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fun.tast.tisch. – User-Centered Design for Interactive Tabletop Interfaces in Neuro-Rehabilitation

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Abstract

The application of tabletop computers and their user interfaces has been explored in different fields during the past years. In the area of rehabilitation, there are only few examples, usually not coupled with an extensive evaluation of both usability and therapeutic progress. This paper introduces the fun.tast.tisch. project which aims at the development of exercises applicable in rehabilitation after acquired brain injury, following an iterative process of user-centered (interaction) design.

1 Introduction and Problem Statement

Daily life routines change immediately after brain injury or stroke. Different types of motor, sensory or cognitive impairments effect the reintegration back to work or social environment. The rehabilitation process aims at improving the performance in daily life. Multidisciplinary teams enable participation in meaningful activities and enhance patients' ability to engage in routine occupations. Technological advancements influence therapeutic practice and facilitate new ways of intervention. Beyond conventional therapy methods, e.g., sensorimotor training or guided limb manipulation, virtual rehabilitation uses virtual reality (VR) to improve abilities. While studies report the benefits of new media in therapy, there still is a need for further evaluation of therapeutic effectiveness and user acceptance (Saposnik & Levin, 2011). MS PixelSense (PS)[1] offers a vision-based surface recognizing fingers, hands and objects. The opportunity to connect manipulation of real objects with VR offers promising aspects for rehabilitation. fun.tast.tisch. uses PS technology for rehabilitation after brain

[1] http://www.microsoft.com/en-us/pixelsense/pixelsense.aspx

injury, focusing on basic cognitive functions. A multidisciplinary team including occupational therapists, experts in assistive technology, software development, interaction, graphic and object design, and usability was set up to examine therapeutic benefits together with patients in clinical practice. Exercises are intended to support individual rehabilitation goals and take over administrative tasks. The application of new technologies should not replace but supplement conventional therapeutic interventions.

2 Related Work

Virtual rehabilitation includes manifold manifestations, e.g., motor trainings using virtual environments (Lucca, 2009) or rehabilitation with video games (Halton, 2008). Our focus, however, is on design, development and application of tabletop-based user interfaces for rehabilitation. (Annett et al., 2009) describe a tabletop system for upper extremity motor rehabilitation, focusing on benefits of interactive tabletop games in general as well as the repeatability and measurability of patients' actions. While in their system no physical objects are used for interaction, most modules developed within fun.tast.tisch. rely on interaction with real objects, because several rehabilitatively approved exercises like Tangram (Bublak & Kerkhoff, 1995) build upon activities that cannot be performed with virtual objects. (Dunne et al., 2010) use tabletops (including interaction with physical objects) in upper extremity rehabilitation for children with cerebral palsy. An additional input modality is a wearable accelerometer that enables patients to manipulate games by changing their posture. The approach, however, deals with rehabilitation for cerebral palsy patients exclusively.

3 User-Centered Design in fun.tast.tisch.

Within fun.tast.tisch., up to ten modules supporting patients and therapists during the rehabilitation process will be developed. To consider users' needs and limitations, an iterative, user-centered approach following the four basic steps of interaction design (Sharp, Rogers, & Preece, 2007) was pursued. The subsequent paragraphs reference our first module, Tangram. Tangram is a dissection puzzle consisting of seven basic shapes ("tans", e.g., triangles). Users have to form a complex shape (e.g., house) arranging the tans. Our version of Tangram supports the automatic recognition of physical Tangram tiles by the tabletop.

Establishing Requirements. First, occupational therapists deduce a comprehensive module description from findings that support Tangram's applicability in neuro-rehabilitation. Further, the description explains the use of similar conventional therapy methods and discusses potentials and threats. Since we aim at enhancing formerly conventional trainings, it is most important to comprehend the therapeutic backgrounds. Next, a Hierarchical Task Analysis (HTA) is derived. HTA is a process of breaking down tasks into sub-tasks, sub-subtasks, etc., resulting in a hierarchical structure; it focuses on physical and observable actions that are performed rather than on software or hardware-specific characteristics, which is beneficial in the context of fun.tast.tisch. Not only should the obvious parts of a setting be integrated into our system but also those that have formerly not been considered by therapy software (e.g., physical objects recognized by the tabletop like Tangram tiles).

Developing Alternatives. On the basis of the HTA, mock-ups are created by interaction designers. So far it was useful to maintain a reasonable level of abstraction regarding control elements and the overall interface to leave enough creative space for the (graphic) designers to fill. Figure 1 shows a mock-up of the Tangram module's configuration dialogue and the respective graphical prototype. Between these two steps, a Cognitive Walkthrough, in which all relevant stakeholders participate, is held.

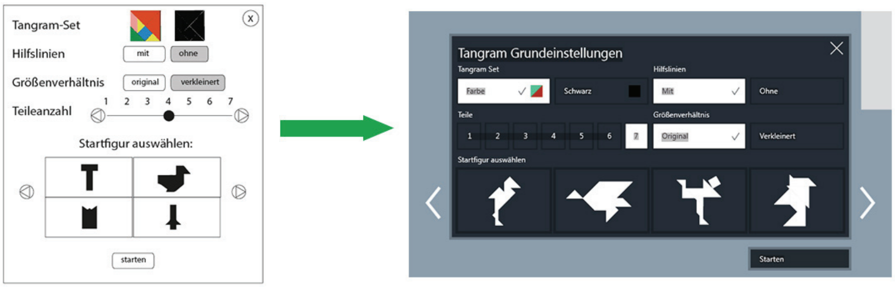

Figure 1: Mock-up based on HTA (left) and corresponding graphical design (right)

Building Interactive Versions. Software developers create functional prototypes on the basis of graphical ones and the HTA. In parallel, the physical objects needed for the module are created by object designers. The results have to allow for sufficient interactivity to conduct user tests in a first evaluation phase.

Evaluation. Therapists and patients are asked to work with the prototypes and provide feedback (usability and user experience are the most important criteria). Intermediate results for Tangram are promising and findings are fed back into the process before starting the second evaluation phase in which an extensive user study will be conducted. Feedback of patients and rehabilitation staff will be collected via (half-) standardized interviews and surveys. Again, results of this phase will be considered for a re-design and -evaluation cycle.

4 Discussion and Future Work

As we follow an iterative development process, there are several modules in different phases of evolution at the same time. At the moment, the first three modules (among them Tangram) are in the software development state or first evaluation phase. The next phase will thus be related to exhaustive evaluation which is currently being prepared. It will take place from July to August 2013 in a clinic for neuro-rehabilitation in Upper Austria. Twelve therapists and numerous patients (divided into three subgroups) will work with fun.tast.tisch. and provide feedback. Additionally, in 2014, there will be a Randomized Controlled Trial to evaluate effectiveness. One group of patients working with fun.tast.tisch. will be compared to a control group receiving conventional therapy.

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