Slide 1

Jak člověk reprezentuje polohu objektů: in silico studie

C. Brom, J. Vyhnánek, R. Kadlec
MFF UK

J. Lukavský
PSÚ AV ČR

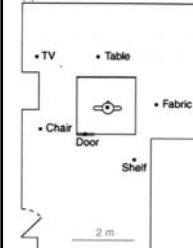**D. Waller**
Miami University, USA
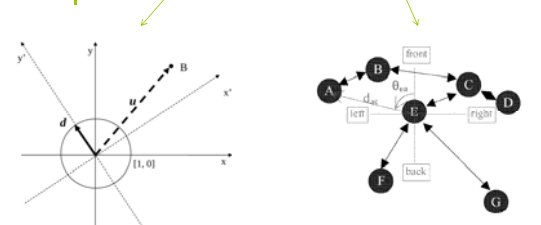
Slide 2

Motivation

- **Where** is the projector?
- What does it mean **"location"**?

- Different time span
  - short-term, inter-mediate term, long-term?

- Different modules
  - egocentric, allocentric, snap-shot?

Slide 3

Egocentric vs. allocentric

Slide 4

Outline

☐ Examples of real experiments

☐ Intelligent virtual agents
  - in silico models

☐ Our experiment in silico

Slide 5

Outline

☐ **Examples of real experiments**

☐ Intelligent virtual agents
  - in silico models

☐ Our experiment in silico

Slide 6

Allocentric vs egocentric representation

[Sholl, 2001]

☐ **Starting point:** Recent debate about whether representation of locations objects is either allocentric, or egocentric, or a combination [e.g. Wang & Spelke, 2003; Burgess, 2006]

☐ Typical proposals: Allocentric vs. egocentric
  - alloc: object-object or object-wall (LTM)
  - egoc: agent-object or place-object (STM)
  - egocentric = updated on-line

Experiment example

Experiment example

- 2 x 2 x 2 design
- Cf.
  - _ vs. C
  - _ vs. P
  - P vs. PC
  - P vs. PCT
  - P vs. PT
  - PT vs. PTC
  - T vs. TC

[Burgess et al., 2004]

Possible explanation

- The card is a landmark
- Both **on-line egocentric updating** and object-landmark links

Possible explanation

- The card is a landmark
- Both **on-line egocentric updating** and **object-landmark links**

But do you really believe that?

- We can **model** the experiment **computationally**…

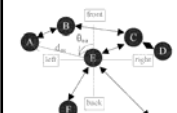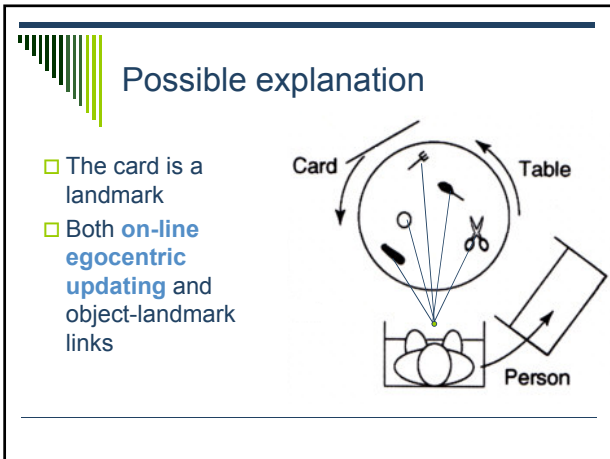## Outline

- Examples of real experiments

- **Intelligent virtual agents**
  - **in silico models**

- Our experiment in silico

Intelligent virtual agent
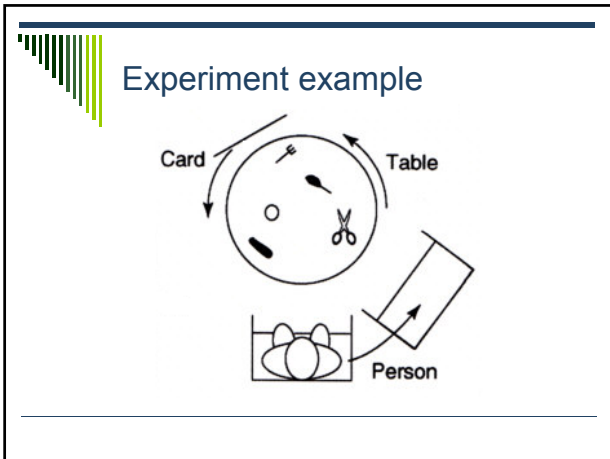
- A piece of software that **imitates** human behaviour in a (typically) interactive virtual environment and that is equipped with a **virtual body**.
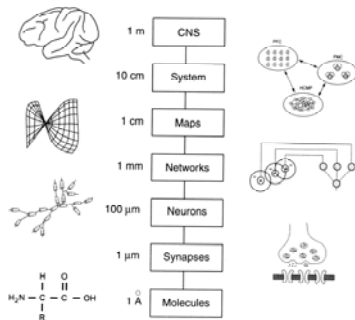- **Believability**, imitation, cheating,...

Mission Rehearsal Exercise, Marsella et al., 2003

Notes on Int. Virtual Agents

- ☐ Computer games
- ☐ 3D simulations

- ☐ Believability vs. plausibility
  - ☐ **Artificial intelligence** vs. *computational modelling*

- ☐ In silico models
  - matlab
  - robots
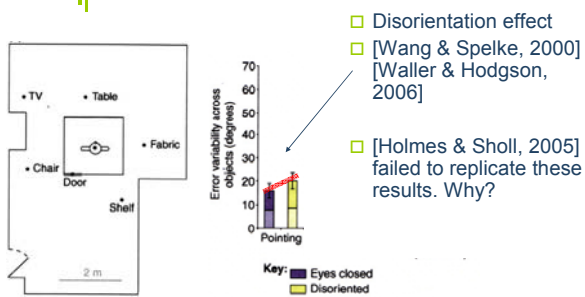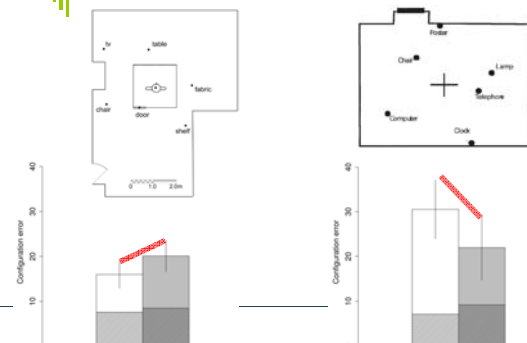 - intelligent virtual agents

Notes on levels of modelling

Outline

- ☐ Examples of real experiments

- ☐ Intelligent virtual agents
  - in silico models

- ☐ **Our experiment in silico**

Motivation

- ☐ Disorientation effect
- ☐ [Wang & Spelke, 2000] [Waller & Hodgson, 2006]

- ☐ [Holmes & Sholl, 2005] failed to replicate these results. Why?

Waller   vs.   Holmes

Hypotheses

- ☐ The booth is the culprit
  - ▪ i.e. the number of perceived objects at a particular moment, integrated over the whole learning phase
  - ▪ suprisingly, this is a new idea
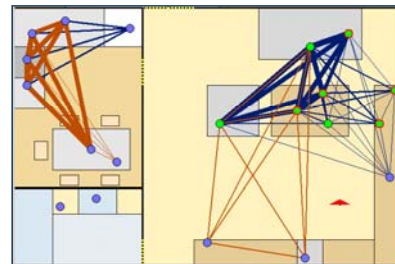
Hypotheses

- ☐ **1:** more accurate object-object representations sooner in the Holmes's than in the Waller's setting
- ☐ **2:** quantitative replication of Waller and replication of the reverse trend in Holmes (with the same parameters)
- ☐ **3:** dtto Waller without the booth vs. Waller with the booth
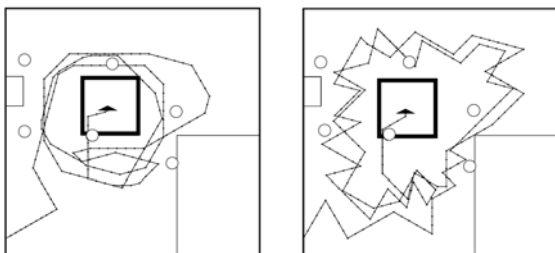
Virtual agent

- ☐ 2D environmental geometry: given
- ☐ Agent-object links (egocentric)
- ☐ Place-object links (allocentric)
- ☐ Object-object links (allocentric)
- ☐ Object-wall links (allocentric)
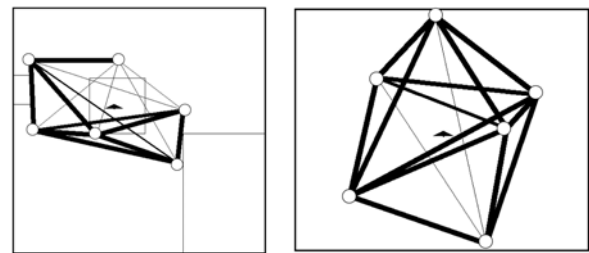- ☐ Incremental with a decay
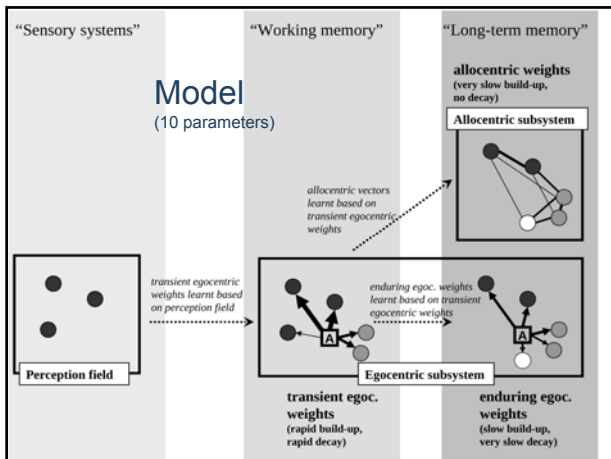- ☐ Exact vs. Gaussian
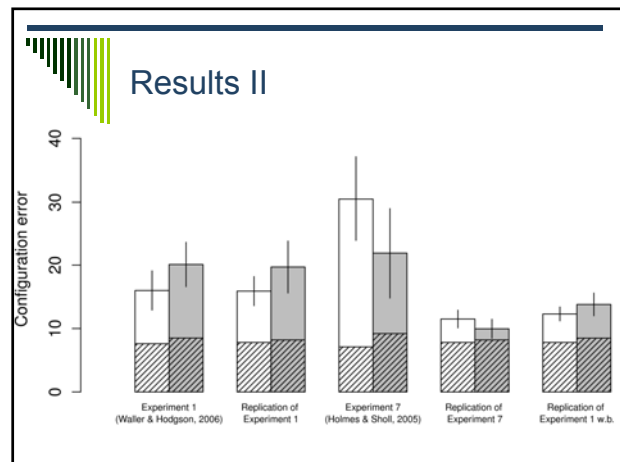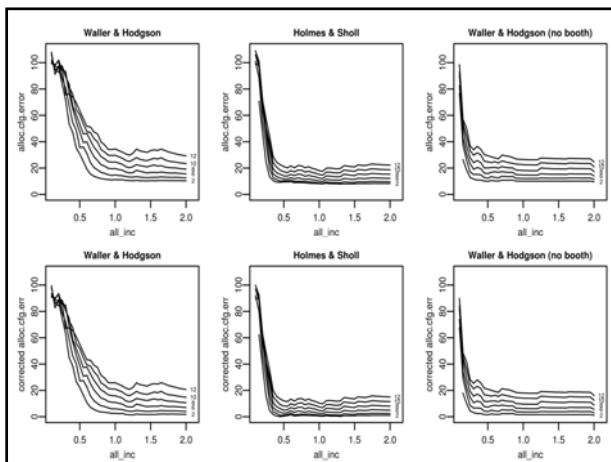
Virtual agent

Example of trajectories

Examples of allocentric representations

Slide 1: Model

"Sensory systems" | "Working memory" | "Long-term memory"

Model
(10 parameters)

allocentric weights
(very slow build-up, no decay)

Allocentric subsystem

allocentric vectors learnt based on transient egocentric weights

transient egocentric weights learnt based on perception field

enduring egoc. weights learnt based on transient egocentric weights

Perception field

Egocentric subsystem

transient egoc. weights
(rapid build-up, rapid decay)

enduring egoc. weights
(slow build-up, very slow decay)

Slide 2: Results I

Results I

□ Varying
  □ the speed of allocentric learning
  □ the level of total memory noise
    □ storage, maintenance, reconstruction

Slide 3

Waller & Hodgson | Holmes & Sholl | Waller & Hodgson (no booth)

Waller & Hodgson | Holmes & Sholl | Waller & Hodgson (no booth)

Slide 4: Results II

Results II

Configuration error

Experiment 1 (Waller & Hodgson, 2006) | Replication of Experiment 1 | Experiment 7 (Holmes & Sholl, 2005) | Replication of Experiment 7 | Replication of Experiment 1 w.b.

Slide 5: Conclusion specific

Conclusion specific

□ The number of the perceived objects is a key variable
□ The egocentric data of Holmes remains the enigma

□ Next steps: real replication?

Slide 6: Conclusion general

Conclusion general

□ Support the existence of (at least) to parallel modules

□ Virtual agents are a powerful tool for computational psychology

[Brom, Vyhnanek, Lukavsky, Waller, Kadlec: Cognitive Systems Research, accepted]

Questions?