Abstract virtual environment for motor rehabilitation after stroke

Preliminary results from a pilot study

AVUS therapy system

The AVUS-system [1] utilizes **abstract and fictive visualizations** of human upper body movements to foster exercise and motor learning after a stroke. The patients' movements are captured and transformed to generate aesthetic visuals with different levels of abstraction. Continuous interaction is provided meaning that every movement results in an immediate visual effect. During the therapy the patients explore in a **self-directed** manner their possibilities to produce various shapes. At the same time they exercise at their limits of motion. **Music** is played and used as input to manipulate the visualizations, too. The concept aims to allow for a **high level of presence** [2], which helps to concentrate on the virtual effects of the movements.

A distinct mode of operation applies the **mirror therapy principle** [3]. In this mode the movements of the unaffected body side are captured and then used to manipulate both sides of the visuals. An illusion of symmetric bilateral movement will be established for the patient. The mirror-therapy-mode aims to enhance motor learning on the affected side.

[1] Schüler T (2012). Generative Design as a method to foster explorative behaviour in virtual motor rehabilitation. 9th ICDVRAT, Laval 2012.
[2] Lombard M, et al. (1997). At the heart of it all: The concept of presence. Journal of computer-mediated communication 3(2).
[3] Ramachandran VS and Altschuler EL (2009). The use of visual feedback, in particular mirror visual feedback, in restoring brain function. Brain 132(7).
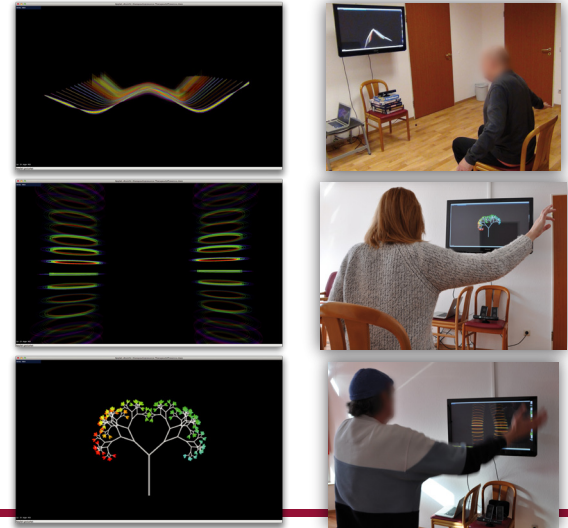
Pilot study

The effects of training with the AVUS-system for motor rehabilitation of patients suffering from a stroke were tested in a pilot study that followed a **controlled case-series** design. **8 hemiparetic patients** (5 EG, 3 CG) in the sub-acute phase after stroke have been tested during their stay in a neurological rehabilitation center. The experimental group (EG) was trained daily with the AVUS-system. The control group (CG) received unspecific upper-limb movement training while listening to background music. Both groups received their treatment for approximately **15 minutes on 5 successive days** in addition to their standard rehabilitation program.

Each day of the intervention the procedure for the EG followed three phases. 1) The patients **observed** visualizations of prerecorded movements and mentally imagined performing the corresponding movements. 2) The patients **explored** the three visualizations each for 90 seconds while operating the system with both upper body sides. 3) The **mirror-therapy-mode** is utilized in the exact same progression. Between all phases short relaxation breaks took place.

Preliminary hypotheses:

A) AVUS-training improves motor function in the hemiparetic limb
B) the self-directedness amplifies subjective performance ratings
C) motor imagery ability correlates with therapeutic outcome
D) presence experience correlates with therapeutic outcome
E) higher exercise rates are expected during mirror-therapy-mode

Methods:

Fugl-Meyer score upper extremity (**FM**)
Colored analogue scale self-rating (**CAS**)
L/R recognition of hand images (**L/R**)
iGroup Presence Questionaire (**IPQ**)
AVUS log data
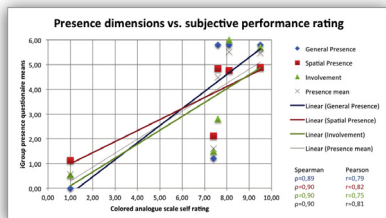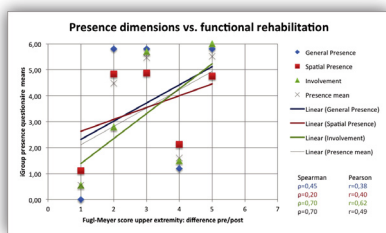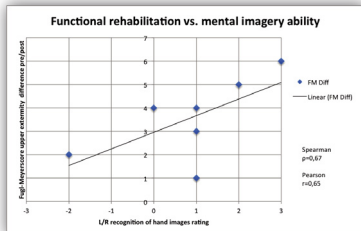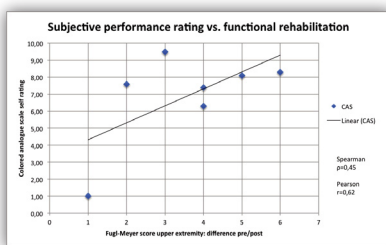
Statistical results

All participants completed the study protocol, however one patient (CG) suffered a fall accident and had to be excluded from statistical analysis. Patients in both groups improved motor function similarly. Hypotheses:

A) open for further investigation
B) indicator: strong correlation between experienced presence and subjective performance rating
C) tendentially confirmed
D) tendentially confirmed
E) AVUS log data (Kinect/OpenNI) was too inaccurate to be analyzed

TP	FM(%)	CAS	L/R	IPQ
SC	+5(38)	8.1	2	5.5
RI	+1(10)	1.0	1	0.6
KE	+6(14)	8.3	3	x
RE	+3(20)	9.5	1	5.5
HG	+2(4)	7.6	-2	4.5
NE	+4(14)	7.4	0	1.6
WE	+4(24)	6.3	1	x
x̄: 5±1.41			Control group	
x̄: 3±1.58			Experimental group	

Confirming the case-series design additional data was collected from each patient in the EG detailing their individual anamneses and semi-structured interviews were conducted. A first examination of this data revealed a good fit between the statistical results and subjective reports. Those patients who scored high were generally positive about the new therapeutic approach. Further analysis is pending.

Artistic environments encourage exploratory behaviour!

Thomas Schüler*, Sonja Drehlmann´, Friederike Kane´, Harry von Piekartz´
*University of Osnabrück, ´University of Applied Science Osnabrück
Email: thschuel@uos.de
Web: www.thomasschueler.de

UNIVERSITÄT OSNABRÜCK

Hochschule Osnabrück
University of Applied Sciences

HEINRICH BÖLL STIFTUNG