GAME-BASED LANGUAGE TUTORING: A CASE STUDY FOR COLOUR

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http://arti.vub.ac.be/~katrien/bcn-game-based-tutoring.pdf

OUTLINE

1. Language games in artificial agents
   - Definition and use
   - Implementation: conceptualization, grammar and learning
2. Language games for tutoring purposes
   - Demonstration and preliminary evaluation

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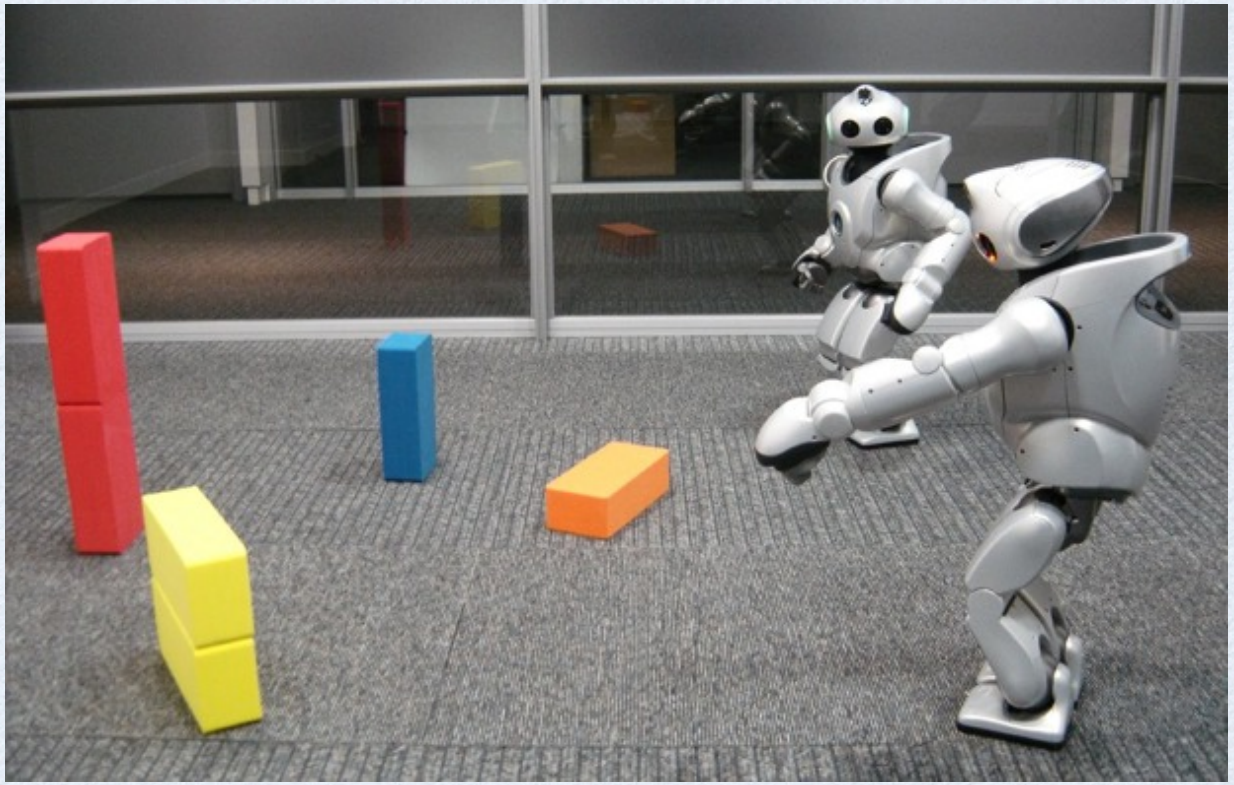
LANGUAGE GAME

Father: Could I have some more water?
Mother: ... *hands over the wine*
Father: No, water please.
Mother: Sparkling?
Father: Yes.
Mother: ... *pours him some water*
Father: Thanks.

LANGUAGE GAME

Robot-1: The yellow block.
Robot-2: *... points to the orange block.*
Robot-1: No *... points to the yellow block.*
Robot-2: The yellow block.



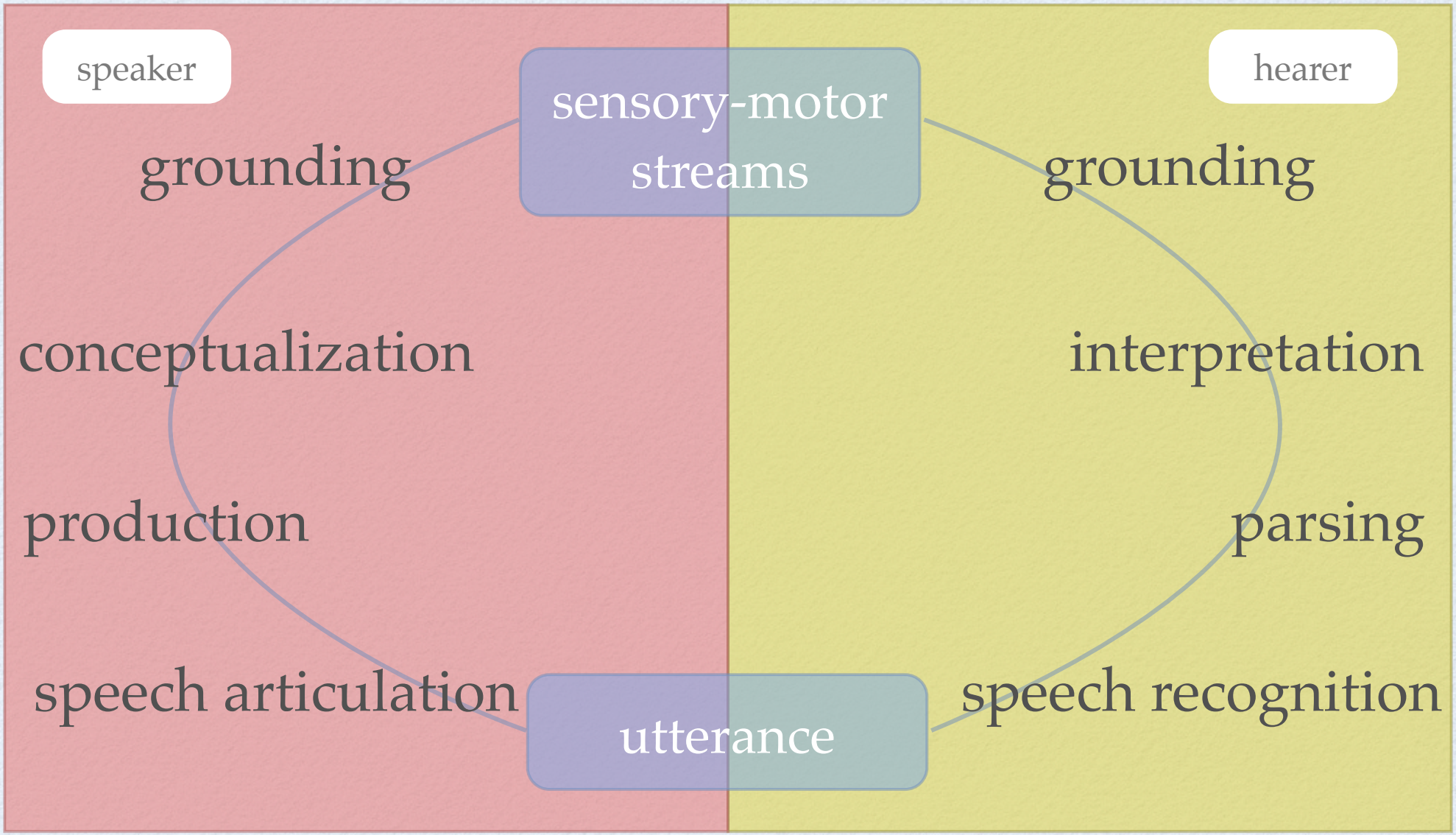
PROPERTIES

- At least two individuals from a community (recurrent interaction)
- Common goal as part of situated cooperative actions
- Common ground
- Routinised interaction pattern (script)
- Interaction involves symbols but also gestures and actions

WHY?

- Captures communication as primary function of language
- Allows addressing issues of **meaning**
- Incorporates issues of **context**
- Language conventions are game/context dependent, not absolute
- Useful to isolate one specific aspect of language

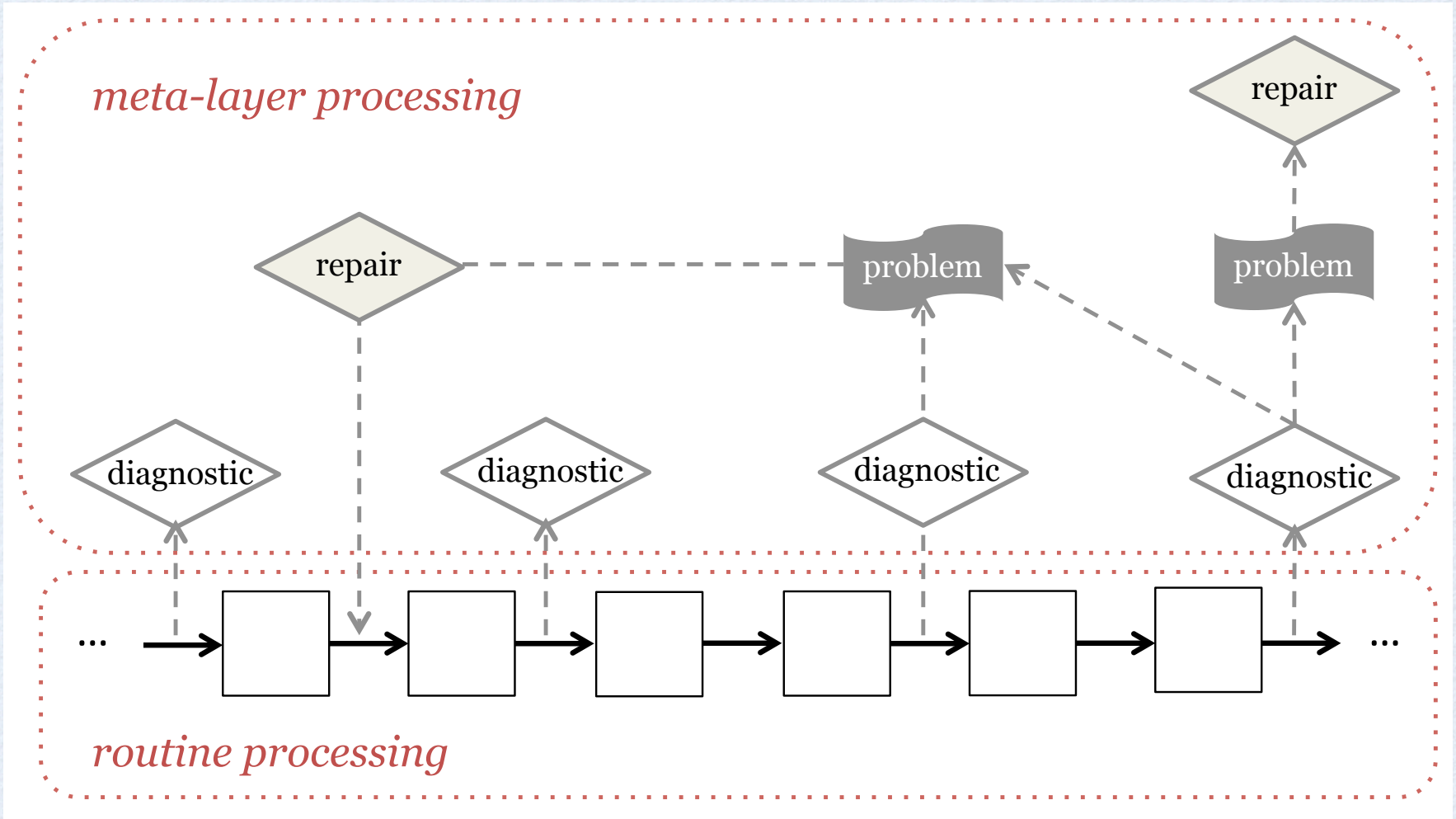
SEMIOTIC CYCLE



BABEL 2

- Operationalization of processes in semiotic circle
- Connection between our core technologies Fluid Construction Grammar (FCG) and Incremental Recruitment Language (IRL) with mechanisms for:
  - multi-agent interactions
  - robotic embodiment
  - cognitive processing
  - learning
- Extensive monitoring system

LEARNING


meta-layer processing
repair
repair
problem
problem
diagnostic
diagnostic
diagnostic
diagnostic
...
...
routine processing

TUTORING GAMES

- Human = tutor; agent = learner
- Both can be speaker or hearer
- Human can mediate the flow of the game (select topic, give feedback)
- Reversed tutoring roles possible (human as a learner)

INTERACTION SCRIPT

1. Human selects one object in the context
2. Human finds distinctive category for the object and names it
3. Agent looks up category name in memory and examines context to find corresponding object
4. Agent signals intended object
5. Human evaluates choice: failure/success

COLOUR DEMO

Start the game

CONCEPTUALIZATION

- RGB colour chip mapped in CIE *L*a*b** space
- One nearest-neighbour classification to find category
- New name => new category [Xu, 2002]

Fei Xu. The role of language in acquiring object concepts in infancy. *Cognition,* 85:223 - 250, 2002.

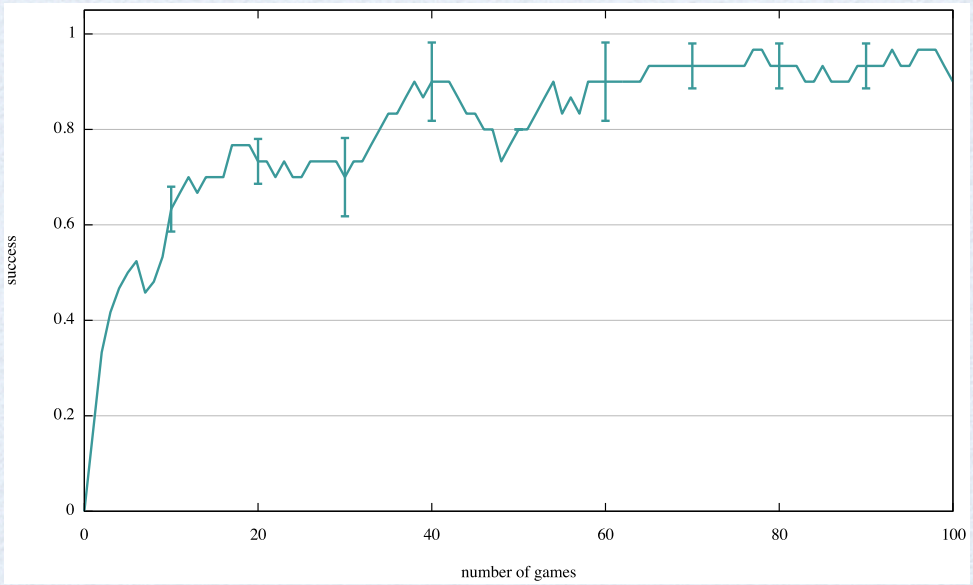
Alignment

- Update colour category at the end of each successful interaction
- Shift existing prototype in direction of colour chip values
- Colour alignment rate specifies new location of protoype (c_{n+1}) linearly between old location (c_n) and topic (t):

$$c_{n+1} = (1 - r_a)c_n + r_a t$$

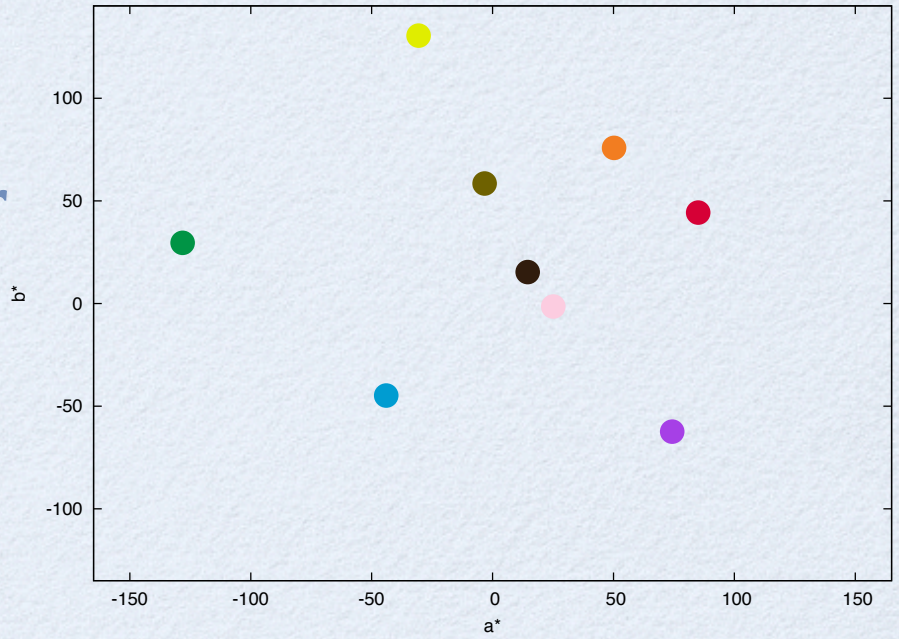
COMMUNICATIVE SUCCESS

- 1 or 0 at the end of the game; measure averaged over 10 games
- Reaches > 80% after 50 games



COLOUR PROTOTYPES

- Positions of colour prototypes after 100 games in CIE *L*a*b** space
- Two basic colour terms uncovered: white and grey
- German speaking tutor



DISCUSSION

- Previous study [Belpaeme and Bleys, 2009] has shown that pre-programmed agents can consistently name 83% of colour chips
- 90% correctly named chips in CTG
- **BUT**! Human tutor can avoid difficult chips => measure reflects similarity in human + agent categories

FUTURE WORK

- Evaluation of the system
- Extension to other domains:
  - Convert existing language game experiments: quantifiers [Pauw and Hilferty 2011], case systems [van Trijp, 2011], spatial language [Spranger et al., 2010]

Simon Pauw and Joseph Hilferty. The Emergence of Quantification. In Luc Steels, editor, *Experiments in Language Evolution.* John Benjamins, Amsterdam, in press.
Remi van Trijp. The Emergence of a Case Grammar. In Luc Steels, editor, *Experiments in Language Evolution.* John Benjamins, Amsterdam, in press.
Michael Spranger, Simon Pauw and Martin Loetzsch. Open-ended Semantics co-evolving with Spatial Language. In *Proceedings of EVOLANG 8*, 2010.

THANK YOU!

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