Generative design* for virtual motor rehabilitation

* rule based generation of artistic output

How can the intrinsic properties of the digital medium aid therapy?

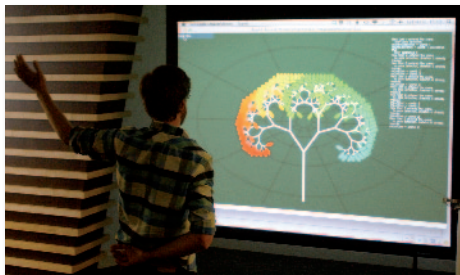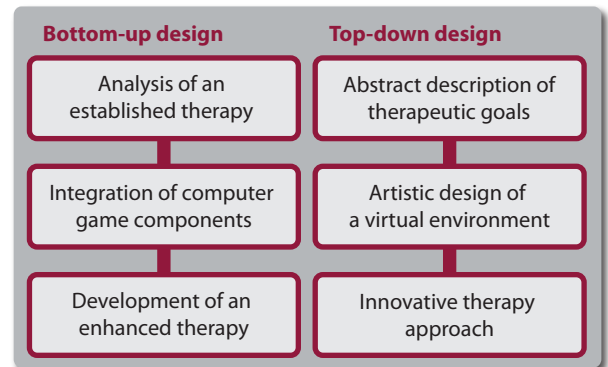### Designing systems for virtual motor rehabilitation

In virtual motor rehabilitation the technology plays a central role for the effectiveness of the treatment and designing the virtual environment is a crucial step. Approaches towards this goal may be classified into two poles: bottom-up design and top-down design.

Properties of the bottom-up approach:
- close integration of the virtual system into established therapy processes
- virtual elements are kept similar to their real world counterparts
- intense communication between developers, clinicians and patients is beneficial
- early user tests are possible

Properties of the top-down approach:
- focus on an innovative application of the digital medium
- loose coupling with established processes
- artistic and fictive design of the virtual environment
- advanced prototype is needed before beginning with the user tests

| Bottom-up design	Top-down design
Analysis of an established therapy	Abstract description of therapeutic goals
Integration of computer game components	Artistic design of a virtual environment
Development of an enhanced therapy	Innovative therapy approach

Top-down design for virtual mirror therapy

Mirror therapy is used in neurorehabilitation for patients following stroke or amputation. The therapeutic goal is to constitute a visual illusion of bilateral symmetric movement according to patients' unilateral movement [1]. Established approaches show the affected limb according to the movement of the healthy limb using a mirror or a virtual environment [2].

The top-down approach is applied to the design of a system for virtual mirror therapy.

- artistic and fictive visualisations are used to constitute the illusion of bilateral movement
- generative algorithms transform the patient's movement into meaningful visual output
- the coupling between movement and visual effects needs to be explored
- the visual output is combined with music for an enganging experience that helps to concentrate on the illusion

Established approaches
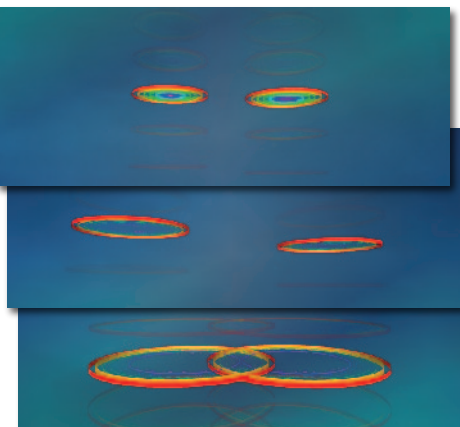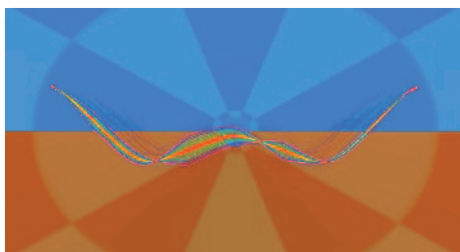
[1] Ramachandran VS, et al. (2009). The use of visual feedback, in particular mirror visual feedback, in restoring brain function. Brain, 132(Pt 7), 1693–1710.
[2] Murray, C. D., et al. (2007). The treatment of phantom limb pain using immersive virtual reality: Three case studies. Disability & Rehabilitation, 29(18), 1465–1469.

User Tests

18 user tests have been accomplished with a prototype of the virtual mirror therapy system.
- approximately 5 minutes treatment
- switching between 3 different visualisations
- 2 phases: bilateral manipulation and mirror therapy
- patients: stroke, brain injury by accident and spinal chord injury
- users were interviewed on their experience after the treatment

Preliminary results of the user tests:
- stroke and brain injury patients reported positive on the treatment
- some stroke patients showed higher activity in the affected limb in mirror therapy mode
- the lack of goals and tasks in the game was both valued and criticised
- purpose for this type of treatment was seen for warming-up, pain distraction and movement exercise
- clinicians used the system as tool to provide visual feedback for their instructions

Artistic environments encourage exploratory behaviour!

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