Interaction humain-robot:
- des simples commandes
- à la coopération

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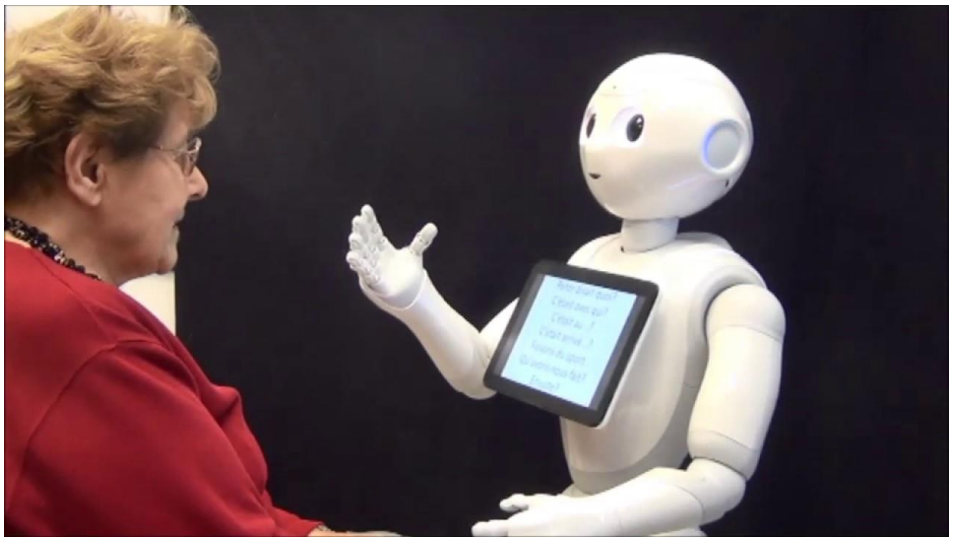
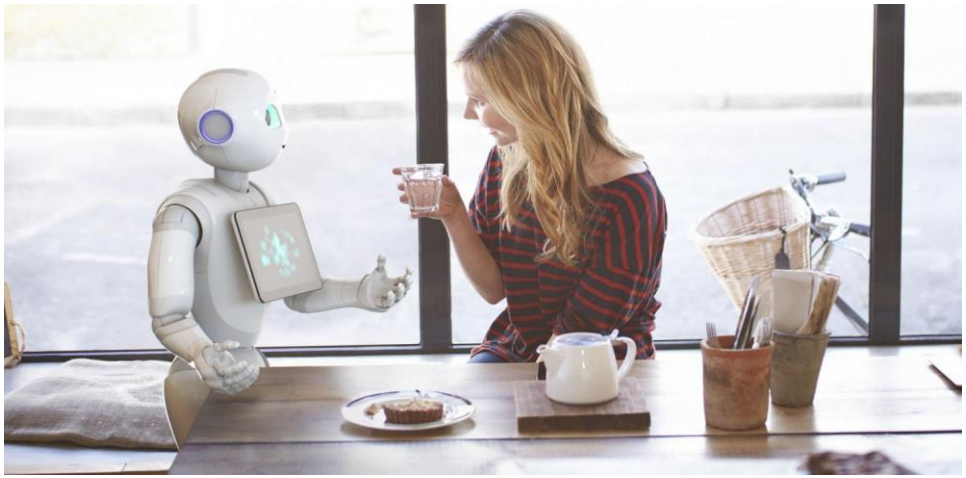
cnrs
dépasser les frontières

Lyon 1

Pourquoi les humanoïdes?

- Pour partager l'espace des humains, avec les humains
- Pour entrer dans les relations naturelles soi-autrui avec les humains





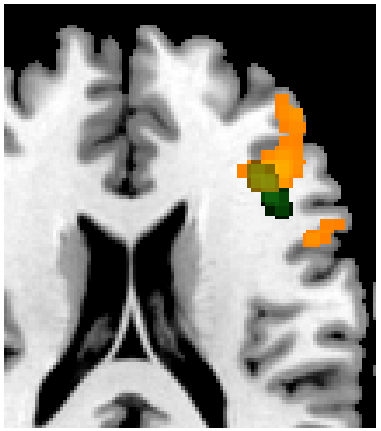
Quelle stratégie pour les robots humanoïdes sociaux?

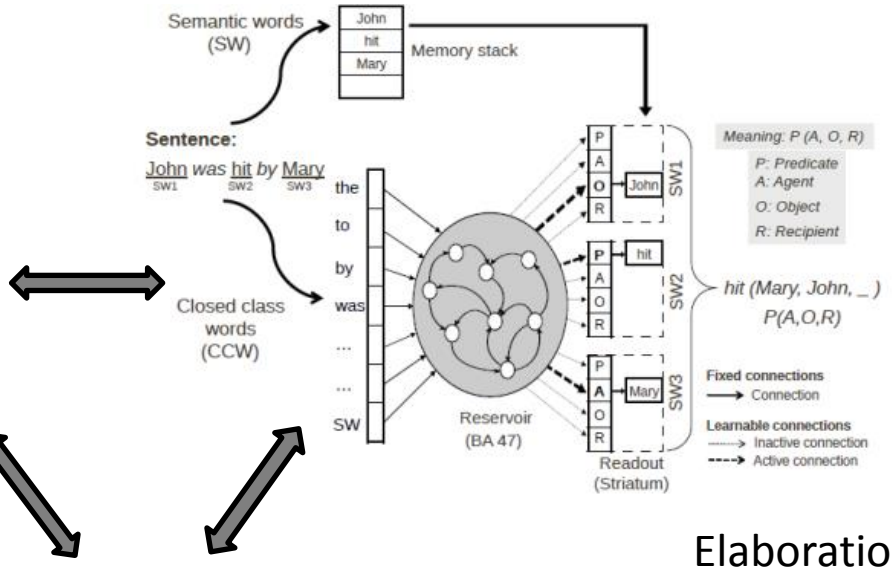
- Basé sur le meilleur modèle - l'humain
- Basé sur la neuroscience humaine
- Neurorobotique
  - Une méthode pour tester nos hypothèses sur le fonctionnement du cerveau
  - Une méthode pour construire des robots sociaux les plus performants

Qu'est-ce que c'est la **neurorobotique**?

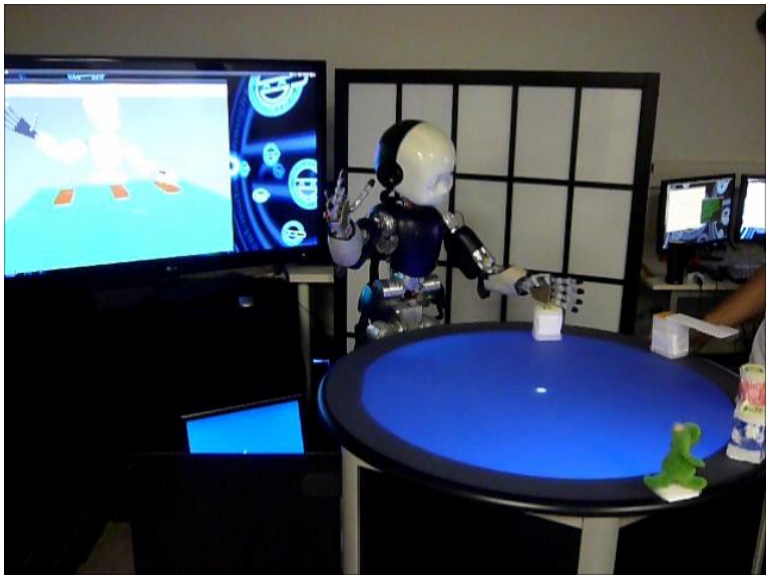
- Une méthode pour tester nos hypothèses sur le fonctionnement du cerveau
- une méthode pour construire des robots sociaux les plus performants

Science du cerveau





Elaboration de modèles
Neuro- informatiques

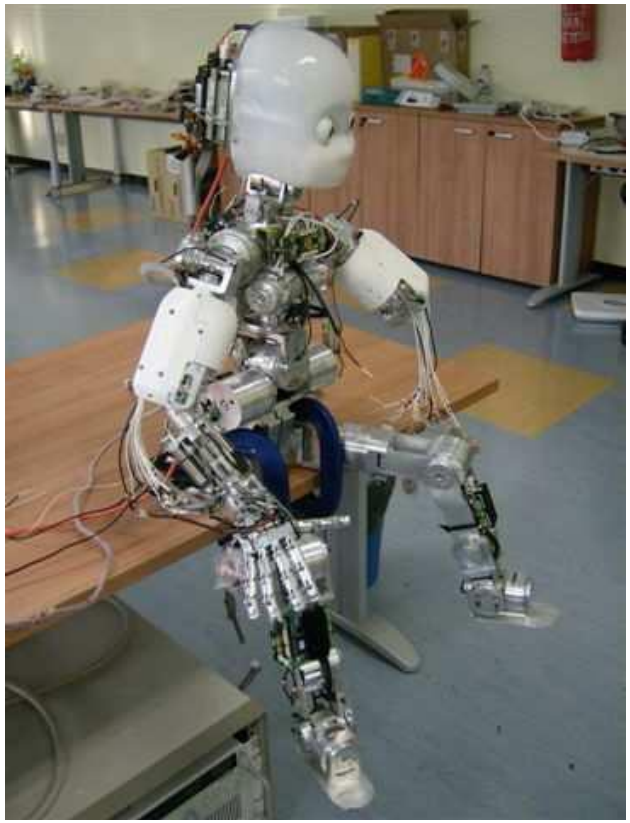


Test de ces modèles
dans le cerveau du robot

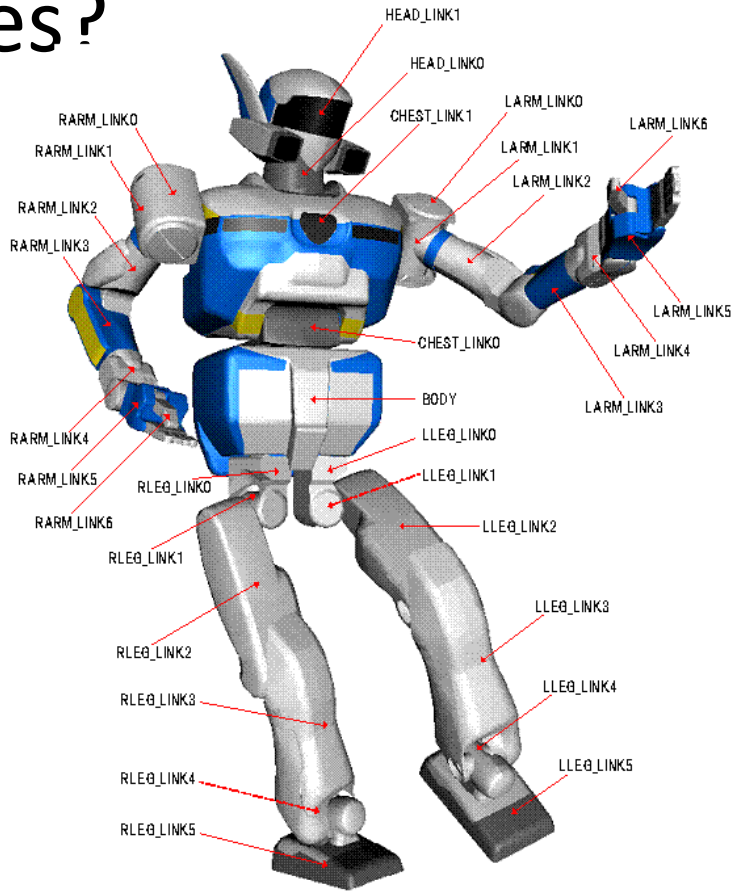
Objectif d'ingénierie

- Créer un robot intelligent capable de coopérer avec les gens
  - Vision, reconnaissance d'action
  - Contrôle moteur, exécution de la planification des actions
  - Langue, répondre et expliquer
  - Mémoire, apprendre et rappeler
- Méthode
  - Inspiré par la cognition humaine
  - Trajectoire "développementale" progressive

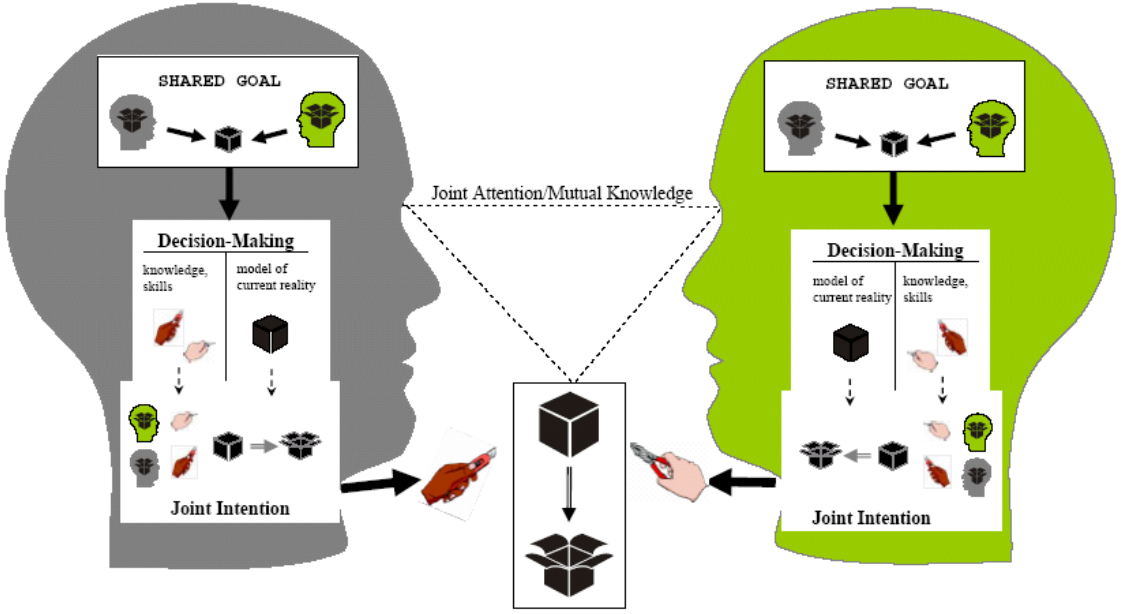
Comment ces robots peuvent-ils coopérer avec les humains dans de nouveaux contextes?



iCub – FP6 IST RobotCub
IIT Genoa



HRP-2 n°14 AIST-CNRS JRL
LAAS Toulouse


SHARED GOAL
Joint Attention/Mutual Knowledge
SHARED GOAL
Decision-Making
knowledge, skills
model of current reality
Joint Intention
Decision-Making
model of current reality
knowledge, skills
Joint Intention

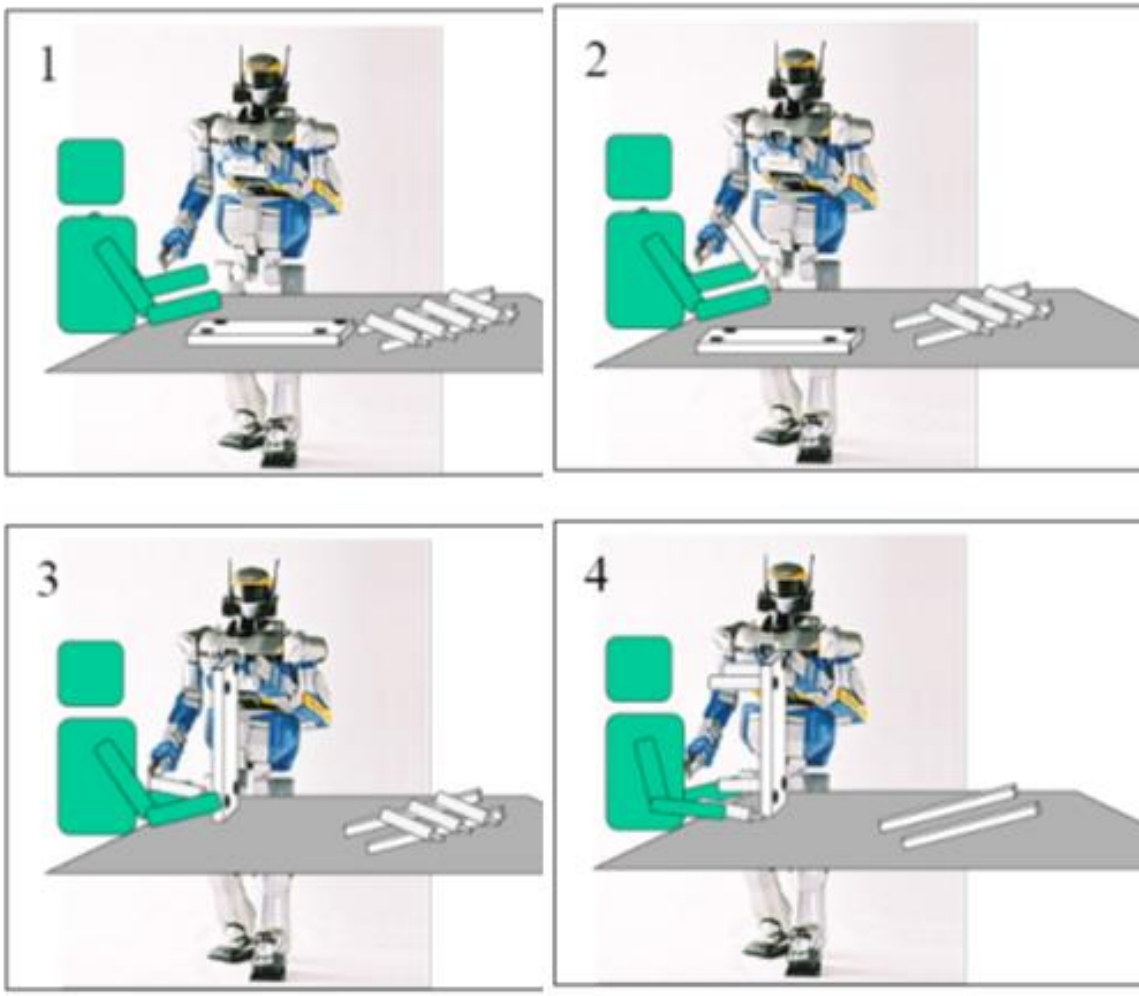
Robot apprend à coopérer avec les humains

- Séquences de moteur fixes
- Comportements moteurs généralisés
- Apprentissage automatique et anticipation
- Apprendre des plans partagés
  - De l'instruction
  - De l'observation

Learning Scenario

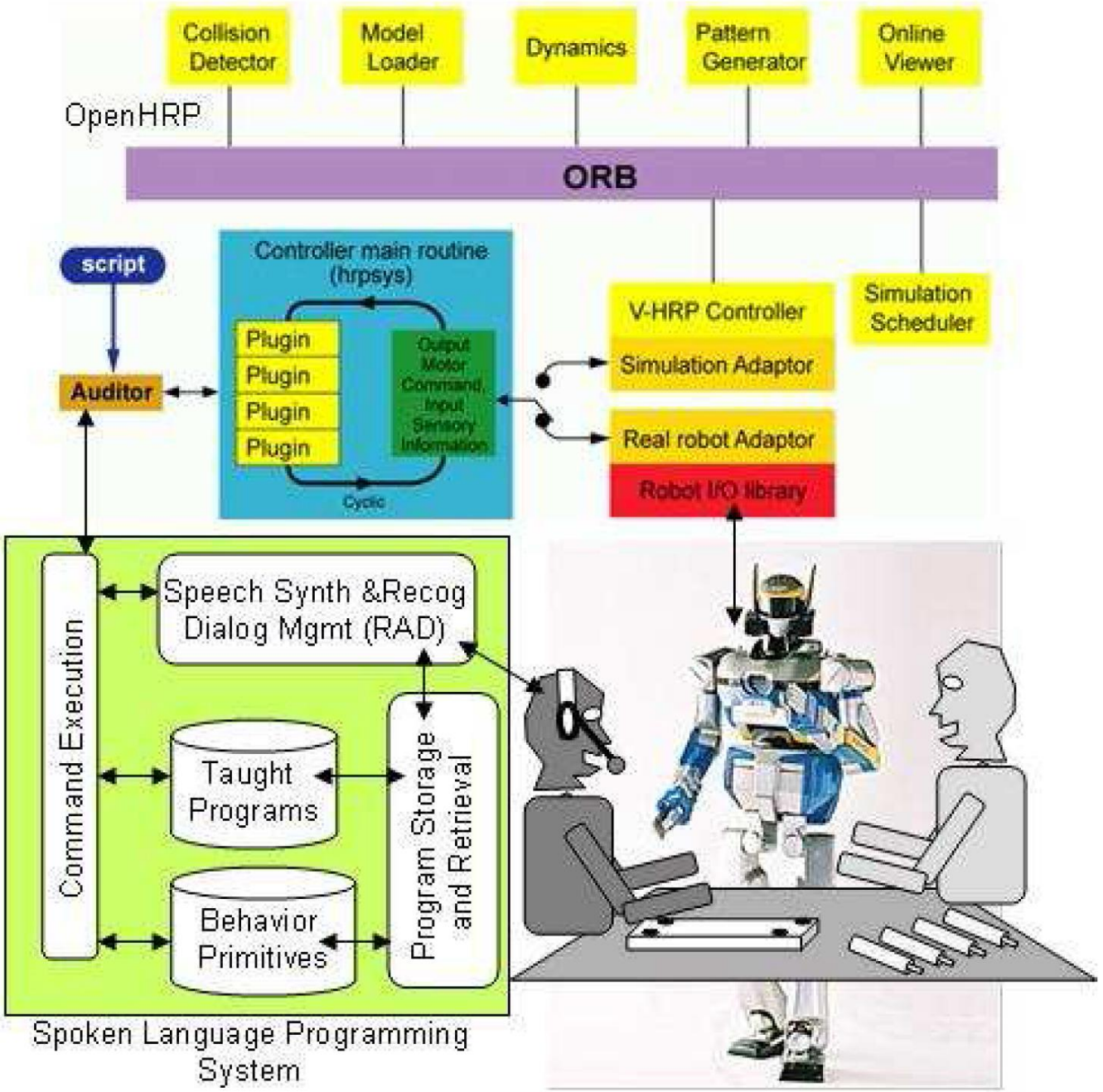
- The robot works with the human to assemble the table
- And learns about the shared task
- To progressively acquire skill
- The robot should have:
  - Some Basic Skills
  - Ability to Learn from the Expert
  - Ability to use language to guide action, including learning

Table-Building Scenario

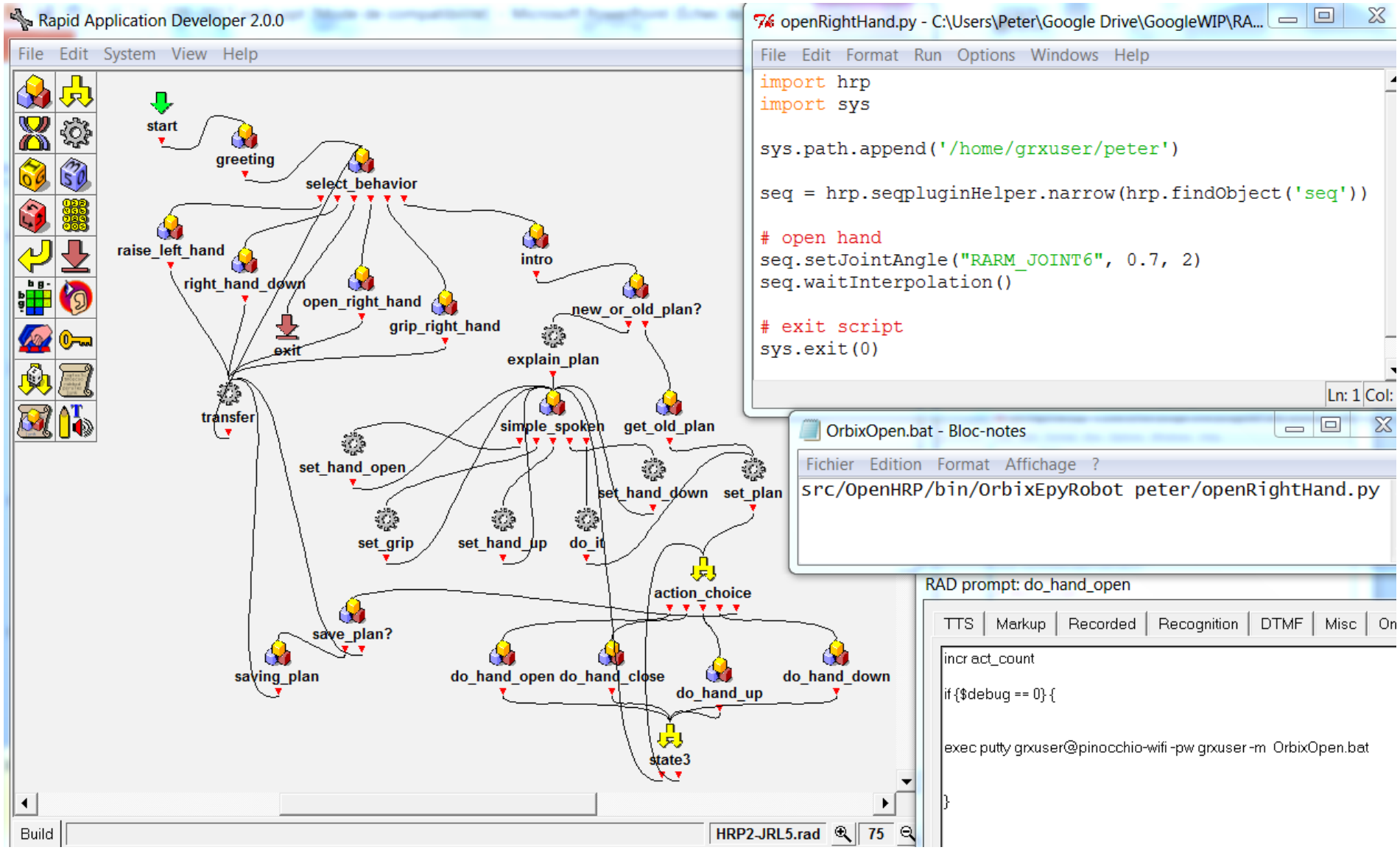


Kawada Industries HRP-2 Platform
CNRS-AIST Joint Robotics Laboratory
LAAS, Toulouse, France

System Architecture



Spoken langauge technology



First Contact with HRP2

July 20, 2006

1. Spoken Language Programming:

Composing primitives into behaviors

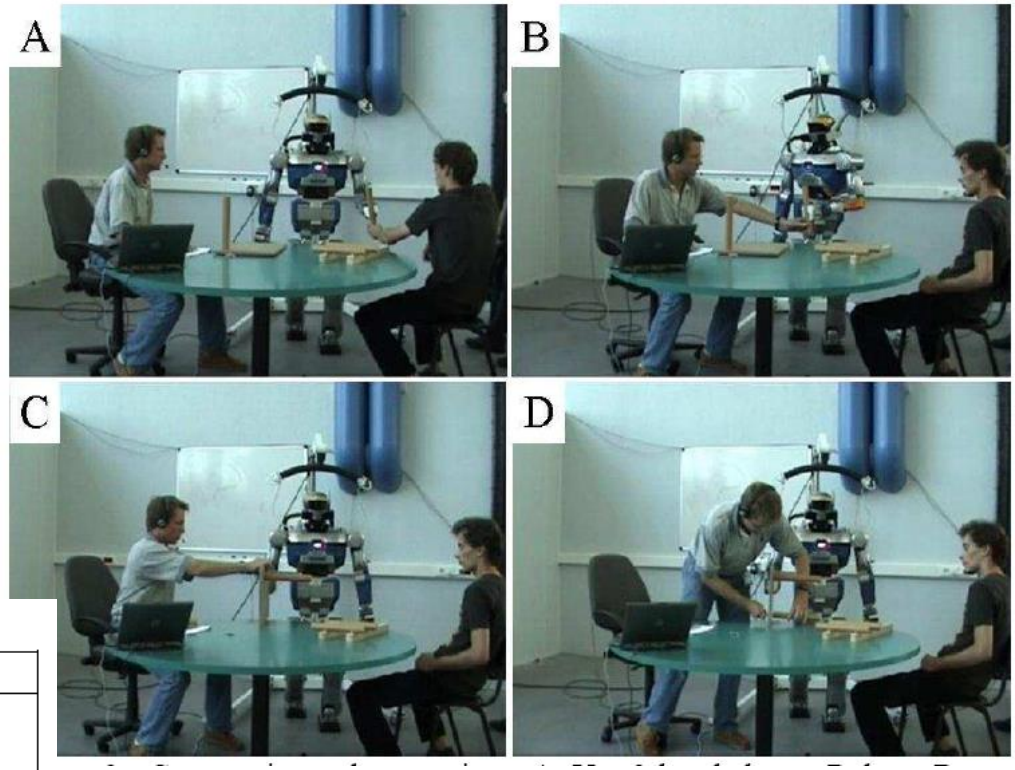


Table 1. Action Commands

Motor Command	Resulting Actions
Prepare	Move both arms to neutral position, rotate chest to center, elevate left arm, avoiding contact with the work surface (5 DOF)
OpenLeft	Open left hand (1 DOF)
CloseLeft	Close left hand (1 DOF)
Give it to me	Rotate hip to pass the object in left hand to user on the right (1 DOF)
Hold	Center hip, raise right arm preparing to hold table top (5 DOF)
Right open	Open right hand (1 DOF)
Right close	Close right hand (1 DOF)

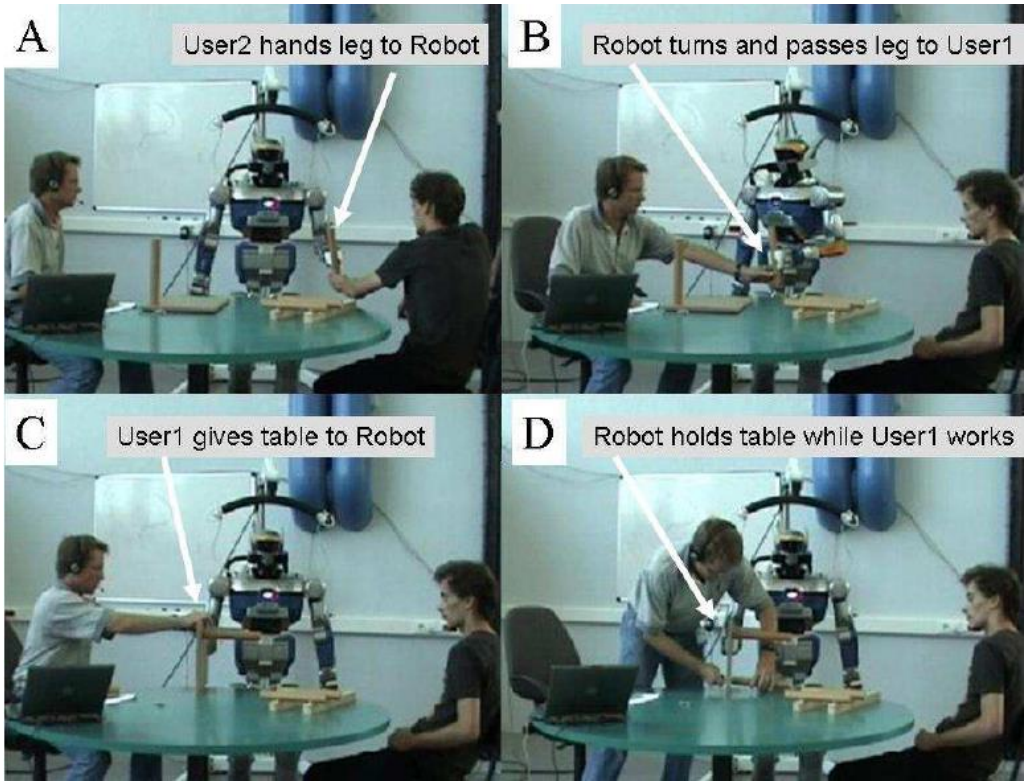
Table 2. Learning and Control Commands

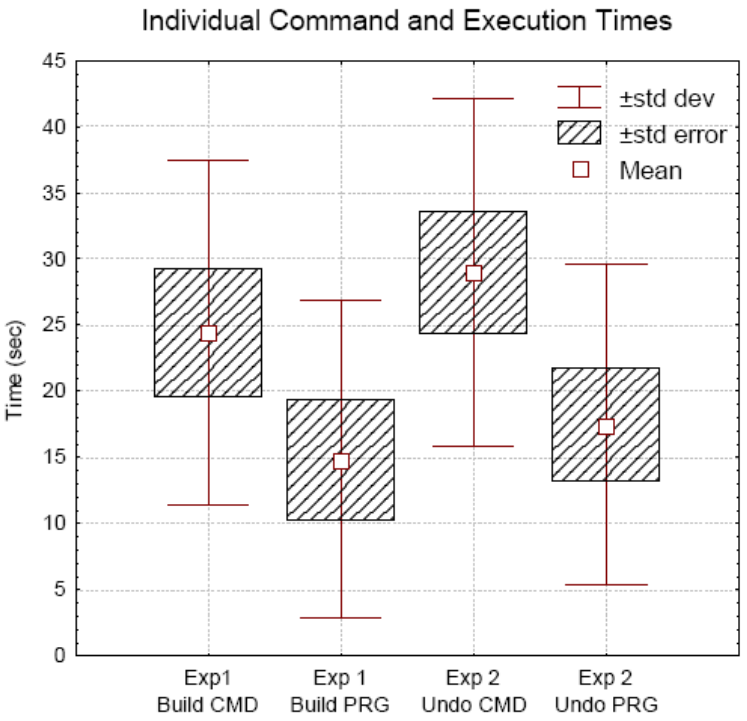
Commands	Correspondence
Learn	Begin encoding subsequent commands
OK	Store encoded command sequence in macro
Macro	Execute the stored macro
Wait	Interrupt command execution until a spoken "continue" command is issued
Continue	Terminate the "wait" pause and resume execution.

Part of Joint Robotics Laboratory project, AIST/CNRS

Dominey, Mallet, Yoshida (2007) IEEE Int. Conf. Robotics & Automation 2007

Table Assembly *and Disassembly*

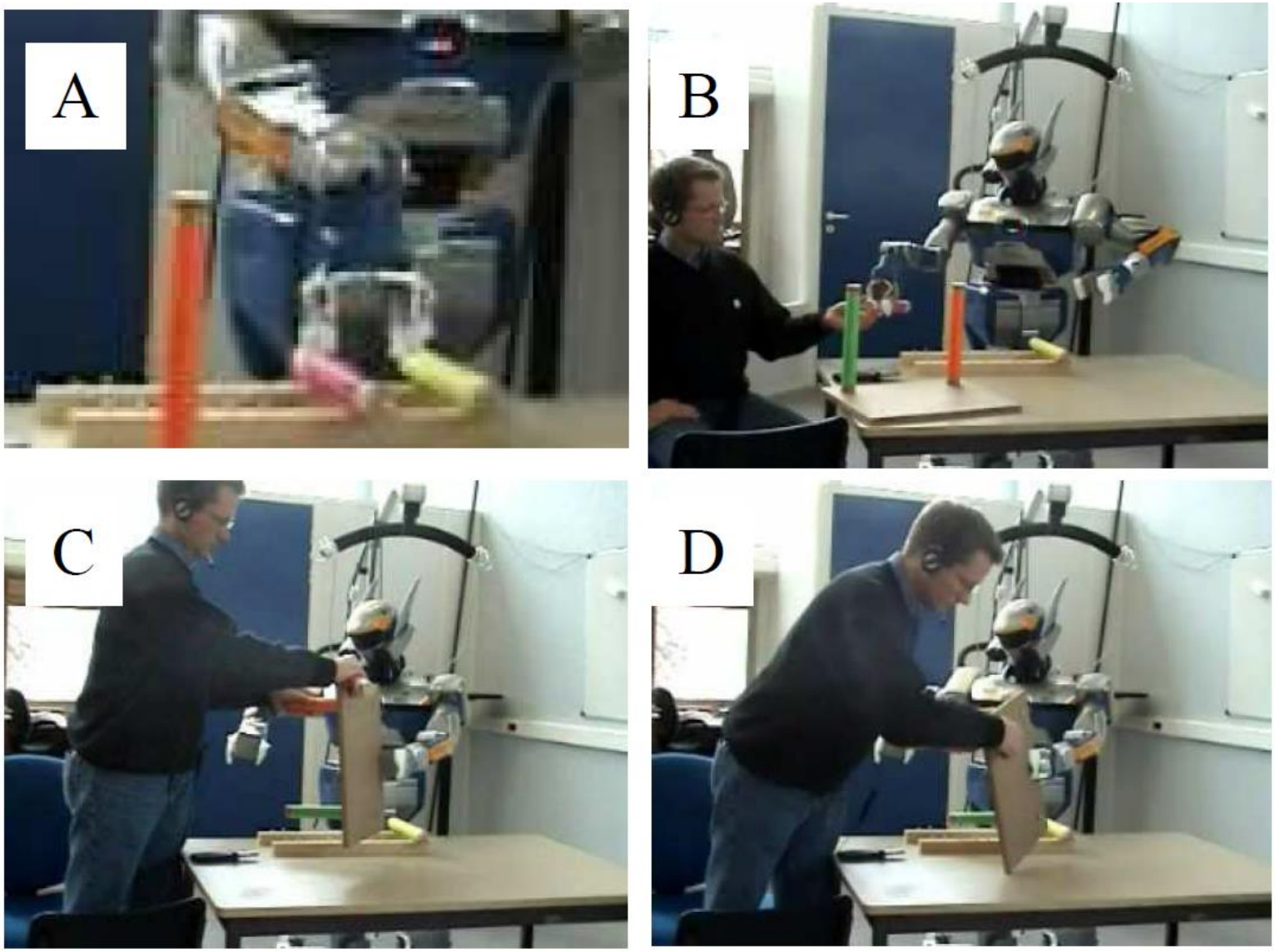




Part of Joint Robotics Laboratory project, AIST/CNRS

Dominey, Mallet, Yoshida (2007) IEEE Int. Conf. Robotics & Automation 2007

Using robot vision to grasp the legs



Vision proc

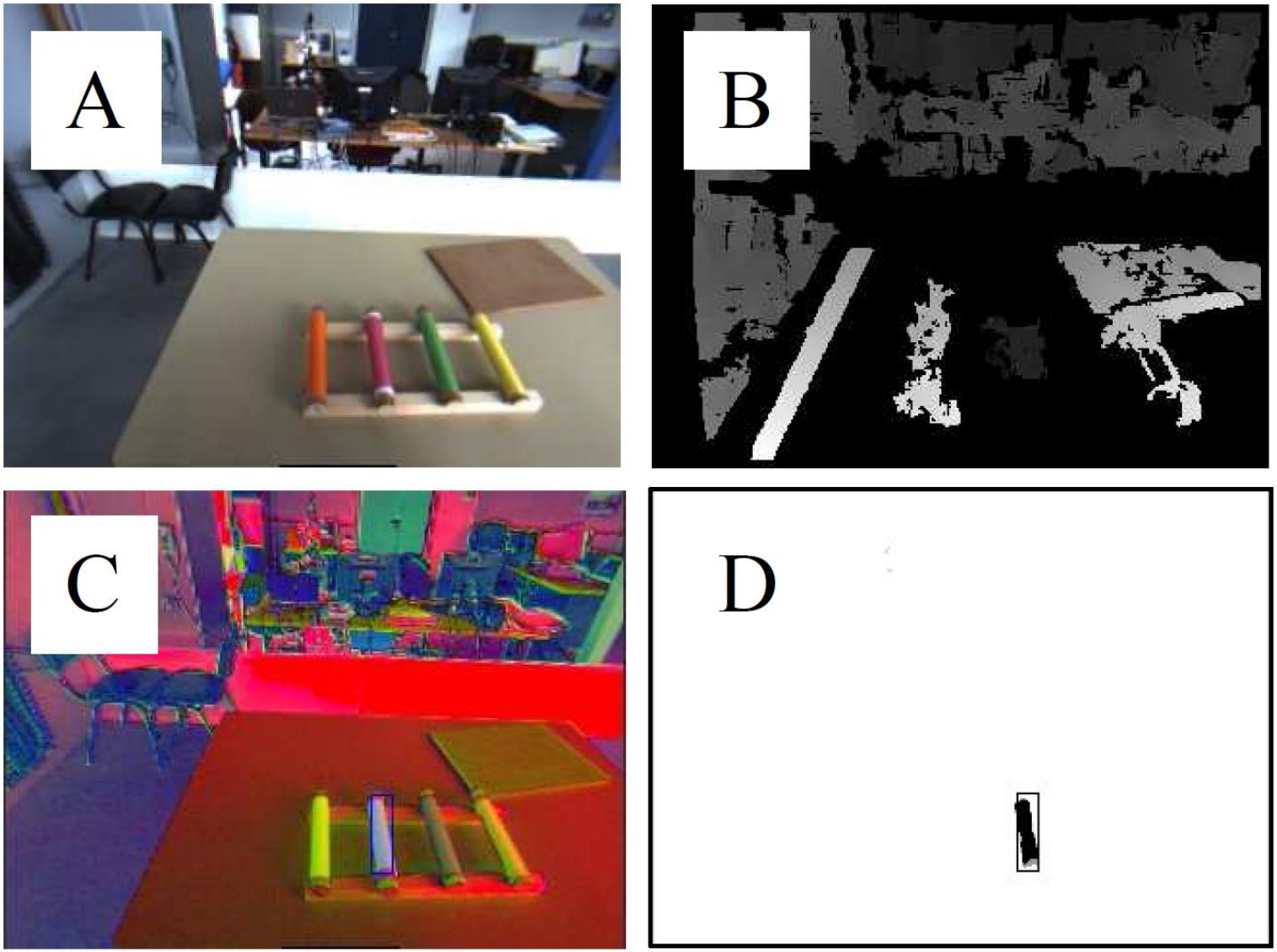


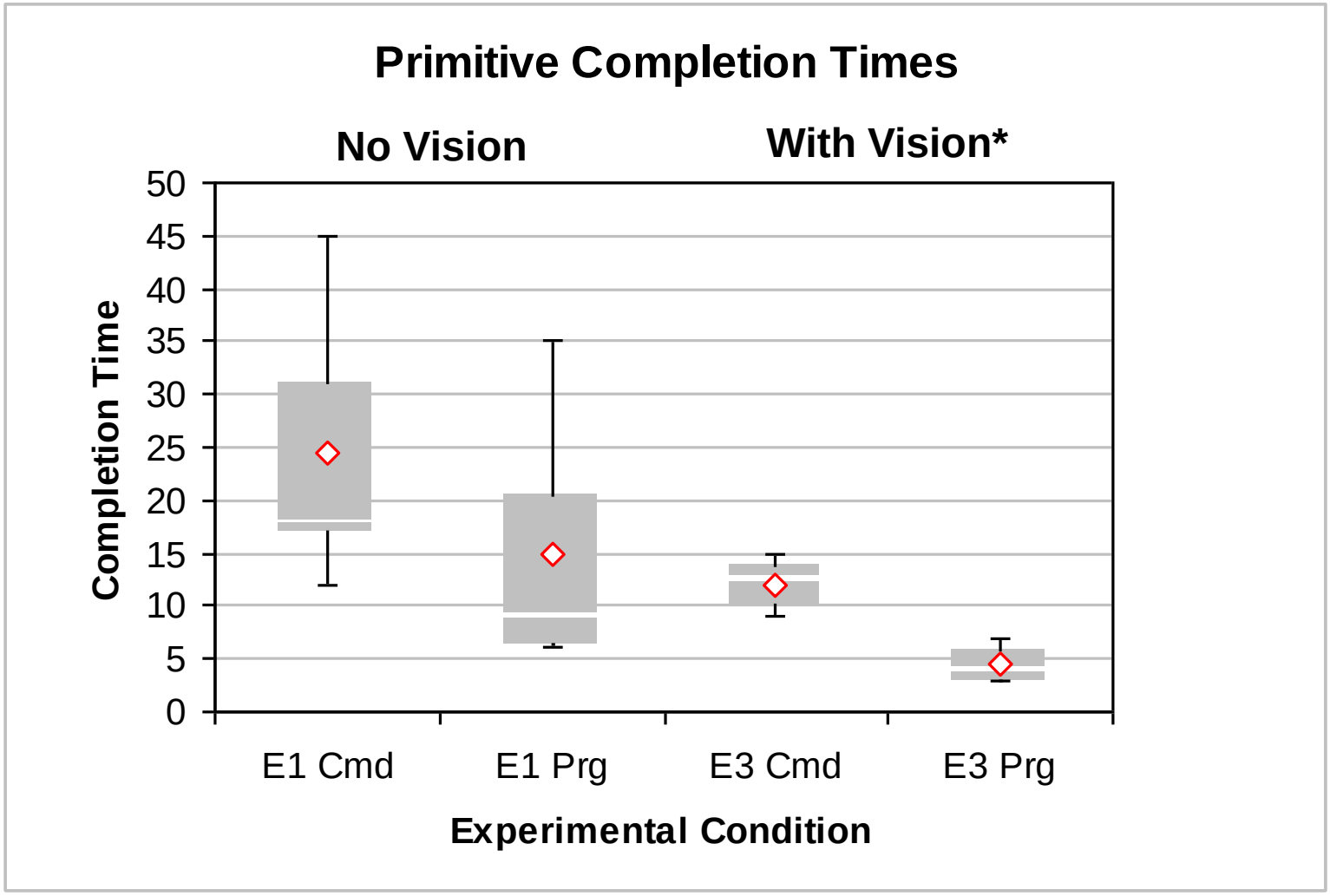
Figure 2. Vision Processing. A - video image with distortion corrected and automatic white-balance correction. B - corresponding depth image - of poor quality, but precise enough to perform the grasping. C - video image in HSV color space. D - camshift algorithm detection of rose leg.

2. Learning Generalized Action Predicates

- H: Give me the ***green*** leg
- *R: What does give mean?*
- *H:*
  - Take the ***green*** leg
  - Turn right
  - Open right hand
- Training with one example
  - *Green* is passed as an argument to TAKE
  - Learned procedure generalizes over (yellow, rose, green, orange)
  - Powerful learning capability with procedures that take variables
- Embodiment of lexical categories
  - Verbs – procedures
  - Nouns – arguments
- Requires more sophisticated skills
  - Vision
  - Inverse kinematics

Part of Joint Robotics Laboratory project, AIST/CNRS
Dominey, Mallet, Yoshida (2007) IEEE Humanoids

Performance Evaluation



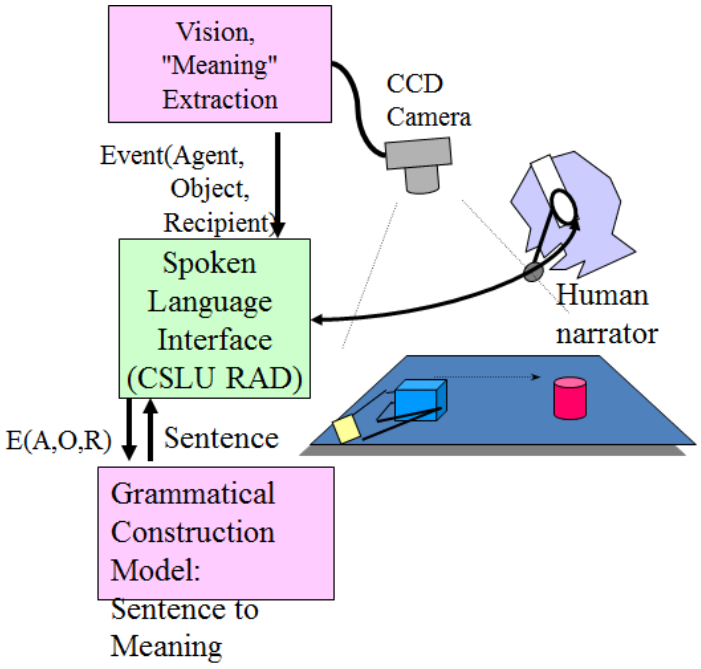
*and improved motion trajectories

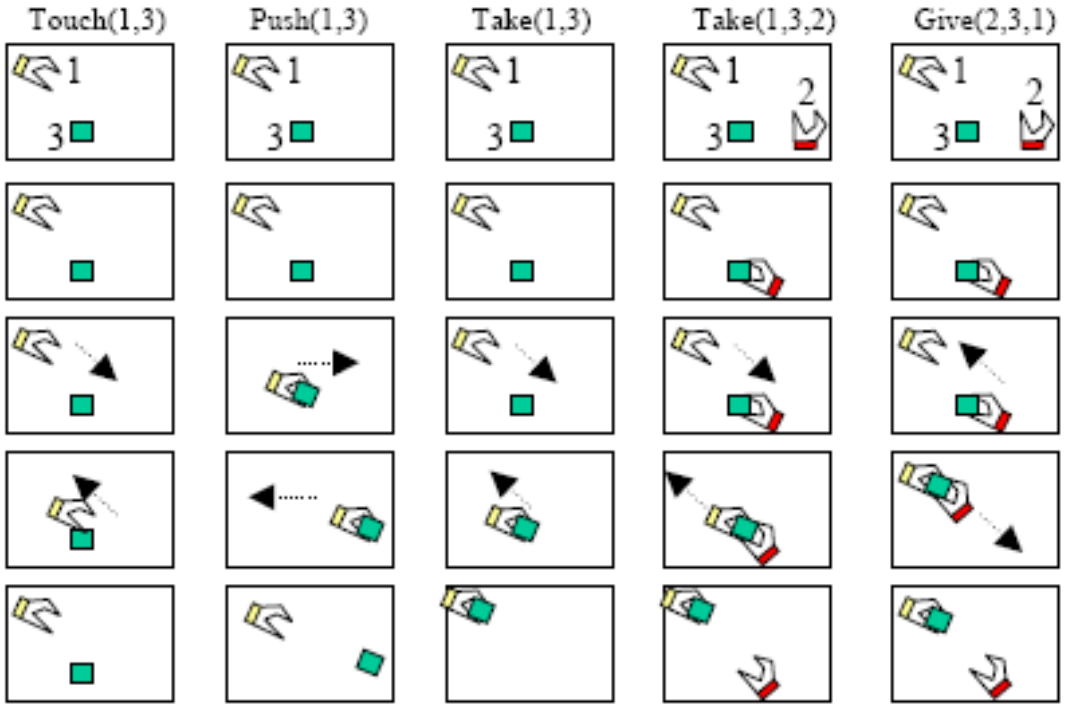
3. Automatic Learning, and Anticipation

- Replace Explicit Programming with
- On-line Learning of complex cooperative behavior
- continuous comparison of current action sequence with ***Interaction History***

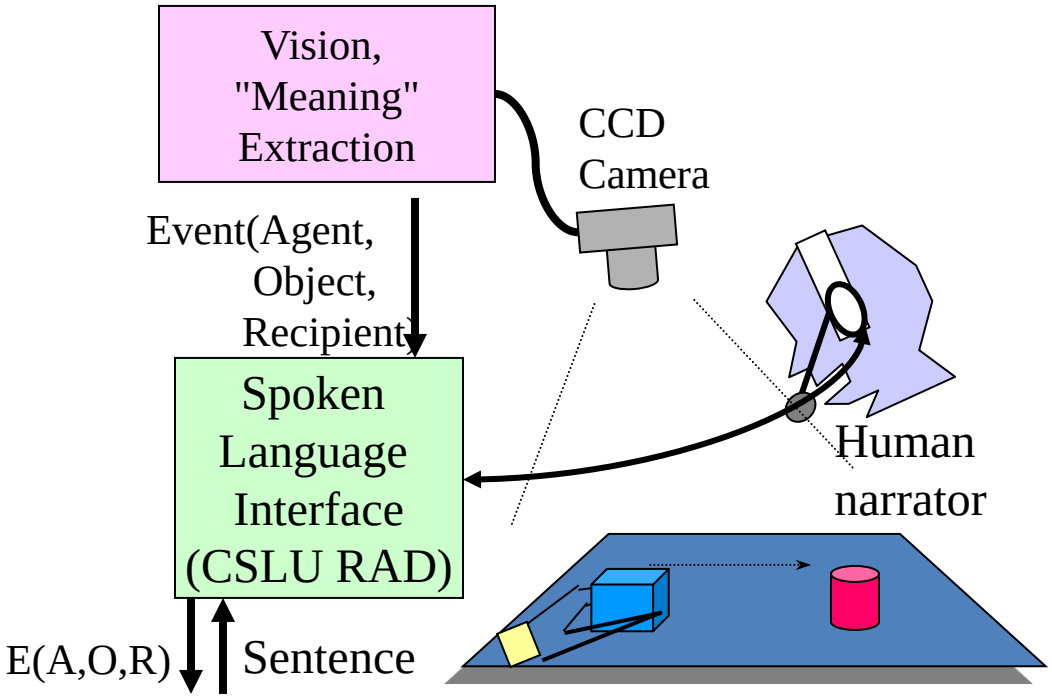
Dominey, Metta, Nori, Natale (2008) IEEE Int. Conf. On Humanoid Robotics

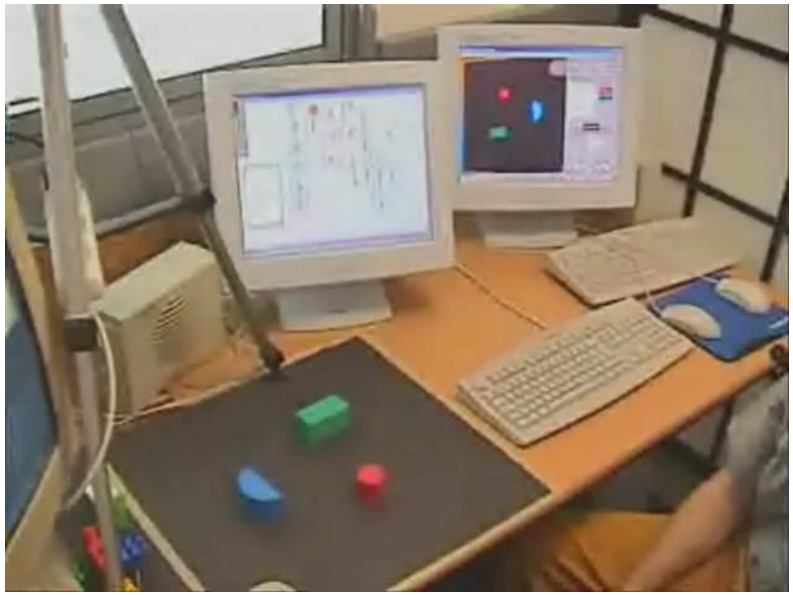
Action Perception: Extracting meaning from vision





Grammatical Constructions for Event Description and Interrogation





Gave(moon, cylinder, block)

- The moon gave the cylinder to the block.
- The block was gave the cylinder by the moon.
- The cylinder was gave to the block by the moon.

CHRIS – Cooperative Human-Robot Interaction System

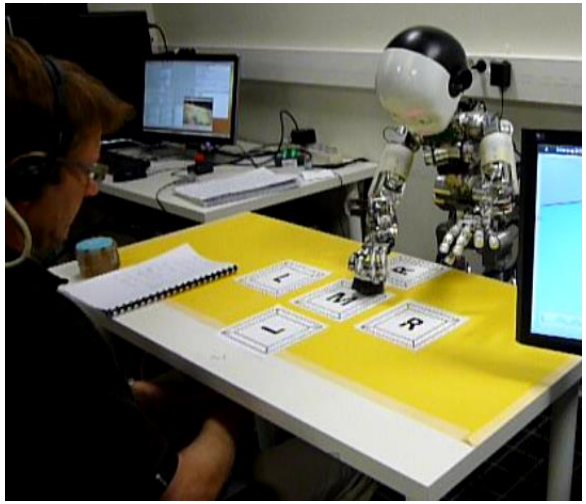
Towards a Platform-Independent Cooperative Human-Robot Interaction System: I. Perception

- Learning objects
- Learning to recognize new actions as sequences of contact-motion primitives
  - Predicate(agent, object)
    - Take(robert, coke-can)

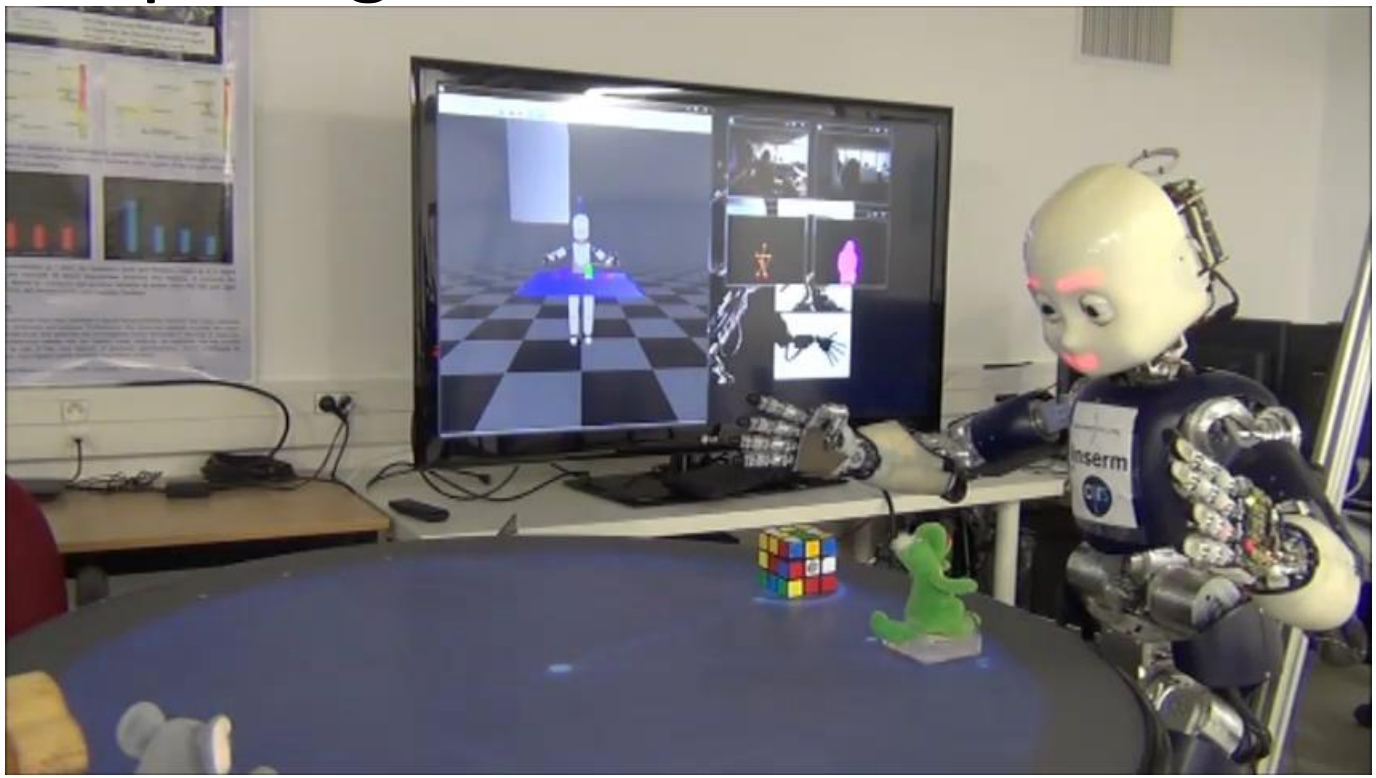
CHRIS – Cooperative Human-Robot Interaction System

Towards a Platform-Independent Cooperative Human Robot Interaction System: III. An Architecture for Learning and Executing Actions and Shared Plans

- Learn action execution
  - put(toy, left) = grasp(toy) release(left)
- Learn shared plan
  - Larry grasp box, robert put toy left, larry put box middle
  - Sequence of actions executed by human and robot



iCub peut parler de son expérience, pour partager un sens commun

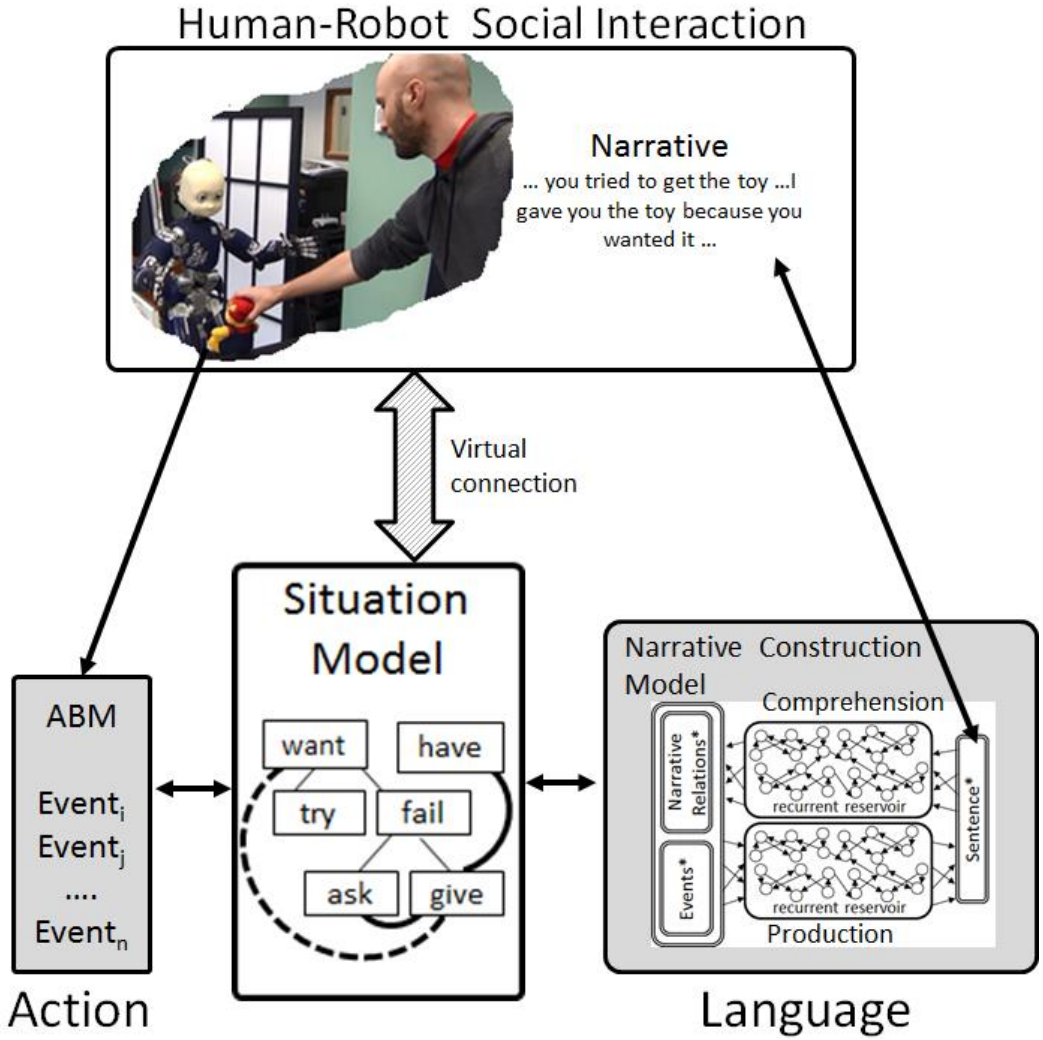


- Commander le robot à agir
- Poser des questions au robot
- iCub peut décrire:
  - Ce qu'il a fait
  - Les résultats de ses actions

Mealier, Pointeau, Gärdenfors, Dominey (in prep)
Hinaut, Lance, Droin, Petit, Pointeau, Dominey (in prep)

Narrative Structuring of experience

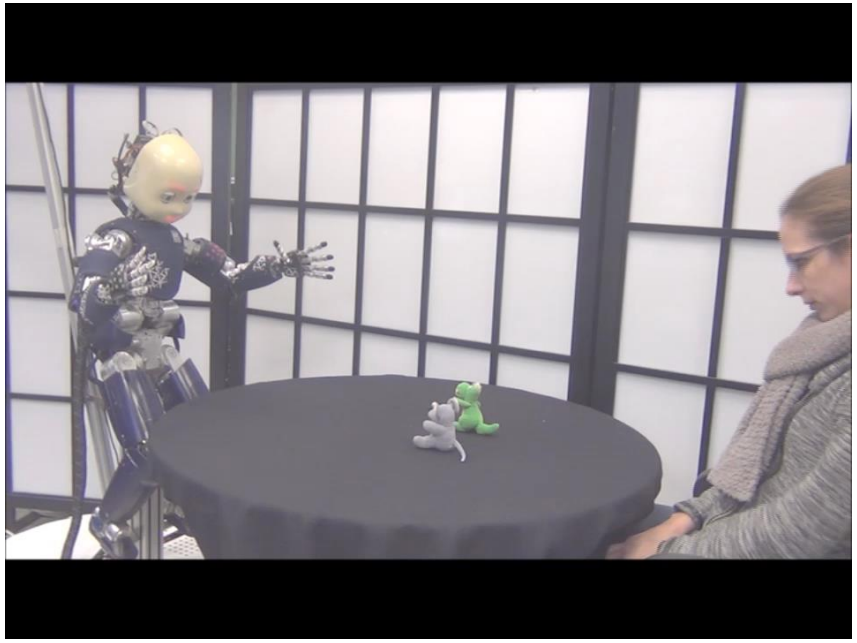
- Child's experience creates skeleton situtation model
- Adult narrative enriches and structures the situation model
  - this is where meaning is created
- Future experience inherets this enriched structure



Situtation model can be fed by experience

Situtation model can be enriched by language

New situations can be understood and explained in terms of experience

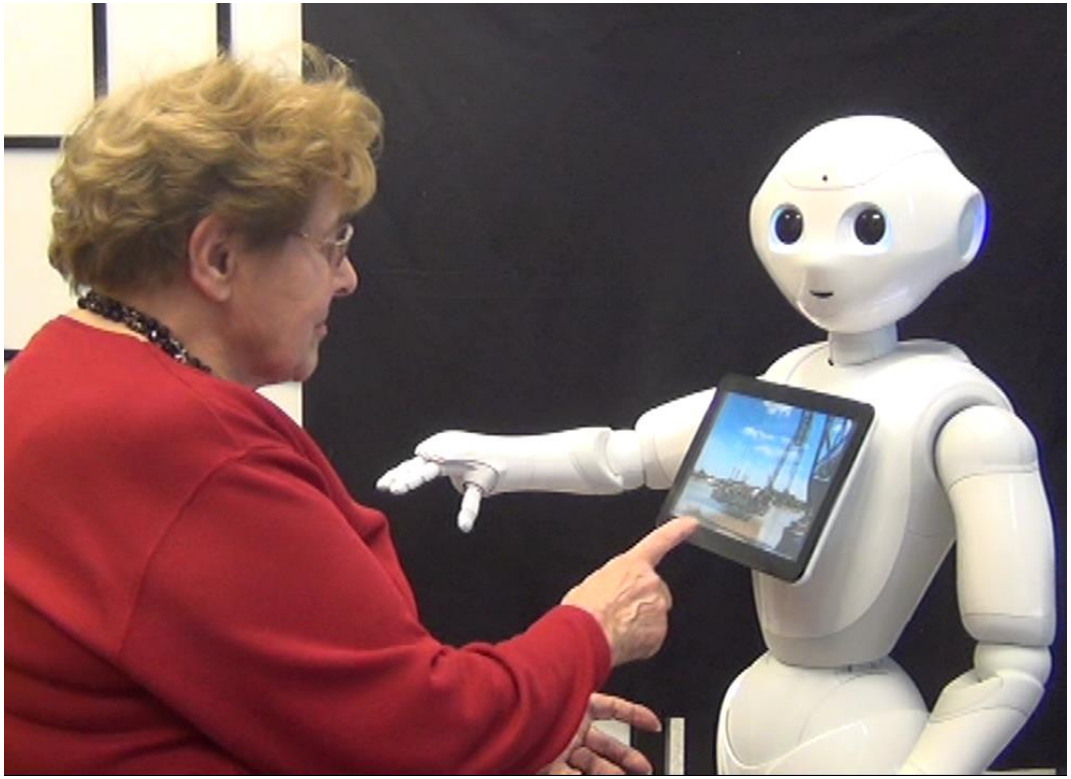


New situation

Narrated based on learned experience

Transférer ces capacités linguistiques vers le monde réel

Un robot compagnon pour améliorer la qualité de vie des séniors



Un robot compagnon pour améliorer la qualité de vie des séniors

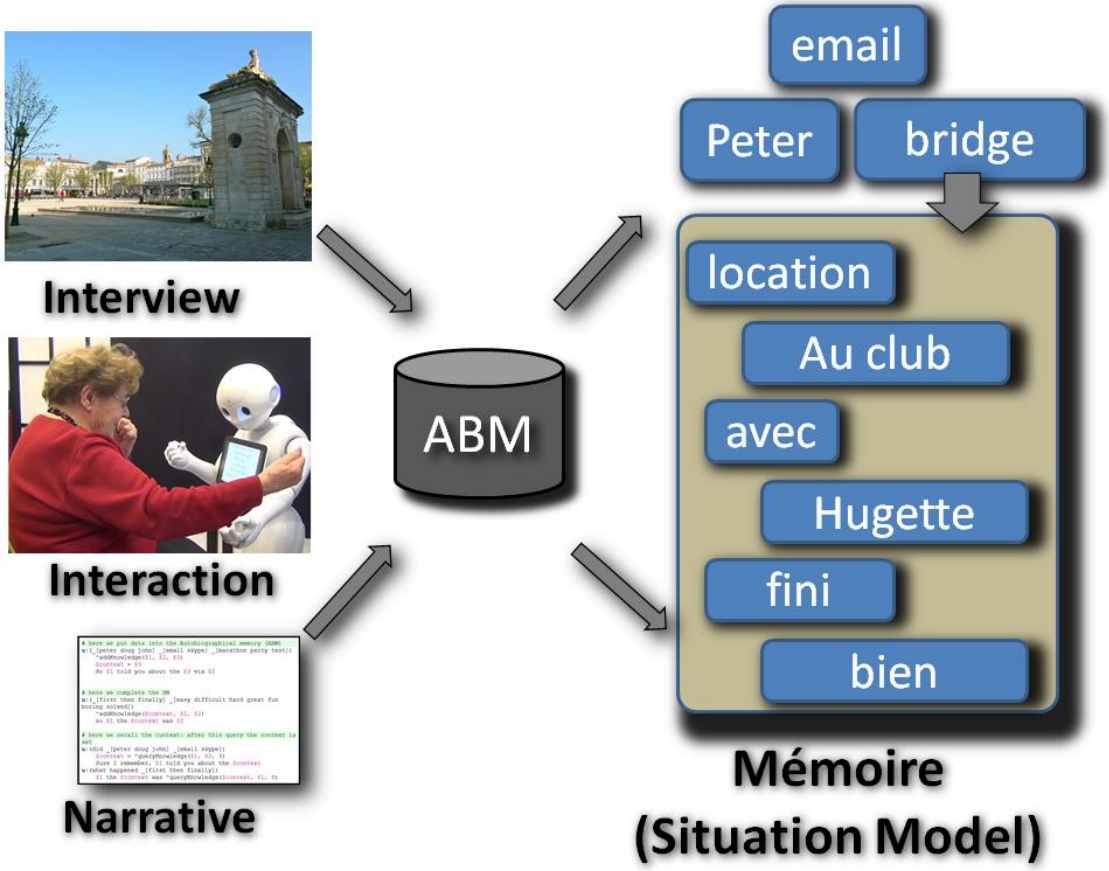
Objectif ?

Créer un compagnon narratif destiné à servir de pont social entre le sujet et son entourage en lui permettant de continuer à stocker le souvenir des expériences partagés.

Comment ?

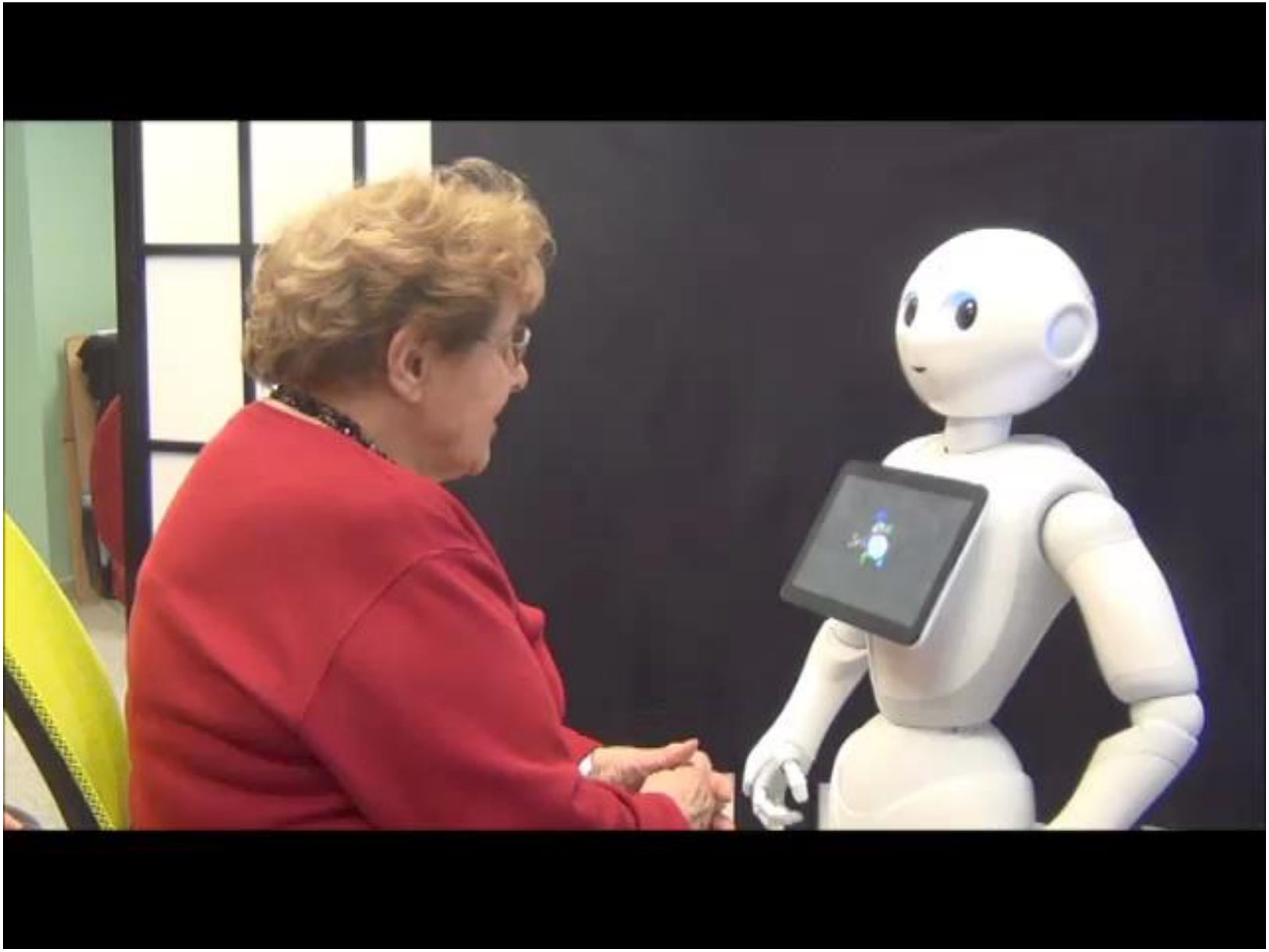
En donnant accès à la personne vieillissante, dont le système de mémoire est défaillant, à un système de mémoire permanent incluant vieux et nouveaux souvenirs.

Compagnon mémoire narrative

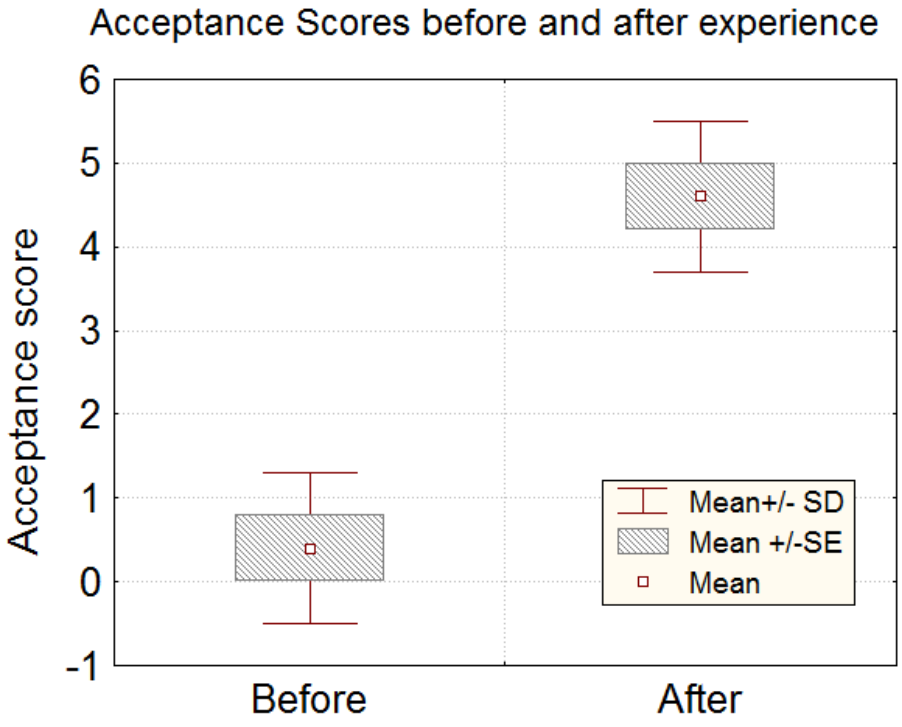


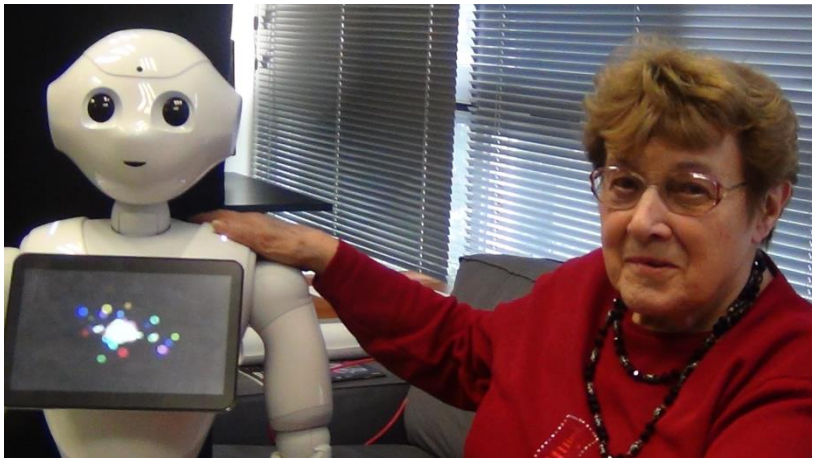
La mémoire autobiographique est remplie de

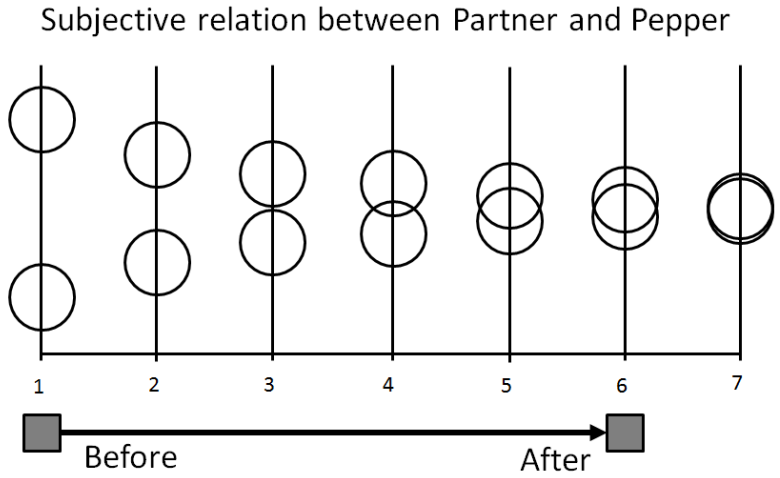
- souvenirs passés de l'interview
- nouveaux souvenirs de
  - Nouvelles expériences
  - Récit du partenaire humain
- Les souvenirs sont reconstruits
  - Dans la mémoire (modèle de situation), et
  - Raconté par le récit



Subjective Measures of Acceptance







Narrative Companion

Social Bridge

Partner

Compatriot

Progression

- Actions simples
- Plans partagés
- Mémoire autobiographique
- Structure narrative

- Des robots au service des personnes

La neurorobotique:
le robot humanoid dans la relation soi-autri

- La neurorobotique:
  - Une méthode pour tester nos hypothèses sur le fonctionnement du cerveau
  - Une méthode pour construire des robots sociaux les plus performants
- La relation soi-autri
  - Échange social entre soi et autrui est la base de l'esprit humaine
- Les robots humanoides
  - partager l'espace des humains, avec les humains
  - construire des représentations narratives de leur expérience commune avec les humains, au service des humains