are involved in comprehension, then Kita & Özyürek 2003 model can be good base for a comprehension model.

Take home points

- Bidirectional links among the Action Generator, Message Generator, Formulator.

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

Acknowledgement

- Asli Özyürek
- Martha Alibali

- Mingyuan Chu
- Lisette Mol
- Hedda Lausberg

- NSF (USA)
- Max Planck Institute for Psycholinguistics (Germany, the Netherlands)
- DFG (Germany)
- ESRC (UK)

End

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