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GUEST EDITORIAL
Cognitive Engineering in Mental Health Computing

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Computer applications in the support of mental healthcare and rehabilitation are becoming more widely used. They include technologies such as Virtual Reality (VR), electronic diaries, multimedia, brain computing and computer games. Research in this area is emerging, and focuses on a variety of issues such as clinical effectiveness of a computer supported intervention, usability of a system, human values that are affected by a technological intervention, actual use, acceptance, and accessibility of these systems. To classify and to understand the objectives of the work presented in this special issue the mental health computing research model is presented. This descriptive model identified four research categories: (1) technology elements, (2) technology intervention, (3) clinical effect, and (4) field use. Each category has its own focus, methods and set of researchers.

Keywords: Cognitive Engineering, Mental Health Computing, Research Model

Special Issue

Mental disorders make up a large amount of the global burden of disease, with an estimation of 14% attributed to neuropsychiatric disorders, and 28% of non-communicable diseases (Prince et al., 2007). Computer support in the diagnosis, care or rehabilitation of these disorders is increasing, motivated by the improvement of effectiveness or more efficient use of healthcare resources. Computer support in prevention programs to make individuals more resilient against mental stress and enhance their overall mental wellness is also receiving research attention. Considerable attention has been devoted to studying the efficacy of some of these systems, and some attention is now being given to the use of these technologies, for example, in a recent special issue in the Interacting with Computers journal (Doherty & Bickmore, 2010). As has been recognized in areas such as consumer electronics and office applications, the interplay between technology and humans is an important factor in determining the use and acceptance of technology. Likewise, as a result, these aspects also seem to be important in the domain of mental health computing, considering the use, acceptance and accessibility of computer support systems for clinical psychology and also the human values these systems effect. This special issue, therefore, focuses on cognitive engineering for technology in mental healthcare and rehabilitation, or more specifically, mental health computing. While cognitive engineering is an approach to analyze, model, design and evaluate interactive, complex systems, cognitive ergonomics is a relatively young branch of science, which focuses on the reciprocal influence between work and the human mind (Hollnagel, 1997), which often nowadays involves the use of computer technology. In this context, work could mean the activities of the therapist, for example, when administering treatment, but also include physical or mental efforts of a patient to accomplish a specific goal. Enhancing knowledge in this area seems essential, as computer support systems for mental health are becoming more complex as multiple actors are supported (e.g. patients, therapists, technical support, social support network, daily care takers), systems are distributed over time and place (e.g. a-synchronized, mobile, and remote care or treatment), and technologies are become more sophisticated (e.g. physiological sensors, artificial intelligent, multi modal interaction). Adding to the complexity of the situation is also the mixture of mental health researchers and technology oriented researchers that are active in this field. However, their involvement differs widely depending on the research focus, which often becomes visible in evaluation activities. For example, some talk about a two-stage approach for the collaborative process between these two types of researchers in the design of this type of technology (Coyle, Doherty, Matthews, & Sharry, 2007), one focusing on the design and development of technology, and the other on the clinical evaluation. Moving from a development view to a research view, research can be placed into four categories (Figure 1), each with their own focus, methods and involvement of researchers.

These categories are (1) technology element, focusing on the specific technology component and its effect on interaction with humans; (2) technology intervention, focusing on the design of a usable and acceptable computer support system; (3) clinical effect, focusing on clinical effectiveness of computerized intervention, and (4) field use, focusing on the use of the computerized intervention in the field. From an intervention perspective, these categories might appear to be successive stages. However, for the researchers involved, especially in the technology element category, a specific intervention might not yet be envisioned. In the opposite direction of the technological innovation is the information flow from the clinical field. This includes feedback about the effect of current technology intervention in the field; problems or limitations of non-technology supported treatment and care; and also new opportunities due to new theories or enhanced clinical knowledge. It is also important to acknowledge values. For example, patient autonomy, respect, and privacy are human values that drive demands and acceptance of technological innovations. With a focus on cognitive engineering, the contributions in the special issue particularly address research in the technology element and intervention categories. Whereas research in these two categories also includes evaluation, in the clinical effect category evaluation is clinical, often directly including the target group, e.g. the patients, with a strong involvement of mental health researchers. Before large scale randomized controlled trails (RCT) are conducted, such as a comparison of the treatment effect between treatment with and without technology intervention (Botella et al., 2007; Krijn et al., 2007), small pilot studies are often carried out, ensuring that researchers have a sufficient understanding about potential additional clinical factors, and ensuring that the technology is stable and usable. RCTs are time consuming, and technological innovations are often frozen once the RCT is underway. One such pilot study is presented by Hourani, Kizakevich, Hubal, Spira, Strange, Holiday, Bryant, and McLean in this issue. These authors compared the efficacy of a newly designed stress inoculation training (SIT) based intervention, predeployment SIT (PRESIT), with current best practices, in this case the U.S. Navy and Marines' combat and operational stress control programs. PRESIT includes a multimedia stressor environment (MSE) that allowed individuals to travel

<table>
<tr><td colspan="4">← Identified problems, opportunities and values ←</td></tr>
<tr><td colspan="4">→ Technological innovations →</td></tr>
<tr><th>Technology element</th><th>Technology Intervention</th><th>Clinical effect</th><th>Field use</th></tr>
<tr><td>Focus on effect of technology components that affect the interactions with a user

Methods include, for example, lab studies, often with non-patients

Strong involvement of technology-oriented researchers</td><td>Focus on establishing usable technological health intervention

Methods include both design activities and, for example, usability studies, often with non-patients, but also with therapists

Often multidisciplinary team</td><td>Focus on efficacy of treatment with technology intervention

Methods include case studies and randomized controlled trials with patients

Strong involvement of mental health researchers</td><td>Focus on daily practice on technology intervention

Methods include field observations, or surveys among patients and/or therapists

Involvement of clinicians</td></tr>
</table>

Figure 1. Mental health computing research model.

in a vehicle through an Iraqi village in a virtual scenario, encountering enemies or events such as explosions, but also cues individuals had to react on to test their reaction time. The results of the pilot study showed support for the MSE and PRESIT in general.

Research in the field use category can also examine clinical efficacy, however, this time in a practical, less controlled setting, for example, a study about observations made in nearly 500 virtual reality (VR) therapy sessions in a clinic (Wiederhold & Wiederhold, 1999). The use and usability problems can also be studied in the field, as was done, for example, during field observations on how therapists used a VR exposure therapy system in the treatment of fear of flying (Brinkman, Sandino, & van der Mast, 2009; Brinkman, van der Mast, Sandino, Gunawan, & Emmelkamp, 2010). As technological innovations for mental healthcare and rehabilitation will become more established, research in this category is likely to increase.

The majority of the work presented in the special issue is focused on the technology element and innovation categories (Figure 2). Research that falls in the technology element category often provides knowledge that can be applied across multiple technology interventions. A good example of this is the work of Busscher, de Vliegher, Ling and Brinkman presented in this issue. They present a study into physiological measurement and the evaluation on neutral VR worlds. Because of individual differences, the physiological baseline measurement is often done in a virtual environment without stressors. However, because of the technology novelty factor, individuals might already be aroused. Their study, however, showed that a neutral virtual world does not have to lead to an increase in arousal, a finding that is beneficial for VR interventions that use physiological measurements. The work presented by Brouwer, Neerincx, Kallen, van der Leer and ten Brinke also provides new insights which are relevant for interventions that apply a VR neuro-bio paradigm, for example, to treat stress-related disorders. They induced stress by simulating a bomb explosion in VR and by giving negative feedback to participants about their performance. Analyzing EEG, ECG and cortisol level, they found that stress was reflected in EEG mid-frontal alpha asymmetry, heart rate variability, and cortisol level. The last paper in the special issue that also can be placed in the technology element category is the work from Cherni, Kadri, Taruella, Joseph, Le Roy and Klinger. The technology element they studied was the screen size of a virtual system that delivered virtual information. They found that increasing the size of the screen improved their participants' perception of the visual information and had a positive effect on performance in the virtual task. Although this task is especially relevant as a part of cognitive rehabilitation intervention for patients with a brain injury, the finding also seems relevant for VR-based therapy in general, and for VR-based applications for non-patients such as virtual training environments. All three studies in this category used non-patients in their experiments, and in two studies this was combined with a group of patients.

As the work of Cherni et al. focuses on a specific intervention, it can also be placed in the technology intervention category. Likewise, the work of ter Heijden and

Technology element ←→ Technology intervention			**Clinical effect**
Evaluating Neutral VR Worlds (Busscher, de Vliegher, Ling, & Brinkman, 2011) Stress Responses in VR (Brouwer, Neerincx, Kallen, van der Leer, & ten Brinke, 2011)	VRE with automated free speech (ter Heijden & Brinkman, 2011) Display size and cognitive rehab (Cherni et al., 2011)	ICT for reminiscing (Mulvenna et al., 2011) Combined use of VR and Music for Rehab (Trobia, Gaggioli, & Antonietti, 2011) The Military – 3MR system (Brinkman, Vermetten, van den Steen, & Neerincx, 2011)	Predeployment stress inoculation training (Hourani et al., 2011)

Figure 2. Contributions to the special issue.

Brinkman, which focused on the treatment of social phobia in VR, has a technology element that is beneficial for the intervention of other mental disorders. Still, their work can be seen as an exploration of various design solutions of a specific intervention – VR-exposure for social phobic patients. They compared three types of automatic free speech implementations that allowed individuals to have a free speech dialogue with a virtual character in a VR environment. They set this against a control condition in which a human operated the verbal response of the character. The study included a group of non-patients and two phobic patients. On several measures the human control condition did not outperform all the automatic conditions, suggesting that an automated semi-scripted conversation might create a similar experience as a manually controlled conversation. Trobia, Gaggioli, and Antonietti also studied the feasibility of a technology intervention – an integrated training approach that combined VR technology and music to support stroke patients in the performance of mental practice. Over a period of eight weeks two stroke patients received treatment with the system, and results showed an increase in motor scores and an improvement in reported activities of daily living. Stroke rehabilitation, therefore, seems to be supported by this intervention. The idea of combining multiple modalities can also be found back in the Military Multi-Modal Memory Restructuring System put forward by Brinkman, Vermetten, van den Steen and Neerincx. Their system was designed to treat combat veterans with posttraumatic stress disorder and focuses on the restructuring and relearning of past events. They report on a series of design and evaluation activities to establish a technology intervention that was usable and enhanced storytelling. As the focus was on establishing a complete design solution, they followed a situated cognitive engineering approach (Neerincx & Lindenberg, 2008) to study the various factors and establish requirements and specifications. The use of design methods seems specifically relevant for the technology intervention category. The focus of these methods, however, should not be limited to technology but should also consider interaction with the various actors and their values as emphasised by value sensitive design methods (Friedman, Kahn, & Borning, 2006). For example, Mulvenna, Doyle, Wright, Zheng, Topping, Boyle and Martin, with their empirical evaluation of card-based and device-based reminiscing not only looked at usability, but also looked at the attitude of older people towards their system. They concluded that results showed no specific barriers to the usage of the system for reminiscing activities.

People Involved

In August 2010 the workshop "Cognitive Engineering for Technology in Mental Health Care and Rehabilitation" was held in Delft, The Netherlands as part of the European Conference on Cognitive Ergonomics. The workshop was organized by Willem-Paul Brinkman, Gavin Doherty, Alessandra Gorini, Andrea Gaggioli, and Mark Neerincx. The special issue is one of the outcomes of that workshop.

Many people have been involved in this special issue and especially the help of the Managing Editor, Emily Butcher, was much appreciated. The following people have acted as reviewers in the special issue:

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References

Botella, C., Garcia-Palacios, A., Villa, H., Banos, R. M., Quero, S., Alcaniz, M., et al. (2007). Virtual reality exposure in the treatment of panic disorder and agoraphobia: A controlled study. *Clinical Psychology & Psychotherapy, 14*(3), 164-175.

Brinkman, W. P., Sandino, G., & van der Mast, C. (2009). Field Observations of Therapists Conducting Virtual Reality Exposure Treatment for the Fear of Flying. *Ecce 2009 - European Conference on Cognitive Ergonomics, 258*, 169-176.

Brinkman, W. P., van der Mast, C., Sandino, G., Gunawan, L. T., & Emmelkamp, P. M. G. (2010). The therapist user interface of a virtual reality exposure therapy system in the treatment of fear of flying. *Interacting with Computers, 22*(4), 299-310.

Brinkman, W. P., Vermetten, E., van den Steen, M., & Neerincx, M. A. (2011). Cognitive engineering of a military multi-modal memory restructuring system. *Journal of CyberTherapy & Rehabilitation, 4*(1), 83-99.

Brouwer, A. M., Neerincx, M. A., Kallen, V., van der Leer, L., & ten Brinke, M. (2011). EEG alpha asymmetry, heart rate variability and cortisol in response to virtual reality induced stress. *Journal of CyberTherapy & Rehabilitation, 4*(1), 27-40.

Busscher, B., de Vliegher, D., Ling, Y., & Brinkman, W. P. (2011). Psysiological measures and self-report to evaluate neutral virtual reality worlds. *Journal of CyberTherapy & Rehabilitation, 4*(1), 15-26.

Cherni, H., Kadri, A., Taruella, A., Joseph, P. A., Le Roy, C., & Klinger, E. (2011). Virtual information display for cognitive rehabilitation: choice of screen size. *Journal of CyberTherapy and Rehabilitation, 4*(1), 73-81.

Coyle, D., Doherty, G., Matthews, M., & Sharry, J. (2007). Computers in talk-based mental health interventions. *Interacting with Computers, 19*(4), 545-562.

Doherty, G., & Bickmore, T. (2010). Special Issue Supportive Interaction: Computer Interventions for Mental Health Introduction. *Interacting with Computers, 22*(4), 241-242.

Friedman, B., Kahn, P. H., & Borning, A. (2006). Value sensitive design and information systems. In P. Zhang & D. Galletta (Eds.), *Human-computer interaction and management information systems: foundations* (pp. 348-372). Armonk, NY: M.E. Sharpe.

Hollnagel, E. (1997). Cognitive ergonomics: it's all in the mind. *Ergonomics, 40*(10), 1170-1182.

Hourani, L. L., Kizakevich, P. N., Hubal, R., Spira, J., Strange, L. B., Holiday, D. B., et al. (2011). Predeployment stress inoculation training for primary prevention of combat-related stress disorders. *Journal of CyberTherapy & Rehabilitation, 4*(1), 101-116.

Krijn, M., Emmelkamp, P. M. G., Olafsson, R. P., Bouwman, M., Van Gerwen, L. J., Spinhoven, P., et al. (2007). Fear of flying treatment methods: Virtual reality exposure vs. cognitive behavioral therapy. *Aviation Space and Environmental Medicine, 78*(2), 121-128.

Mulvenna, M. D., Doyle, L., Wright, T., Zheng, H., Topping, P., Boyle, K., et al. (2011). Evaluation of card-based versus device-based reminiscing using photographic images. *Journal of CyberTherapy & Rehabilitation, 4*(1), 63-72.

Neerincx, M. A., & Lindenberg, J. (2008). Situated cognitive engineering for complex tasks environments. In J. M. C. Schraagen, L. Militello, T. Ormerod & R. Lipshitz (Eds.), *Naturalistic decision making and macrocognition* (pp. 373-390). Ashgate, UK: Aldershot.

Prince, M., Patel, V., Saxena, S., Maj, M., Maselko, J., Phillips, M. R., et al. (2007). Global mental health 1 - No health without mental health. *Lancet, 370*(9590), 859-877.

ter Heijden, N., & Brinkman, W. P. (2011). Design and evaluation of a virtual reality exposure therapy system with automatic free speech interaction. *Journal of CyberTherapy & Rehabilitation, 4*(1), 41-56.

Trobia, J., Gaggioli, A., & Antonietti, A. (2011). Combined use of music and virtual reality to support mental practice in stroke rehabilitation. *Journal of CyberTherapy & Rehabilitation, 4*(1), 57-61.

Wiederhold, B. K., & Wiederhold, M. D. (1999). Clinical observations during virtual reality therapy for specific phobias. *Cyberpsychol Behav, 2*(2), 161-168.