

Therapeutic Presence Virtual Illusions for Neurorehabilitation

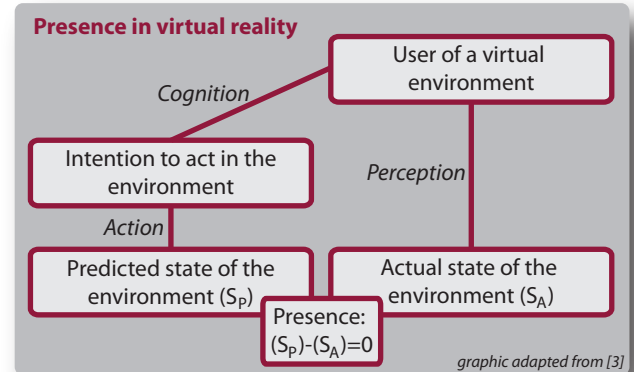
How can the intrinsic properties of the digital medium aid therapy?

Virtual reality and presence in neurorehabilitation

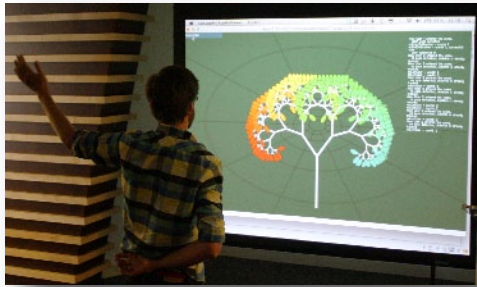
Virtual reality plays an increasingly important role in neurorehabilitation. Virtual illusions of movements can be used to trigger corresponding neurologic activity in the observer because the brain prioritizes visual over proprioceptive feedback [1]. **We believe more in what we see than in what we feel regarding our limb positions.**

The term *presence* describes a related experience: the perceptual illusion of nonmediation [2]. Users perceive and react to sensorial stimuli of a virtual environment as if they were real. The experience of presence is strong when users can successfully transform their intentions into actions [3].

When virtual illusions are used for neurorehabilitation a strong experience of presence seems to be important for the therapeutic effect. Because computers can generate arbitrary visual feedback based on recorded movements, presence can be influenced. This offers chances for **innovative therapy approaches not possible without the technology.**



[1] Moseley G. L., et al. (2008). Is mirror therapy all it is cracked up to be? Current evidence and future directions. *Pain*, 138(1), 7–10.
[2] Lombard M., et al. (1997). At the heart of it all: The concept of presence. *Journal of computer-mediated communication*, 3(2), 20.
[3] Riva G. (2009). Is presence a technology issue? Some insights from cognitive sciences. *Virtual Reality*, 13(3), 159–169.



Artistic virtual environment for 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 [4]. Established approaches show a moving limb on the affected side according to the movement of the healthy limb using a mirror or a virtual environment [5].

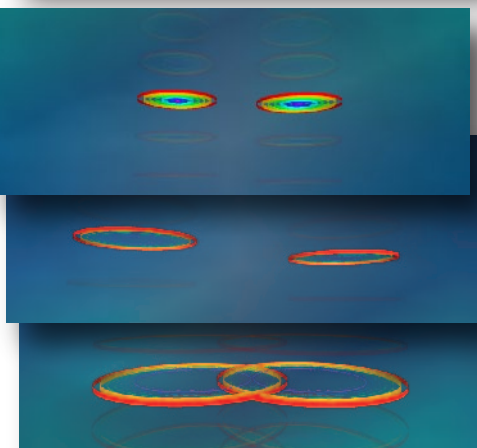
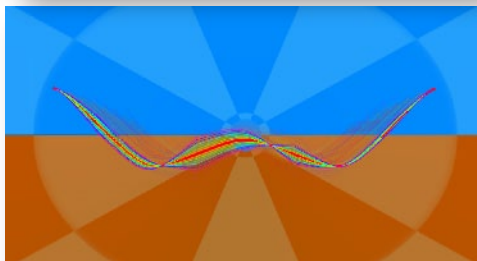
A virtual environment is developed to investigate artistic and geometric visual feedback for mirror therapy.

- artistic and geometric 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 engaging experience that helps to concentrate on the illusion

Established approaches



[4] 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.
[5] 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 and spinal cord 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!