Behavioral Archetypes for Stroke Rehabilitation Technologies

Bushra Alkadhi[1(✉)] and Areej Al-Wabil[2(✉)]

[1] College of Computer and Information Sciences, King Saud University, Riyadh, Saudi Arabia
balkadhi@ksu.edu.sa

[2] Center for Complex Engineering Systems, King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia
areej@mit.edu

Abstract. Being a leading cause of death and serious long-term disability across the world, stroke and cerebrovascular diseases became a major burden on health and social care. However, research has shown that early therapy intervention with stroke patients has the potential for significant improvements in terms of cognitive and motor abilities. Integration of technology into rehabilitation such as the robot-assisted therapy, virtual reality applications, and telecare systems have changed the way rehabilitation programs are being delivered and it overcame some of the limitations and challenges that come with conventional therapy programs. Understanding the target audience and their behavior is of crucial importance to be considered in an early design phase especially with this kind of systems that have tedious nature and involve multiple groups of users (patients, therapists, and caregivers). In this study, we aim to adopt a participatory design approach that engages users and stakeholders in developing stroke rehabilitation technologies aligned with behavioral archetypes that are modeled around their behavioral perspectives. We believe that using archetypes in user research gives us a better view of behavior in interaction design of rehabilitation systems and provide developers with a model to validate interactive elements in stroke rehabilitation systems and user flows at a macro level. In this paper, a user study was designed to be conducted to validate behavioral archetypes of these groups through interviews and focus group sessions with different physicians, therapists and caregivers in rehabilitation centers.

Keywords: Stroke · Rehabilitation · Behavioral archetypes
User-Centered design

1 Introduction

According to the World Health Organization, data has shown that stroke remains a leading cause of death and disability since 1990 [1]. As population demographics shift over time and with the increasing number of people affected by stroke comes the crucial importance of rehabilitation and recovery process. Many surviving stroke patients often suffer from severe and long lasting impairments, from motor to cognitive issues, that affect their daily activities [2]. These limitations caused by stroke may include lack of

C. Stephanidis (Ed.): HCII Posters 2018, CCIS 851, pp. 10–16, 2018.
https://doi.org/10.1007/978-3-319-92279-9_2

muscle control, muscle weakness, total paralysis, vision problems, speech/language problems, or memory loss, depending on the part of the brain that was injured and the severity of the injury [3, 4]. However, recent studies have shown that with proper post-stroke rehabilitation and early, intensive and repetitive exercises patients can gradually restore some degree of their motor and cognitive performance [2].

Due to the slow progress and tedious nature of therapy programs especially with this kind of morbidity, rehabilitation and recovery process usually takes a long time and effort. Sometimes, it may even lead to patient's lack of motivation and early termination of the exercises, which is consistently linked to therapeutic outcomes and recovery [5]. Therefore, researchers nowadays are studying new ways to enhance the process through an efficient, easy to use and personalized design of rehabilitation systems that help the patient to smoothly regain strength and independence [2]. Understanding target audience of a system; their demographics and needs has a profound effect on the design of the system and influences most of the decisions that designers make for a good user experience. However, such information about the user may lose its value and be misinterpreted if presented as static figures and numbers [6]. Behavioral archetype is a fictitious representation or a scenario of a specific group of system users, created during design stage and is modeled around behavioral and motivational perspective. Through behavioral archetypes, designers can understand and respond to their users' needs and preferences in a more engaging and empathetic way especially in healthcare and rehabilitation systems.

This paper discusses the feasibility of using behavioral archetypes as a tool for designing rehabilitation systems for stroke. It is organized as follows: the first section discusses some of the previous work in using technology in stroke rehabilitation and the adoption of personas and behavioral archetypes in user experience design. The second section describes an exploratory design approach for using behavioral archetypes in designing stroke rehabilitation systems and the study design for evaluating these archetypes.

2 Related Work

2.1 Technology in Stroke Rehabilitation

Repeated studies have shown that Intensive post-stroke rehabilitation program can significantly help patients to gradually regain their performance and results in positive outcomes. As technology continues to advance, it changed the way healthcare is being delivered and it helped to overcome some of the limitations and challenges that come with conventional therapies [7]. The integration of technology into rehabilitation was motivated by the need to improve clinical outcomes by enabling novel modes of exercises and to alleviate the burden associated with traditional rehabilitation programs which are based on one-to-one practice sessions with the therapist especially when there is a lack of trained healthcare personnel. Moreover, with the increasing emphasis on cost reduction in healthcare, technology has resulted in a shorter length of stay for inpatient rehabilitation as the patient can continue the therapy even after discharge, in a home based setting [8, 9]. Following are examples of technologies used in stroke rehabilitation.

Robot-Assisted Therapy
Mirror Image Movement Enabler (MIME) (see Fig. 1), developed in 1998, is an example of a Robot-Assisted therapy system that simulates conventional rehabilitation techniques for the upper limb after stroke in which a robot manipulator help patients, at any impairment level, to repeatedly practice and complete stereotyped movement patterns and it supports several modes of Robot-Subject interactions. When compared with an equally intensive conventional treatment, Robot-Assisted therapy had an advantage and had shown significantly greater strength improvements overtime. [9]

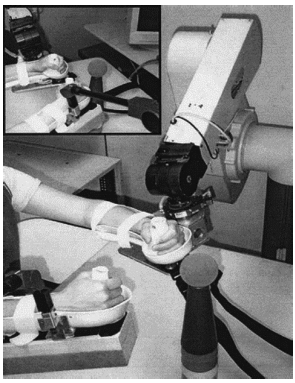

Fig. 1. Robot-Assisted training through MIME. [9]

Brain Computer Interfaces (BCI)
Another novel technology that is being increasingly employed in rehabilitation programs is the brain computer interfaces. BCI is "a computer based system that translates brain signals into commands for an output device to perform a desired action". Research has demonstrated the efficacy of BCI technology in post-stroke rehabilitation as it helps to restore motor control after stroke or other traumatic brain disorders. Because stroke affects parts of the brain that are responsible of motor functions, BCI could be used to induce and guide activity dependent brain plasticity by focusing on motor tasks that require the activation or deactivation of specific brain signals. Several motor action and motor imagery platforms have been developed for EEG acquisition, processing and classification of brain signals such as Emotive headset. [10]

2.2 Personas and Behavioral Archetypes in UX Design

The application of User–Centered Design (UCD) approach has shifted the focus in system development to be driven by user's needs instead of technical requirements. Therefore, knowing the user and his/her interaction with the system became the most relevant factor to achieve usability goals and product success. Representing user's information could be done through segmentation and user modeling techniques such as personas and archetypes that encapsulate users' characteristics, needs and behavior. Persona was originally introduced in the HCI community by Cooper [6] where he

described persona as "a precise description of a user's characteristics and what he/she wants to accomplish". It is a fictitious representation of a hypothesized group of users based on their demographics, needs, goals and biographical characteristics that would guide the design decisions and help the project team to visualize user segments and build solutions for them. However, characteristics and behavior of users interacting with the system do not always align, and differences are at times volatile. Personas often do not include details on behavioral patterns and how they interact with the system. Therefore, a novel way that encompasses such patterns is through behavioral archetypes. Behavioral archetypes are fictitious representations of system users that are modeled around their behavioral perspective, motivation and pain points. Using archetypes in user research gives us a better view of behavior in interaction design and provide developers with a model to validate interactive elements and user flows. User modeling has been used in designing healthcare systems to improve the experience of patients and healthcare professionals. [11]

3 Exploratory Design Approach Using Behavioral Archetypes

Research has shown that early therapy intervention with stroke patients has the potential for significant improvements in long-term outcome in terms of cognitive, sensory and motor function. To design and develop interactive rehabilitation technologies for stroke patients, it is important to understand the context of use, pain points for patients and therapists, aspirations of all stakeholders, and motivations. By involving families and health professionals in the early design phase of rehabilitation technologies for stroke, we aim to produce a therapy intervention, which users and stakeholders would embrace and engage with. The objective of adopting a participatory design approach in developing stroke rehabilitation systems is to understand their true needs and, in turn, unmet design opportunities for stroke rehabilitation technologies.

3.1 Method

In this study, we are engaging patients and domain experts including caregivers, therapists and physicians as co-creators and co-designers in the development process of stroke rehabilitation systems by using behavioral archetypes. Co-creation and co-design is a participatory design method where stakeholders and domain experts are being involved in collective acts of creativity in designing the system where they play several roles depending on their level of expertise and creativity [12]. We defined a set of archetypes for each stakeholder (patient, caregiver, therapist, and physician) that could be used in designing stroke rehabilitation systems and we aim to validate them with domain experts and patients through interviews and focus groups to see the feasibility of using them as a tool in the design of such systems.

3.2 Participants

A stratified purposeful sampling approach will be conducted for this study that divides the population into groups by a specific characteristic, not geographically. The study sample is separated into physicians, therapists, caregivers and patients. A sample from each of these strata will be taken using convenience sampling methods.

3.3 Apparatus

The behavioral archetypes are listed in a single-page form (see Fig. 2) for each category of stakeholders (patient, caregiver, therapist, and physician). These forms will be used in interviews and focus group sessions to evaluate the presented archetypes and how they could contribute to the design process.

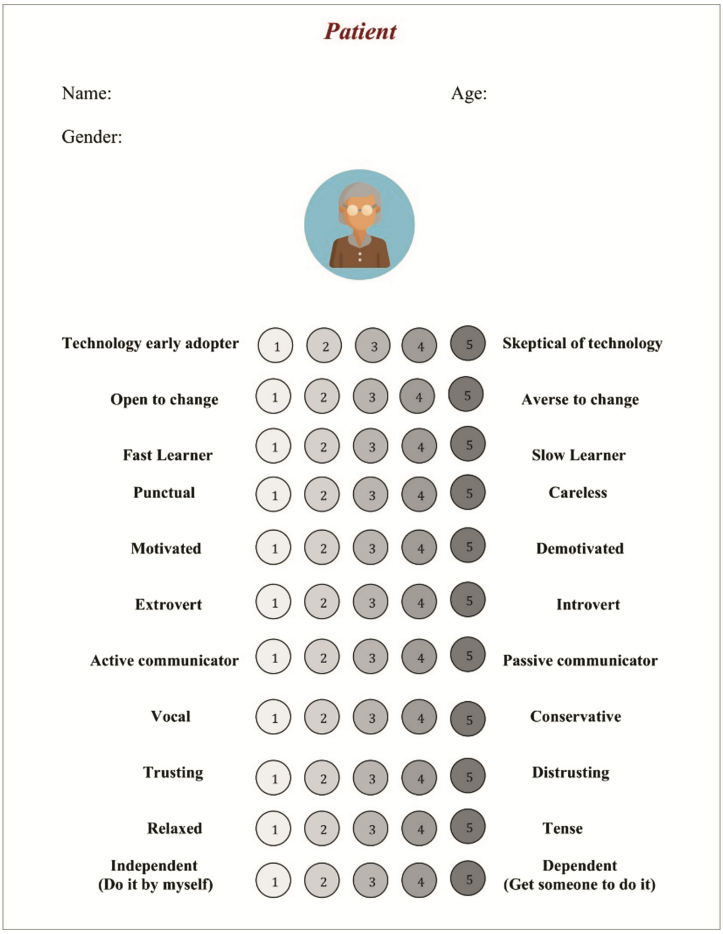

Fig. 2. Patient's behavioral archetypes form.

In defining the archetypes and to make sure they reflect the important qualities that shape our social and psychological aspects, we considered the Big Five personality traits, also known as the Five Factor Model (FFM), which is a well known theory in psychology and social science that summarizes the different factors of personalities into five broad scalable dimensions of personality traits which are Openness to experience, Extraversion, Conscientiousness, Agreeableness, and Neuroticism. Each of these dimensions represents a range between two extremes (e.g. extraversion vs. introversion). In our study, we chose archetypes that could relate to these personality dimensions with a scale from 1 to 5 for each archetype. For example, openness was covered by archetypes regarding technology adoption and openness to change, extraversion was covered by archetypes such as motivation and activeness in communication, and neuroticism was represented as relaxation and independence. [13]

4 Conclusion

Adopting participatory design approaches such as personas and other user modeling techniques is of crucial importance for optimizing the usability by understanding user's needs and pain points especially in healthcare and rehabilitation systems that have a great impact on health and quality of life. However, demographic data and other personal characteristics are not always reflecting behavioral patterns and how people interact with systems. Therefore, using behavioral archetypes would eliminate this gap by considering behavioral models of different groups of users and how you expect them to interact with the system. This research studies the feasibility of using behavioral archetypes for designing stroke rehabilitation technologies. The paper discussed the design of an exploratory study that will be conducted to validate a set of defined archetypes for stroke rehabilitation systems by domain experts. Evaluation sessions will be carried on with physicians, therapists, caregivers and patients through interviews and focus groups to evaluate the proposed set of archetypes for each category. Future work would involve using these archetypes in developing rehabilitation systems for stroke and in testing the usability of such applications. It will help developers to understand and respond to users needs and problems in a more empathetic way.

Acknowledgement. We would like to thank the HCI lab at King Abdulaziz City for science and Technology in Saudi Arabia for funding this research. We also thank Roundicons for making the archetypes icons freely available at www.flaticon.com.

References

1. Truelsen, T., Begg, S., Mathers, C.: The global burden of cerebrovascular disease. Epidemiology and Burden of Disease, WHO Geneva (EBD/GPE) (2015)
2. Moital, A.R., Dogramadzi, S., Ferreira, H.A.: Development of an EMG controlled hand exoskeleton for post-stroke rehabilitation. In: Proceedings of the 3rd 2015 Workshop on ICTs for Improving Patients Rehabilitation Research Techniques - REHAB 2015 (2015). https://doi.org/10.1145/2838944.2838961

3. INS - International Neuromodulation Society: Motor impairment. http://www.xneuromodulation.com/motor-impairment. Accessed 24 Dec 2017
4. Johns Hopkins Medicine Health Library: Effect of Stroke, p. 00777. https://www.hopkinsmedicine.org/healthlibrary/conditions/adult/cardiovascular_diseases/effects_of_stroke_85. Accessed 24 Dec 2017
5. Maclean, N., Pound, P., Wolfe, C., Rudd, A.: The concept of patient motivation: a qualitative analysis of stroke professionals' attitudes. Stroke **33**, 444–448 (2002). https://doi.org/10.1161/hs0202.102367
6. Junior, P.T.A., Filgueiras, L.V.L.: User modeling with personas. In: Proceedings of the 2005 Latin American Conference on Human-Computer Interaction - CLIHC 2005 (2005). https://doi.org/10.1145/1111360.1111388
7. Valles, K.B., Montes, S., de Jesus Madrigal, M., Burciaga, A., Martínez, M.E., Johnson, M.J.: Technology-assisted stroke rehabilitation in Mexico: a pilot randomized trial comparing traditional therapy to circuit training in a robot/technology-assisted therapy gym. J. NeuroEng. Rehabil. **13**, 83 (2016). https://doi.org/10.1186/s12984-016-0190-1
8. Lum, P.S., Burgar, C.G., Shor, P.C., Majmundar, M., Van der Loos, M.: Robot-assisted movement training compared with conventional therapy techniques for the rehabilitation of upper-limb motor function after stroke. Arch. Phys. Med. Rehabil. **83**, 952–959 (2002). https://doi.org/10.1053/apmr.2001.33101
9. Lum, P.S., Burgar, C.G., Van der Loos, M., Shor, P.C., Majmundar, M., Yap, R.: MIME robotic device for upper-limb neurorehabilitation in subacute stroke subjects: a follow-up study. J. Rehabil. Res. Dev. **43**, 631 (2006). https://doi.org/10.1682/jrrd.2005.02.0044
10. Ang, K.K., Guan, C.: Brain-computer interface in stroke rehabilitation. J. Comput. Sci. Eng. **7**(2), 139–146 (2013). https://doi.org/10.5626/jcse.2013.7.2.139. Korean Institute of Information Scientists and Engineers
11. Chang, Y., Lim, Y., Stolterman, E.: Personas. In: Proceedings of the 5th Nordic Conference on Human-Computer Interaction Building Bridges - NordiCHI 2008 (2008). https://doi.org/10.1145/1463160.1463214
12. Sanders, E.B.-N., Stappers, P.J.: Co-creation and the new landscapes of design. Des. Crit. Prim. Sour. **4**, 5–18 (2008). https://doi.org/10.5040/9781474282932.0011
13. John, O., Srivastava, S.: The Big-Five trait taxonomy: history, measurement, and theoretical perspectives. In: Pervin, L., John, O. (eds.) Handbook of Personality: Theory and Research, 2nd edn, pp. 102–138. Guilford Press, New York (2001). (Chapter 4)
14. Pyae, A., Yuen, T.B., Gossage, M.: Persona development for designing human-centered rehabilitation games for stroke patients. PsycEXTRA Dataset. https://doi.org/10.1037/e570102013-025
15. Alankus, G., Proffitt, R., Kelleher, C., Engsberg, J.: Stroke therapy through motion-based games. ACM Trans. Access. Comput. **4**, 1–35 (2011). https://doi.org/10.1145/2039339.2039342
16. Balaam, M., Rennick Egglestone, S., Hughes, A.-M., Nind, T., Wilkinson, A., Harris, E., Axelrod, L., Fitzpatrick, G.: Rehabilitation centred design. In: Proceedings of the 28th of the International Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA 2010 (2010). https://doi.org/10.1145/1753846.1754197