Cyberpsychology, Behavior, and Social Networking
Volume 25, Number 10, 2022

DOI: 10.1089/cyber.2022.29257.ceu

Open camera or QR reader and scan code to access this article and other resources online.

Cognitive Rehabilitation in the Metaverse: Insights from the Tele-Neurorehab Project

Compiled by: Sara Ventura, PhD,[1,2] Giada Lullini, PhD,[3] and Giuseppe Riva, PhD[4,5]

This column will try to describe the characteristics of current cyberpsychology research in Europe. In particular, CyberEurope aims at describing the leading research groups and projects running on the other side of the Ocean.

Stroke and severe brain injury are the main causes of cognitive impairments resulting from brain damage that more frequently affects the parietal, frontal, midbrain, or brainstem structures. Injuries may be reflected in language, attention, memory, and executive dysfunctions, with a significant impact on daily life activities. After discharge from hospital, patients must undergo a long rehabilitation program to restore their cognitive and motor functions. However, only 25% of them recover completely, and the remaining 75% need constant and profound rehabilitation, varying from weeks to several months or years.[1]

Cognitive rehabilitation encompasses a wide range of therapeutic cognitive interventions to achieve functional changes for strengthening or reestablishing previously learned patterns of behavior or establishing new patterns of cognitive activities to compensate for impaired neurological systems. Nevertheless, most patients encounter many barriers in receiving medical attention due to geographical or time limitations, or to the loss of motivation in pursuing the rehabilitation, with negative consequences for treatment adherence.[2] Furthermore, in most countries, public hospitals are suffering from an economic crisis, resulting in a limited number of rehabilitators (developments in the health system have led to the number of stroke survivors doubling over the last 30 years). Thus, the healthcare system must be revitalized.

The Tele-Neurorehab Project

To overcome these issues, telemedicine is a possible option. It was first introduced in 1970s, and it refers to the practice of medicine using an interactive multimedia communication technology to replace the usual physical interaction between the healthcare professional and the patient.[3] Telerehabilitation has emerged as an alternative method of delivering conventional rehabilitation services to patients via technologies, allowing them to access services in their own homes or other locations with the aim of integrating and improving the effectiveness, efficiency, and appropriateness of rehabilitation.[4]

The potential of cognitive rehabilitation through virtual reality and exergaming has been demonstrated in the published literature.[4] However, there is a lack of studies investigating the feasibility of those rehabilitation programs administered via telerehabilitation, especially in clinical samples. For this purpose, a tele-neurorehabilitation project, Tele-Neurorehab, was developed within the SC Medicina Riabilitativa e Neuroriabilitazione, IRCCS ISNB, in Bologna, Italy, with the aim of investigating the feasibility and effectiveness of a rehabilitation protocol for people with severe brain injury after stroke or acquired brain injury. This project was founded by the Italian Ministry of Health (CE21122).

Rehabilitation is provided by an advanced technology system, the Khymeia HomeKit (http://khymeia.com/en/), which offers several exergames (i.e., playing with a virtual ball, drawing, fishing, imitating limb movements, etc.) that can be experienced at home using a portable PC or a tablet. The HomeKit can be further extended using the Khymeia VRRS—Virtual Reality Rehabilitation System—a Class I certified medical device.

Both the HomeKit and VRRS use a kinematic acquisition system that does not require any specific setting or reference to the starting position of the patient, being automatically generated by the system, thereby enabling exercises to begin straight away.

At the beginning of the treatment, patients and their caregivers receive brief training at the hospital to understand how to use the device. Then, they take the system home and perform the rehabilitation program autonomously for 4

[1]Department of Psychology, University of Bologna, Bologna, Italy.
[2]Instituto Polibienestar, University of Valencia, Valencia, Spain.
[3]IRCCS Istituto Scienze Neurologiche, Bologna, Italy.
[4]Humane Technology Lab, Catholic University of Milan, Italy.
[5]Applied Technology for Neuro-Psychology Lab, IRCCS Istituto Auxologico Italiano, Milan, Italy.

weeks, 5 days per week, with a weekly online session with the therapist. Each session last 50 minutes. To complete the program, patients must perform all 20 sessions.

According to Dr. Giada Lullini, the principal investigator of the project, the system allows the therapist to follow more patients than they would usually do in person at the hospital, thereby also improving rehabilitative efficacy. As Dr. Lullini explains, ''The scientific paradigms underpinning the system are ones of 'augmented feedback' and 'motor imagery.' The augmented feedback, through exercises performed in a digital platform, allows the 'knowledge of results' and the 'knowledge of performance' of movements to be developed. In this way, the central nervous system can activate a crucial mechanism of 'physiological learning,' producing as the final outcome an effective increase in performance quality.''

Results from a Pilot Study

The results of the pilot study using the HomeKit platform are promising. A total of 14 patients completed the Tele-Neurorehab protocol. Eight were men, and six were women, with a mean age of 49.21 years and with an average education level of 13 years. There were 11 patients with acquired brain injury (including hemorrhagic stroke) and three who had had ischemic strokes. Regarding adherence to the program, out of the total of 20 expected sessions, two patients registered fewer than 20 sessions (65% of the protocol), one patient registered 20 sessions (100% of the protocol), and 11 patients registered more than 20 sessions (125% of the protocol). Moreover, participants were very satisfied with the experience, with an average score of 3.61 (range 1–4) on the Client Satisfaction Questionnaire (CSQ-8).

The Next Steps: Adding the Social Dimension

The results of the pilot study will pave the way for the creation of a second generation of Tele-Neurorehab, which will aim to offer remote and immersive healthcare to a wider range of patients and to create a virtual community among patients and caregivers.

In fact, as underlined by Dr. Sara Castaldini, also involved in the project, a critical feature still missing in telerehabilitation is the social dimension: ''Many patients live in a non-stimulating environment and their caregivers are not able to support them effectively. In my view patients need to share their experience with others who have had the same problem, maybe practicing together the exergames and learn from each other.''

The emergence of the metaverse could fit this gap.[5] The metaverse is the result of the convergence between virtual and physical spaces, where users can interact within the augmented world, meet each other virtually, and immerse themselves in performing virtual activities that give real experiences.[6] As explained by Dr. Lullini, ''In contrast to traditional simulation technologies such as virtual reality or augmented reality, the metaverse is by definition a social technology. Moving telerehabilitation to the metaverse will allow the development of communities of patients who will share their problems and experiences within a digitally augmented rehabilitative setting. Moreover, differently from actual healthcare services, the rehabilitative experiences will be always available, really supporting the concept of continuity of care.''

References

1. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. The Lancet Neurology 2009; 8: 741–754.
2. Bayley MT, Hurdowar A, Richards CL, et al. Barriers to implementation of stroke rehabilitation evidence: findings from a multi-site pilot project. Disability & Rehabilitation 2012; 34:1633–1638.
3. Perednia DA, Allen, A. Telemedicine technology and clinical applications. JAMA 1995; 273:483–488.
4. Sarfo FS, Ulasavets U, Opare-Sem OK, et al. Telerehabilitation after stroke: an updated systematic review of the literature. Journal of Stroke & Cerebrovascular Diseases 2018; 27:2306–2318.
5. Riva G, Wiederhold BK. What the metaverse is (really) and why we need to know about it. Cyberpsychology, Behavior, & Social Networking 2022; 25:355–359.
6. Wiederhold BK, Riva G. Metaverse creates new opportunities in healthcare. Annual Review of CyberTherapy & Telemedicine 2022; 20:3–8.

Address correspondence to:
Sara Ventura, PhD
Department of Psychology
Università di Bologna
40126 Bologna
Italy

E-mail: sara.ventura@uv.es

Giada Lullini, PhD
IRCCS Istituto Scienze Neurologiche
40139 Bologna
Italy

E-mail: giada.lullini@isnb.it

Giuseppe Riva, PhD
Humane Technology Lab
Catholic University of Milan
Largo Gemelli 1
20100 Milan
Italy

E-mail: giuseppe.riva@unicatt.it

Sources: Cordis, European Commission, and European Union