ÉCOLE POLYTECHNIQUE
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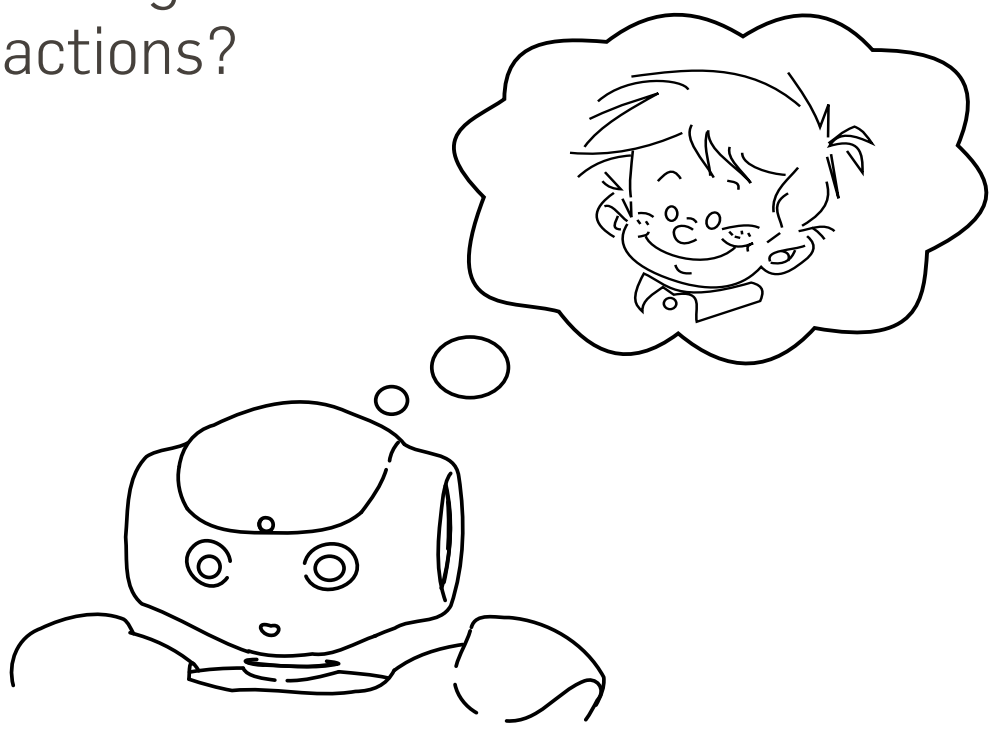
Mutual Modelling in Educational Child-Robot Interaction

Does a second level of modelling enable higher quality interactions?

EDRS candidacy exam



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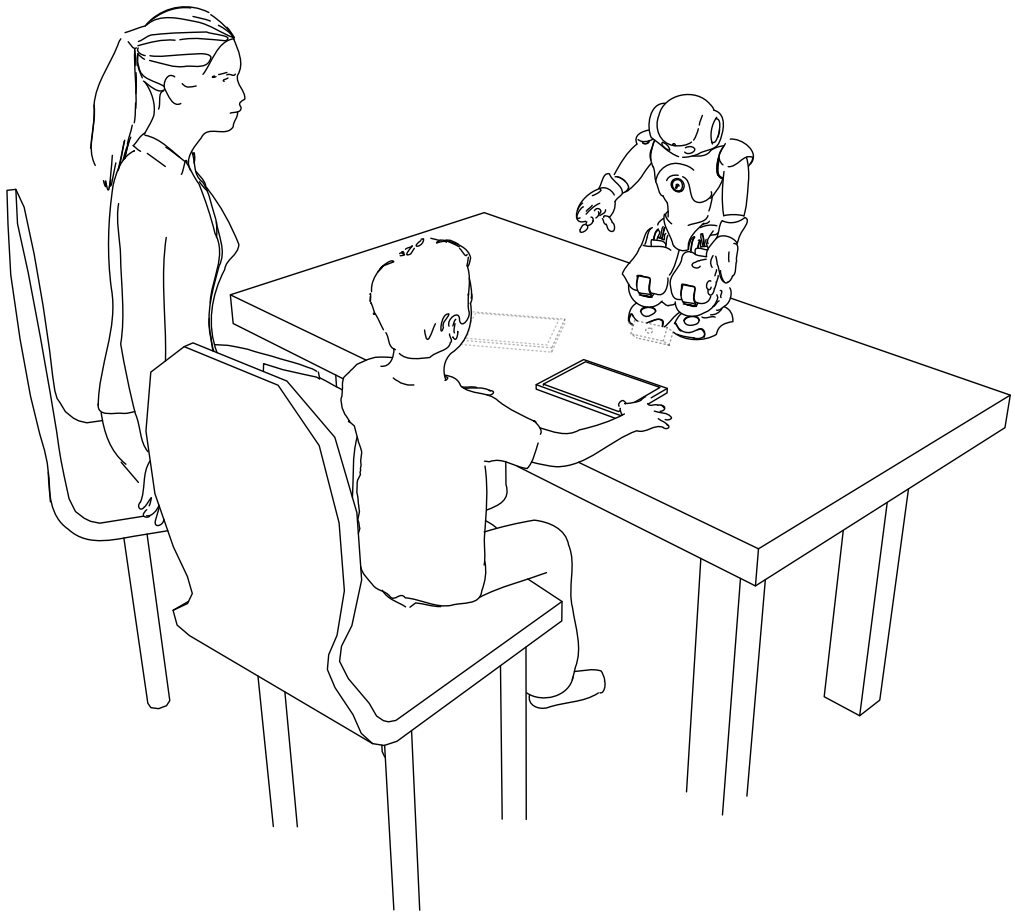
University of Lisbon

INTRODUCTION

THE COWRITER ACTIVITY



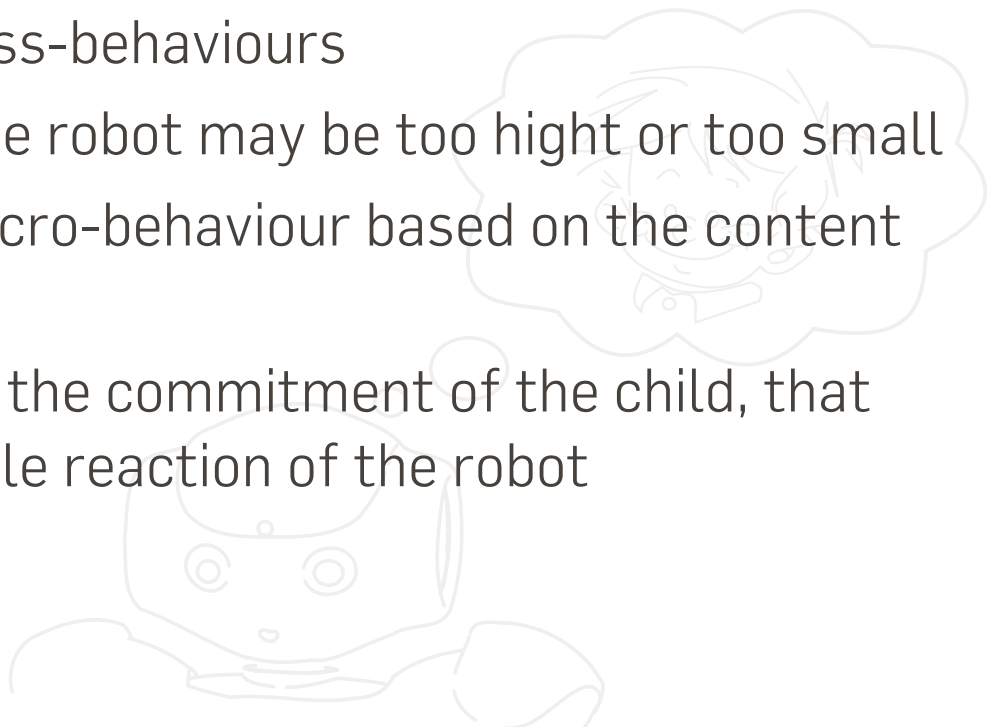
HENRY INTERACTING WITH NAO

[1] Jacq, A., Lemaignan, S., Garcia, F., Dillenbourg, P., Paiva, A. Building Successful Long Child-Robot Interactions in a Learning Context HRI 2016

LIMITS

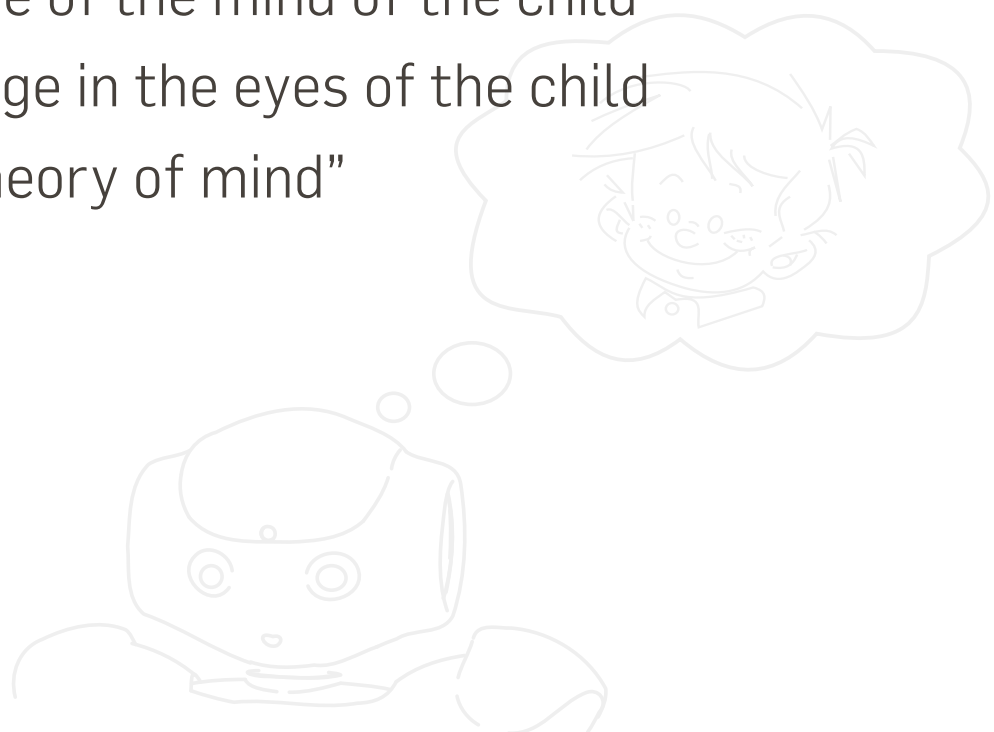
We don't know if the child understand exactly what we want him to understand.

- The robot needs to be able to show that he did not understood eventual miss-behaviours
- The learning speed of the robot may be too hight or too small
- The robot could have micro-behaviour based on the content of the interaction
- Sometimes we can lose the commitment of the child, that could be solve by a simple reaction of the robot



LIMITS

- The robot must be aware of the mind of the child
- It must react to his image in the eyes of the child
- It needs an “artificial theory of mind”



MUTUAL MODELLING IN HRI

LEVEL 1

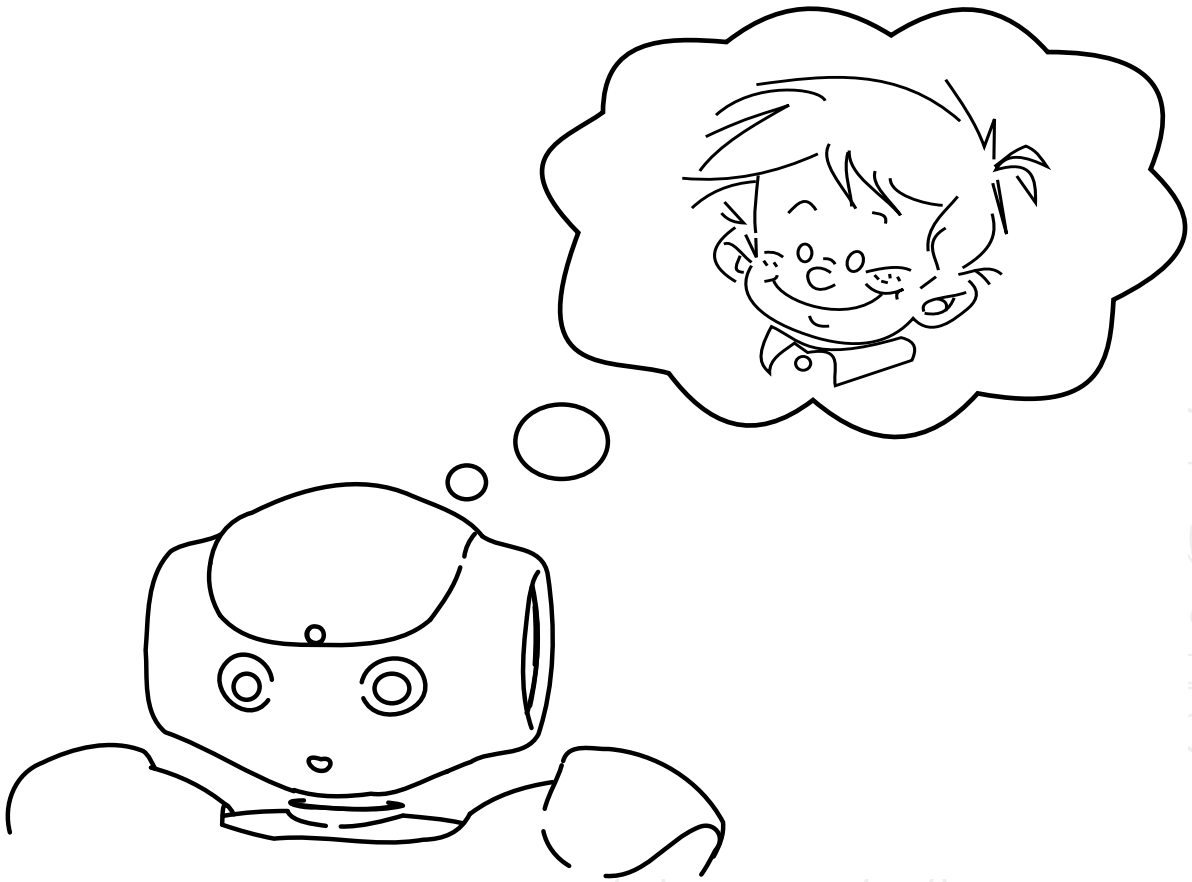


Figure: The robot building a model of the child: a first level of mutual modelling.

LEVEL 2

Figure: The robot building a model of itself perceived by the child: a second level of mutual modelling.

FRAMEWORK

NOTATIONS

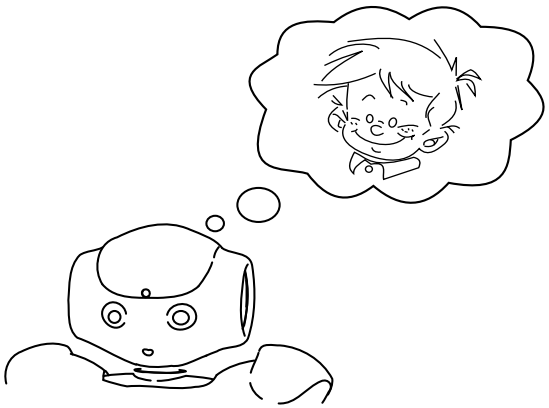


Figure: M_C (1st level)

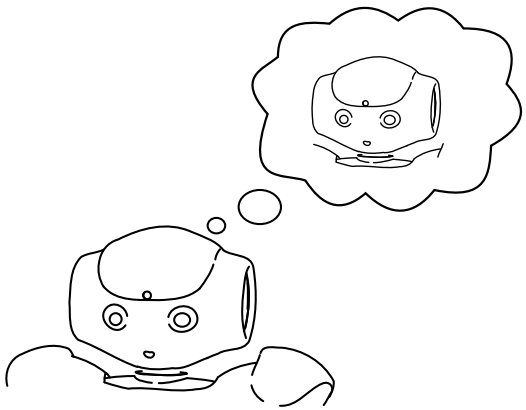


Figure: M_R (1st level)

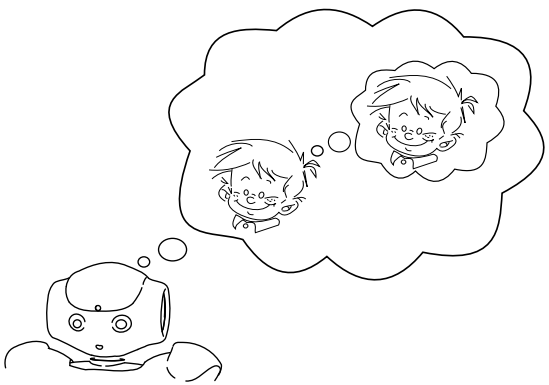


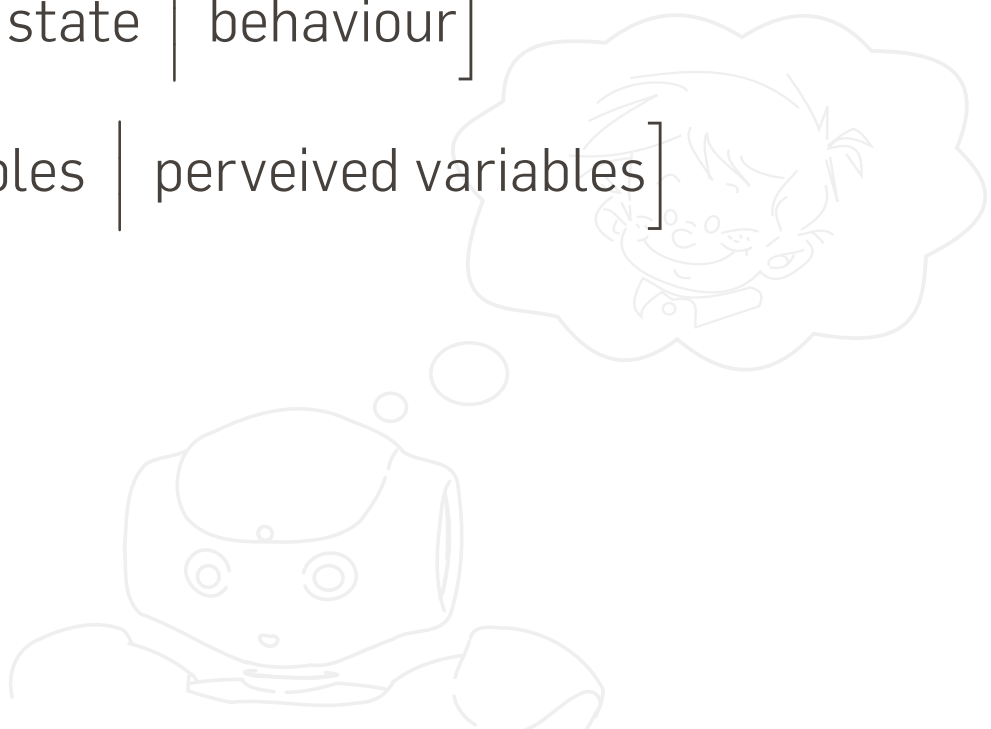
Figure: $M_{C,C}$ (2nd level)

Figure: $M_{C,R}$ (2nd level)

EXPECTED CAUSALITIES

$$\mathbb{P}\left[\text{mental state} \,\middle|\, \text{behaviour}\right]$$

$$\mathbb{P}\left[\text{abstract variables} \,\middle|\, \text{perveived variables}\right]$$



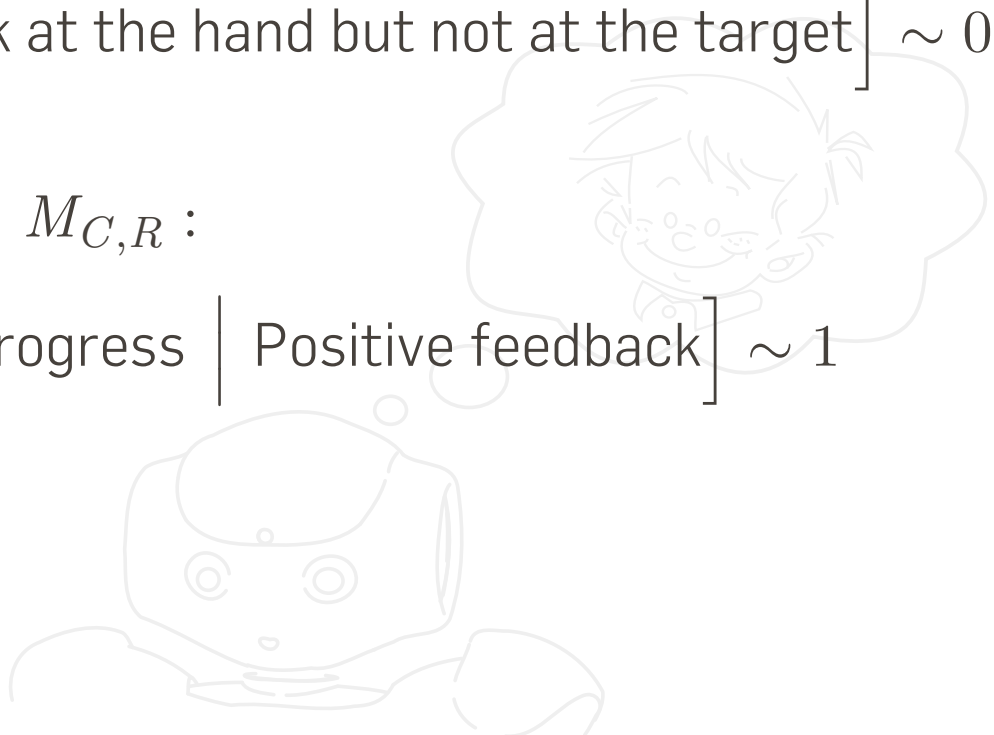
EXPECTED CAUSALITIES

$$M_C :$$

$$\mathbb{P}\left[\text{Understand pointing} \,\middle|\, \text{look at the hand but not at the target}\right] \sim 0$$

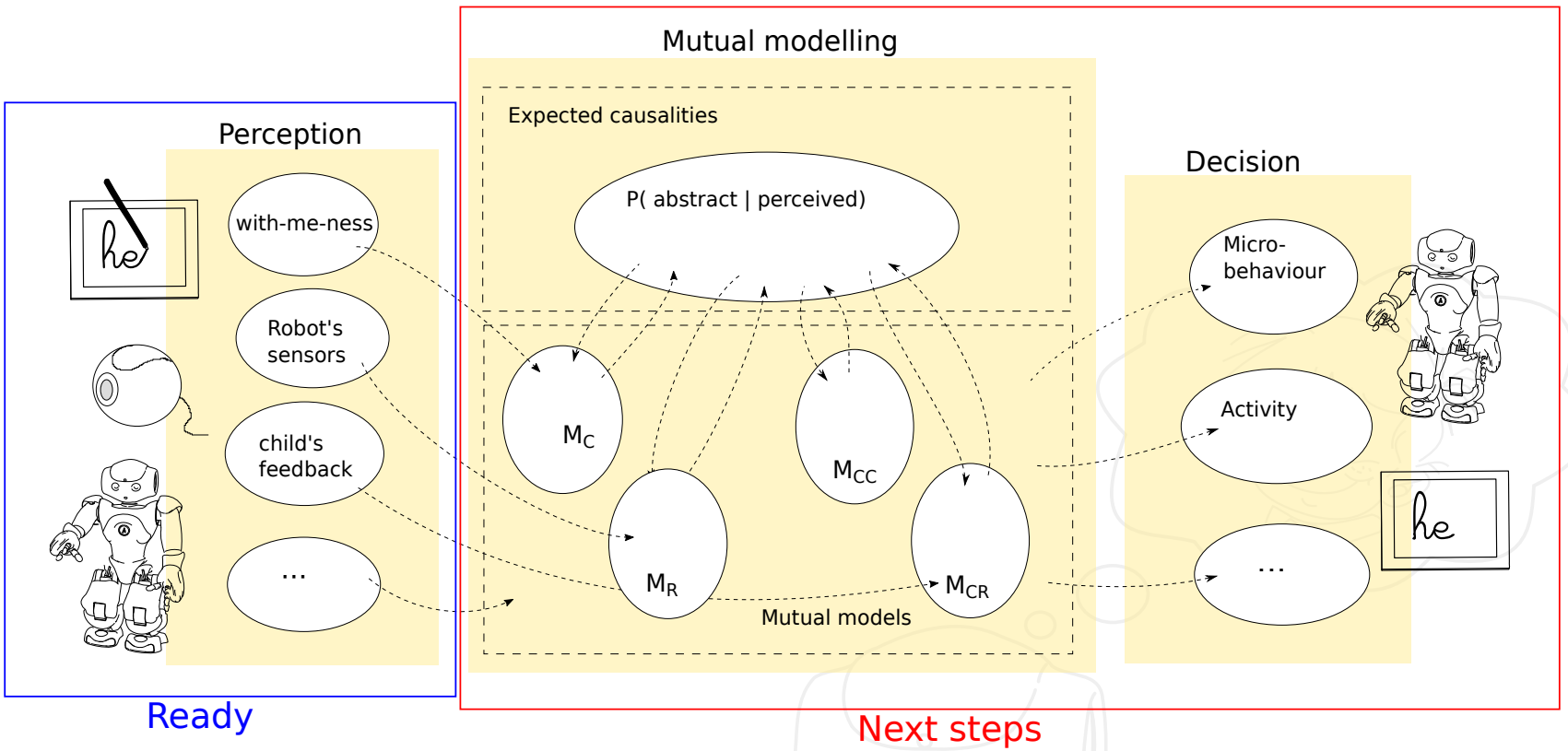
$$M_{C,R} :$$

$$\mathbb{P}\left[\text{Understand robot's progress} \,\middle|\, \text{Positive feedback}\right] \sim 1$$



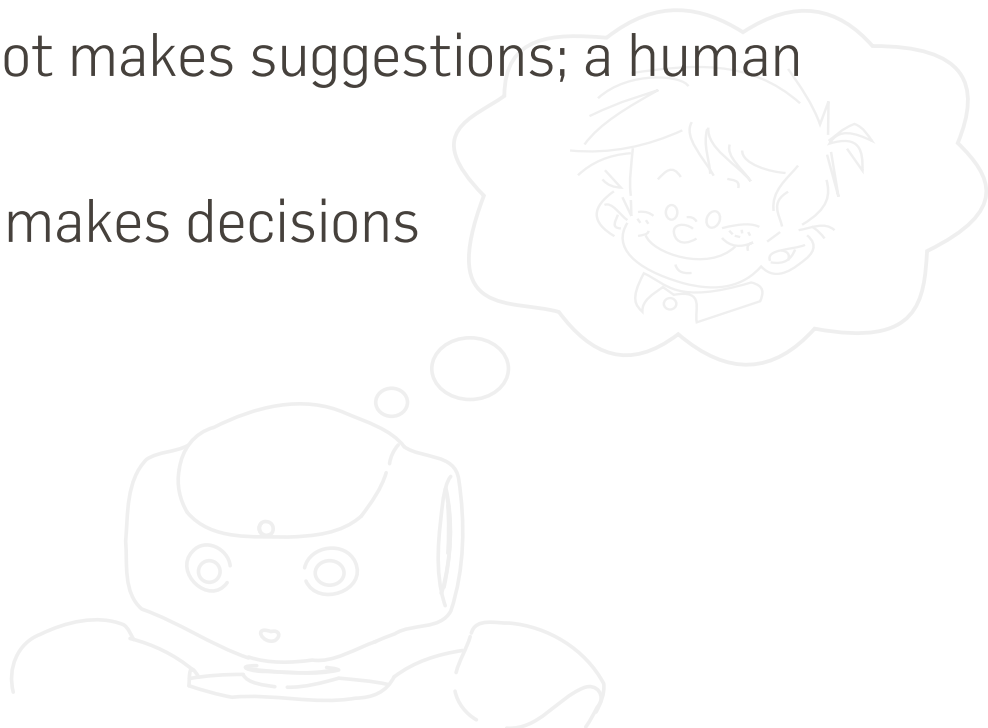
COGNITIVE ARCHITECTURE

GLOBAL DESCRIPTION



DECISION MAKING

1. Wizard-of-Oz: A human takes decisions; the robot learns
2. Mixed-initiative: The robot makes suggestions; a human agrees or disagrees
3. Autonomous: The robot makes decisions



WHAT IS ALREADY HERE ?

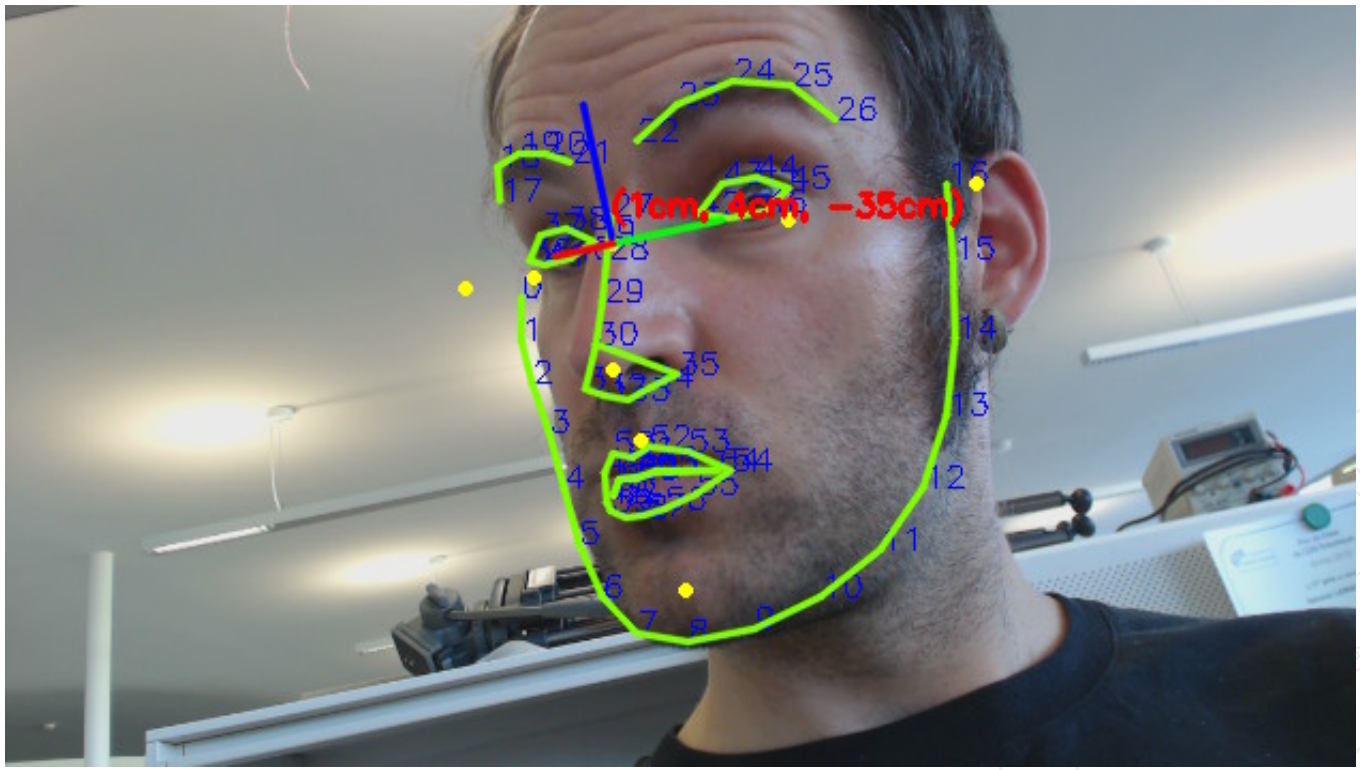


Figure: online with-me-ness

[2]Lemaignan, S. and Garcia, F. and Jacq, A. and Dillenbourg, P. From Real-time Attention Assessment to “With-me-ness” in Human-Robot Interaction HRI 2016

WHAT IS ALREADY HERE ?

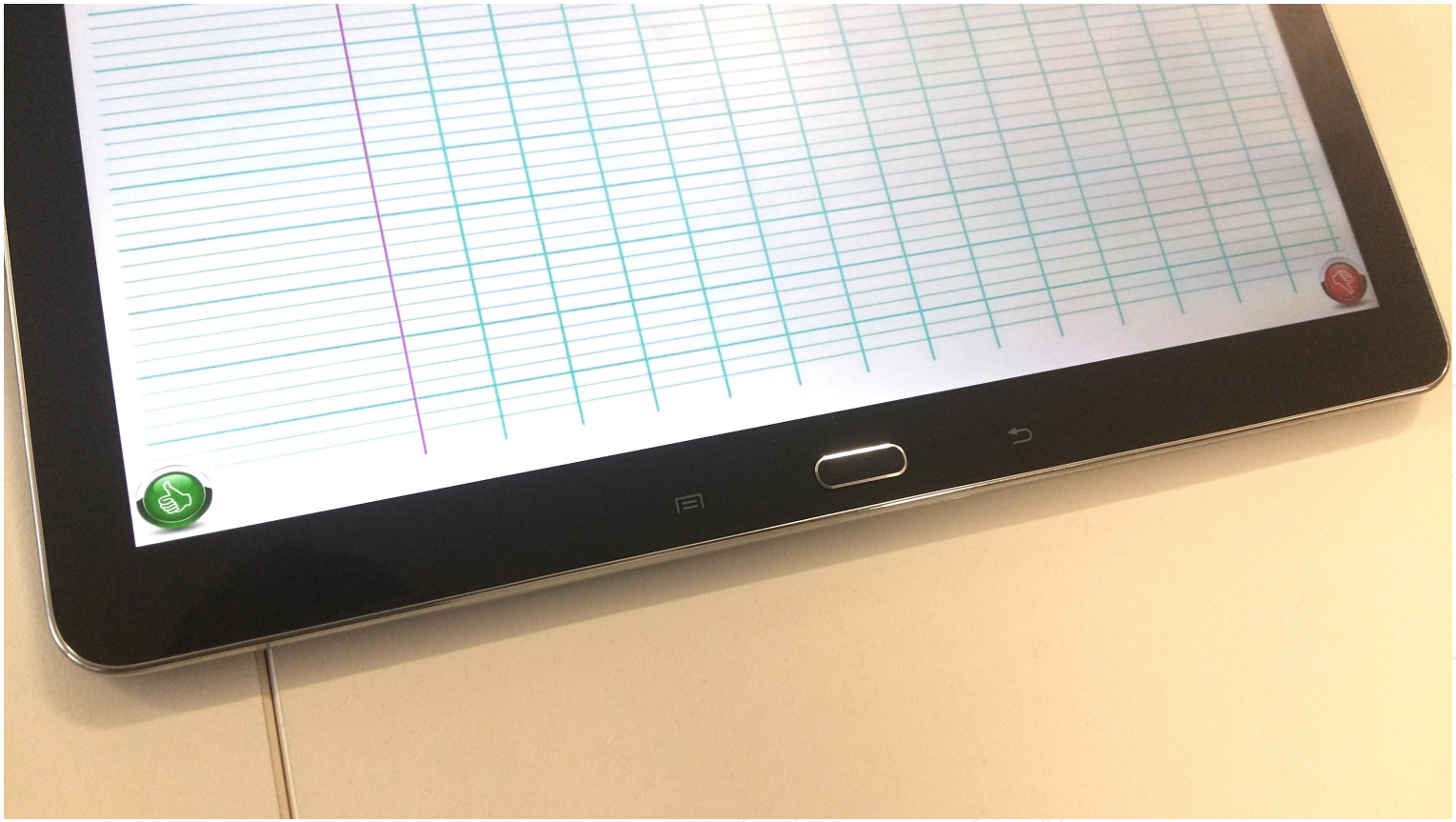
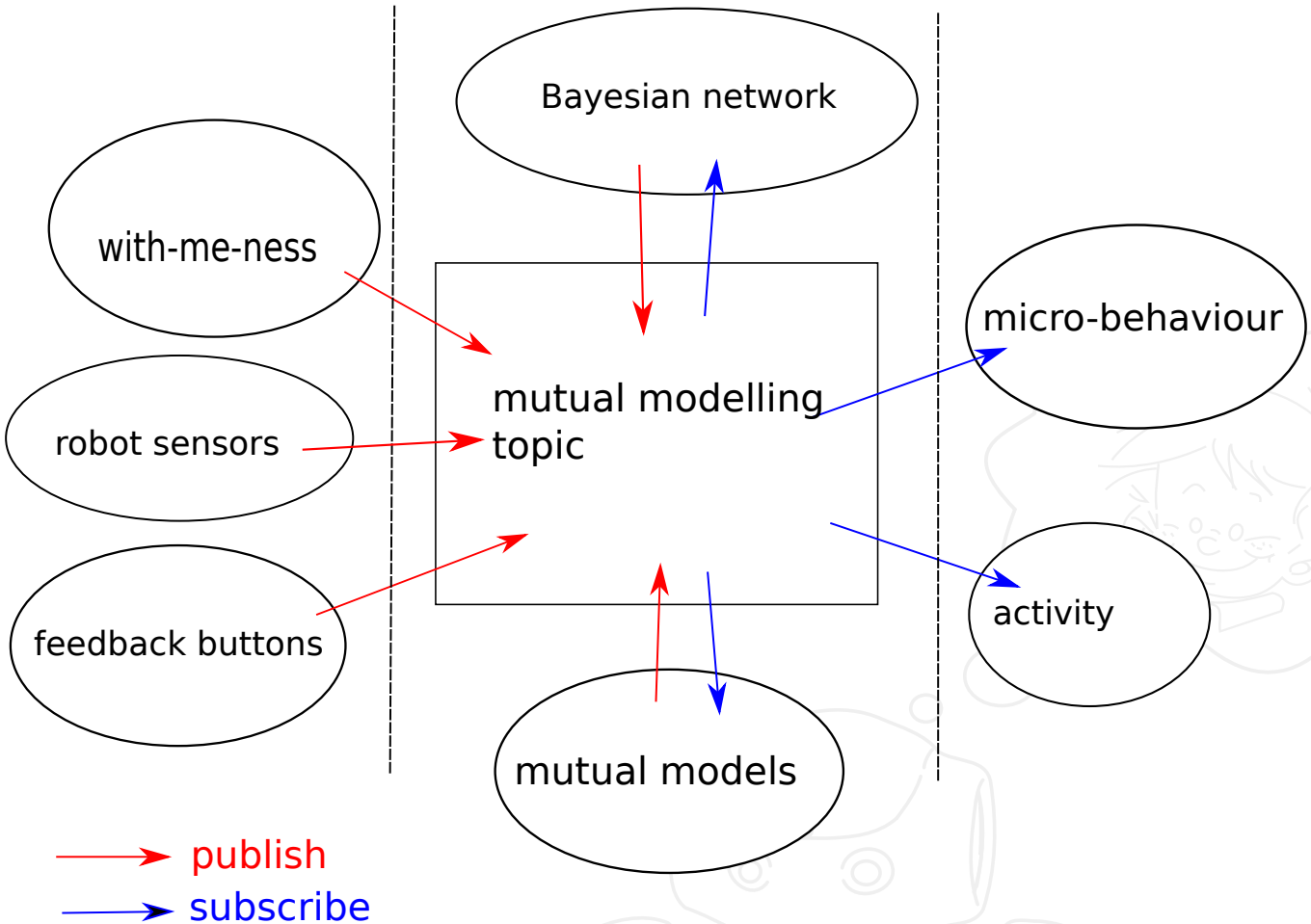


Figure: Buttons for feedback

IMPLEMENTATION

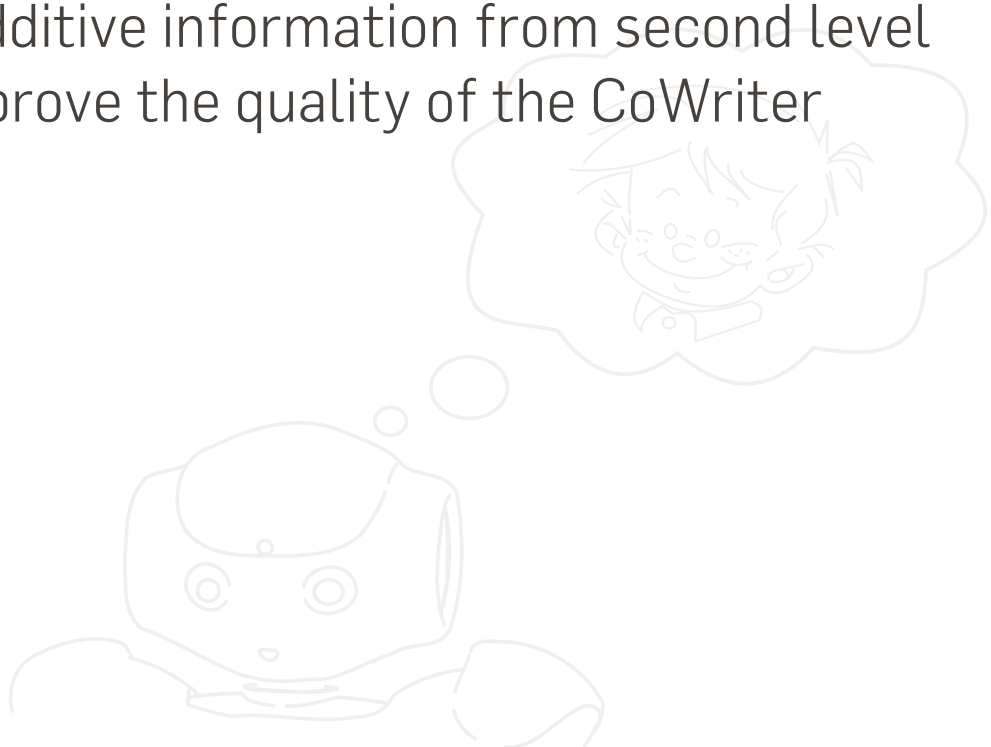
ROS NODES


Bayesian network
with-me-ness
robot sensors
feedback buttons
mutual modelling topic
micro-behaviour
activity
mutual models
publish
subscribe

EVALUATION

HYPOTHESIS

- Decisions made using additive information from second level of mutual modelling improve the quality of the CoWriter interaction.



QUALITY OF THE INTERACTION ?

1. Quantity of demos
2. Time spent to write demos
3. Progress of child/robot
4. With-me-ness
5. Feedback buttons

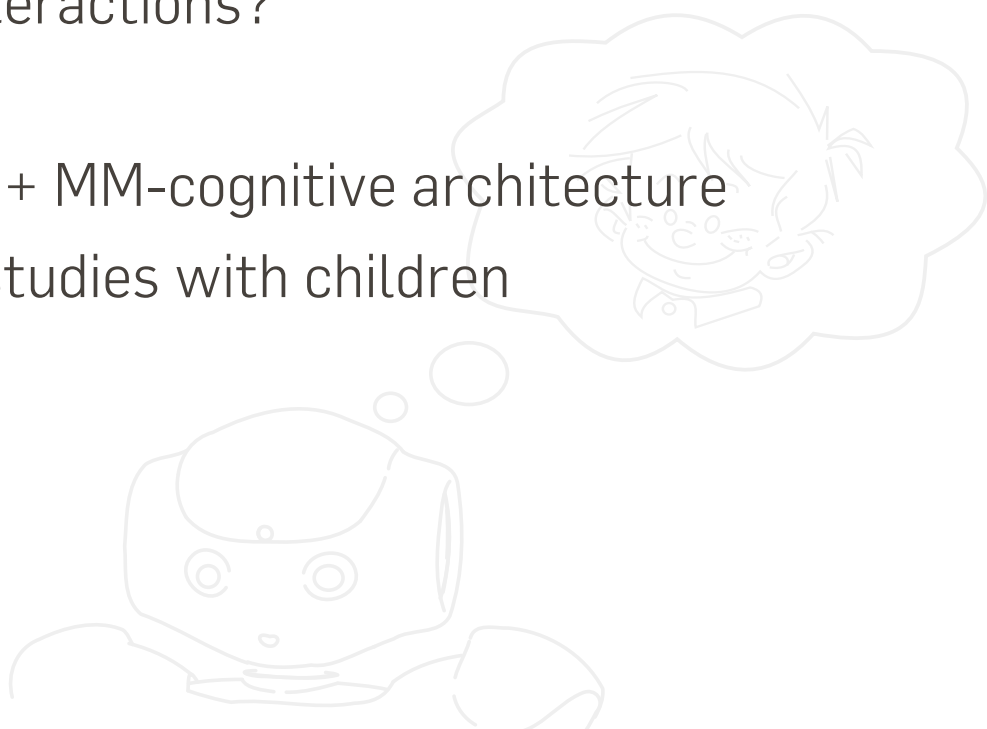
EXPERIMENTAL STUDIES

- Long-term studies
- Children with real deficits
- Professional facilitators

CONCLUSION & PLANNING

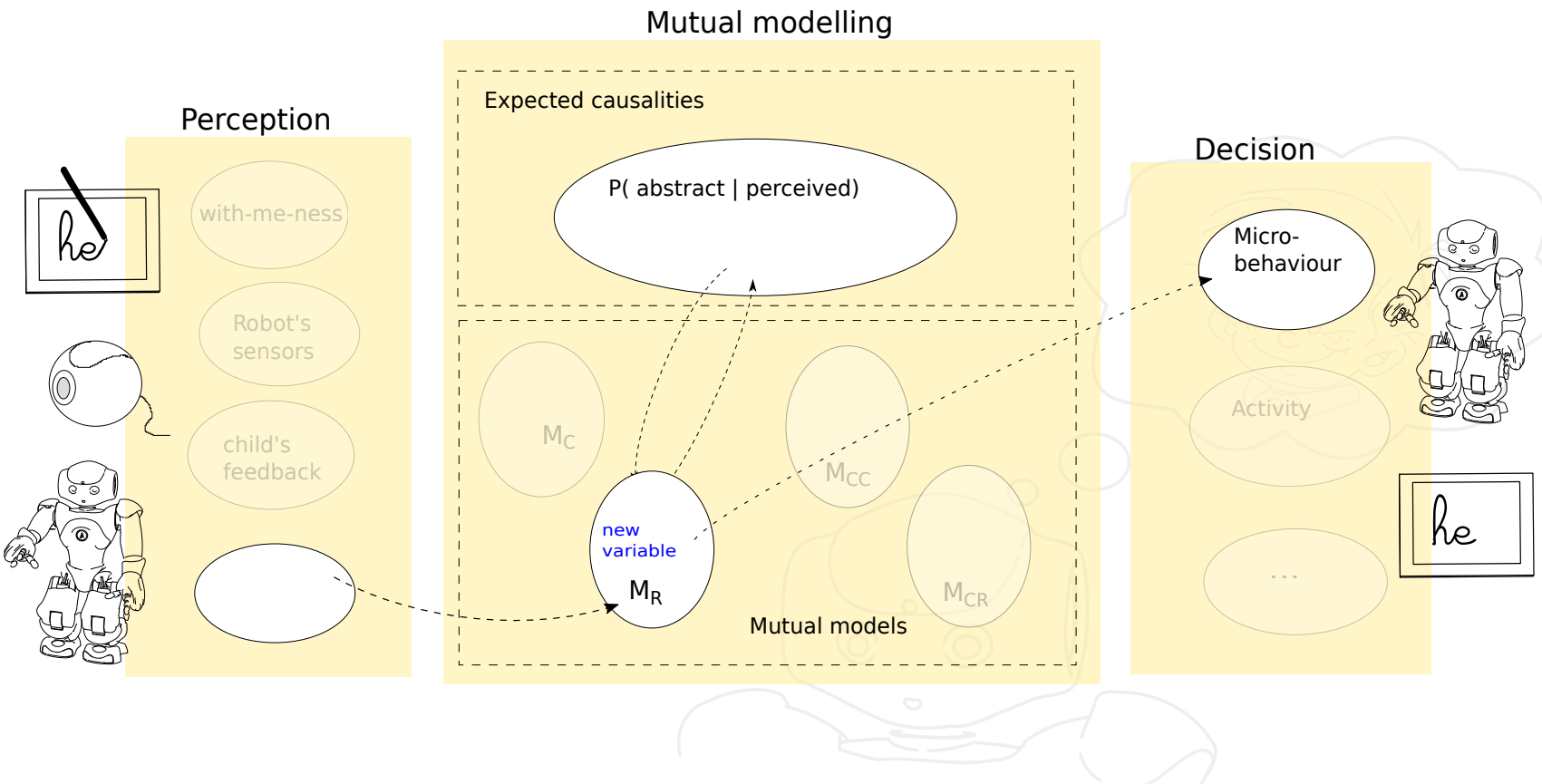
REMIND

1. Question: Does a second level of modelling enable higher quality interactions?
2. Hypothesis: Yes.
3. Tools: CoWriter activity + MM-cognitive architecture
4. Evaluation: Long-term studies with children



STEP BY STEP APPROACH

New variable (or group of variables) → New experiment to test the impact




Thank you !