Virtual reality and affective gaming based cognitive training

M.Sc. Thesis project, progress report
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TU Delft

Delft University of Technology

- 5 months project work at ETH Zurich

IRIS

Institute of Robotics and Intelligent Systems

SMS

Sensory-Motor Systems Lab

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In this presentation

Introducing

motivation and game based training

A study designed to investigate motivating training design

Overview of the software in development

Challenges in VR based therapy

- Gaming factors can be used to increase patient motivation and adherence.
- Interface challenge: wires, displays and peripherals.
- Engineering challenge: proper support for data mining, extraction & analysis (for therapists).
- Preventive training during preclinical stage may increase cognitive reserve and resilience to pathology.

Source: Adapted from Rizzo & Kim, 2005, A SWOT analysis of the field of virtual reality rehabilitation and therapy

Affective gaming

- *Affective computing*: computers and programs which take the player's affective (emotional) state into account.

- *Affective gaming*: affective games adapt their content based on the player's (inferred or measured) emotional state.

- High level design heuristics: "Emote me, assist me, challenge me".

Sources: Picard, 2000, Affective Computing

Gilleade et al, 2005, Affective videogames and modes of affective gaming

Generic design heuristics: challenge me

- Adapt game difficulty based on inferred skill level of the player.

- Multiple training modes:
  - Normal: fixed number of trials.
  - Time limited.
  - Continue until 1 incorrect response given.
  - Continue until 3 incorrect responses given.

- Record scores and virtual medals to show a history of player achievements.

Generic design heuristics: assist me

- Provide multimodal (supportive) feedback on task goals and performance.
- Engage peripheral vision by offering additional depth cues.
- Allow player to verify what was done correctly or incorrectly

Generic design heuristics: emote me

- Adapt game difficulty based on inferred emotional state of player.

- Use of music and sound effects to influence mood and emotion.

Designing motivating training scenarios

- Principal research questions:
  - Does the use of affective game based training influence the rate of learning and motivation, when compared to a standard computer based training?
  - Does the use of devices which support more natural and embodied interaction lead to a higher rate of acceptance by the targeted population?

Study protocol

- Targeted population:
  - 1st study: healthy elderly.
  - 2nd study: elderly with mild cognitive impairments.

- In a single session each participant completes:
  1. A training round for a cognitive task.
  2. Two feedback rounds (background & motivation).
  3. A performance assessment round for a cognitive task.

Round	Duration (min)	Group 1 (n=26, control)	Group 2 (n=26)
Introduction	5		
Questionnaire 1	5		
Training	22	Standard computer based	Affective gaming based
Questionnaire 2	5		
Assessment	8	Standard computer based	Standard computer based

(based on expected large effect size, using an independent two-sample t-test, with power = .80, alpha=.05)

Research vehicle: Mental Rotation Task

Rationale for using the MRT in this experiment:

- As a widely used instrument for cognitive assessment it is particularly suitable for investigating generic gaming factors that influence motivation.
- As a visuo-spatial task it is particularly suitable for virtual and augmented reality.
- Stimulus complexity (and thus level of challenge) can be controlled precisely.

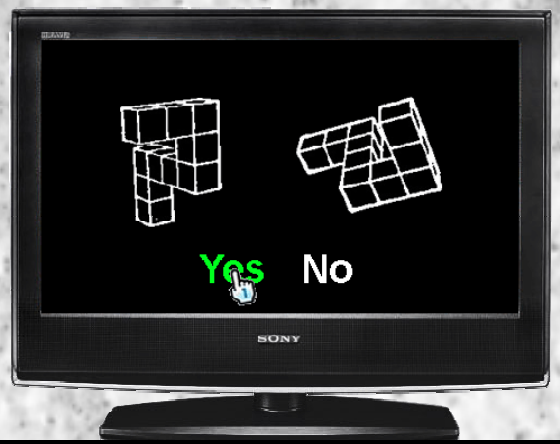
Sources: Rizzo et al, 1998, the virtual reality mental rotation spatial skills project

Hardware overview

Wii remote allows gestural interaction with virtual objects (pointing, dragging, selecting) and tactile and auditory output

IR LED glasses allow tracking of head position & gaze direction

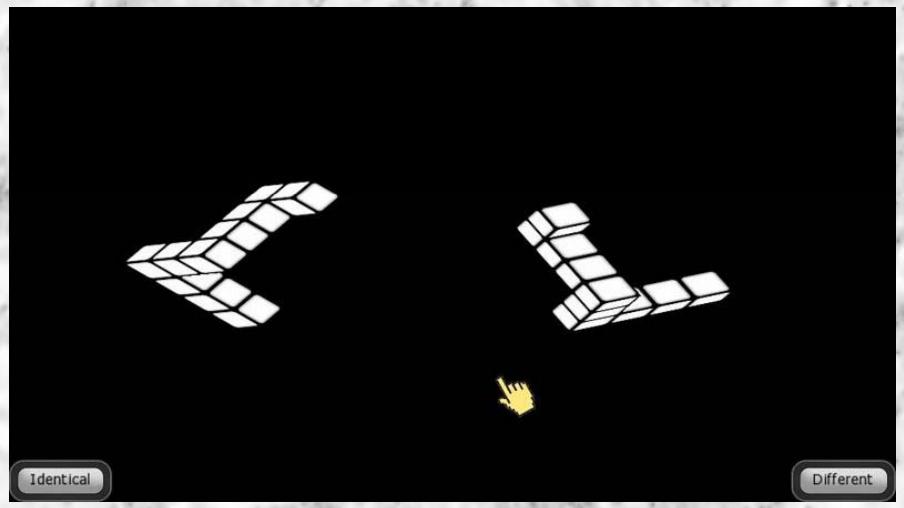
Training and Assessment



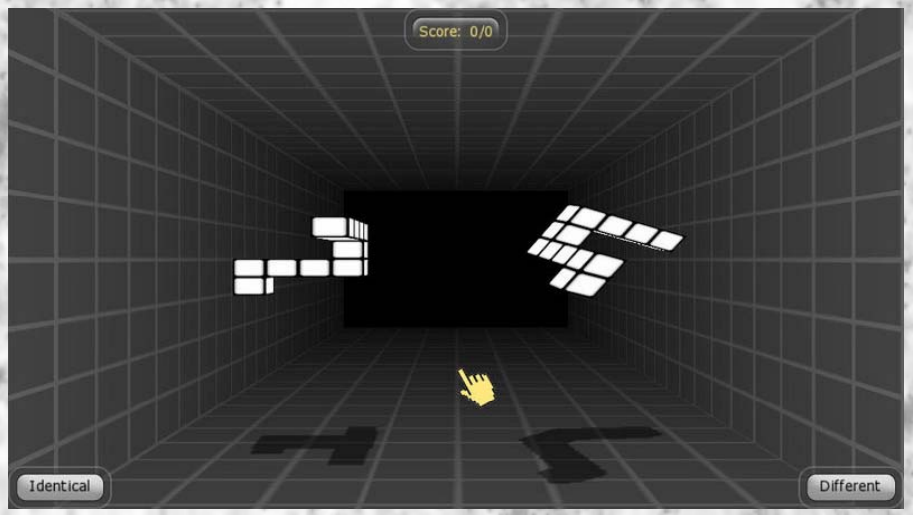
With headtracking support, a TV screen allows virtual objects to appear in front or behind of it

Software overview: training

Standard mode (training and assessment)



Affective mode(s)

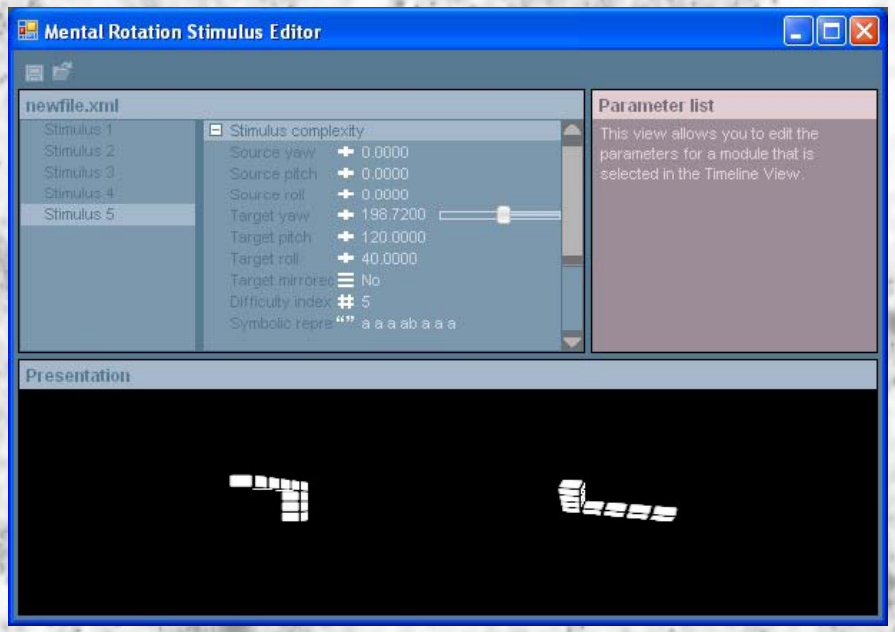


In general:

- Graphic and Interaction design aimed at elderly:
  - E.g. multimodal feedback (visual, auditory, tactile)
- Each mode starts with a brief introduction
- Can be fully operated with either a gamepad, a mouse, or a keyboard

Software overview: create & analyze

Stimulus profile editor for all game modes



Performance data recording and exporting:

Trial	Correct	RT	Symbolic stimulus	Difficulty	Mirrored	Source yaw	Source pitch	Source roll	Target yaw	Target pitch	Target roll
1	Yes	9.1116	a ae a a ad a ab a a	1	No	0	0	0	130	60	240
2	Yes	9.4008	a ae a a ad a ab a a	1	No	160	120	230	40	150	260
3	Yes	6.6543	a ae a a ad a ab a a	1	No	120	40	130	40	120	210
4	Yes	129.504	a ae a a ad a ab a a	1	Yes	70	130	120	80	160	260
5	No	7.006	a ae a a ad a ab a a	1	Yes	120	220	230	140	250	60
6	Yes	6.4255	a ae a a ad a ab a a	1	Yes	120	40	130	140	20	110

Project status

Sensory-Motor Systems Lab

Mar – Jun 2010

- Conduct pilot study with lab members.
- Obtain study approval from ‘ETH EK’.
- Conduct 1st study with healthy elderly.

Q4 2010 (TBD)

- Propose study to ‘Kantonale EK’.
- Conduct 2nd study with clinical population.

M.Sc. Thesis status

Delft University of Technology

Apr 2010 – Jul 2010

- Conduct pilot study with lab members
- Write, submit and defend thesis