On the Importance of Tailor-made Speech Relearning Software for Stroke Rehabilitation

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Abstract: Post stroke rehabilitation is a global issue with increasing challenges today when the percentage of older adults is increasing. There is a need for new solutions to better assist stroke survivors' normally long way back to a good and independent life. The various post stroke impairments can be divided into the categories of cognitive, motoric and speech impairment, and the three also have their interrelations. This position paper has a focus on rehabilitation of stroke survivors' speech impairments, and the use of technology-enhanced systems to assist the speech relearning. The current reuse of language learning software for primary school students is doubtful, and should better be replaced by tailor-made and adaptable tools that fit the target group. Finally, the recommendation is a long-term strategy where some initial costs should fund the design, development and evaluation of new digital tools for speech relearning. This should be conducted in a collaboration between researchers, speech therapists, stroke patients. The approach should be iterative and user-centred, with both speech therapists and stroke patients as the end-users.

1 INTRODUCTION

Stroke is a major cause of disabilities in adults where a stroke survivor may suffer from long term physical and mental impairments (Palmcrantz et al., 2017). Due to a rapidly increasing percentage of older adults all over the world, age-related chronic diseases are also increased and stroke is one of those diseases (Ahmad et al., 2019). It has some serious impacts on the patient's overall daily life activities and often, the friends and family of the patients are also affected (Mozelius et al., 2019). Stroke impairments and their rehabilitation are generally divided into speech, motoric and cognitive disabilities (Ahlin et al., 2019).

This position paper focuses on speech impairments and the use of technology-enhanced systems to perform different types of rehabilitation exercises. After the stroke, patients' ability to read, write, speak and listen can be decreased (Tousignant et al., 2018). Consequently, patient's social and professional life is deeply affected and usually, they fail to continue their professional work and social activities that may lead them to an isolated and depressed state of mind (Ahmad et al., 2019).

Intensive and long-term rehabilitation is needed right after the stroke that involves different kinds of therapies and exercises (Palmcrantz et al., 2017). However, the human and financial resources needed for the rehabilitation after stroke are not enough in the hospitals and rehabilitation centres (Zhang et al., 2016). The compromised independent life of stroke survivors is also an issue with traditional speech rehabilitation therapies where patients need to stay in the rehabilitation centres for a long time. Recent studies highlighted that living independently in the home environment has some positive impacts on the patient's health condition and the process of healing becomes faster and more effective (Christophorou et al., 2016, Ahlin et al., 2019). Different types of technology-enhanced systems (TES) such as software applications to perform relearning exercises can be useful in this context (Ahmad et al., 2019).

However, several studies highlighted that acceptance of TES also has some critical factors that need to be addressed such as trust, e-health literacy, personal integrity and usability (Ahmad & Mozelius, 2019, De Veer et al., 2015). Another critical factor that has got less attention is the lack of tailor-made software solutions for speech learning with a design that builds on the target group's special needs. Speech therapists today, frequently use software applications that are developed for primary school students in the relearning process for older adults (Ahlin, Ahmad &

Mozelius, 2019). In this position paper authors argue for the importance of speech relearning software that is tailor-made for stroke survivors. Arguments have been gathered in a mix of a literature study, and from personal reflections on earlier studies on stroke rehabilitation.

2 STROKE REHABILITATION

A stroke patient's way back to a joyful life and independent life after stroke is a long and tedious journey, where patients and relatives have to struggle hard for a successful relearning of earlier skills and knowledge (Greveson & James, 1991; Broeren et al., 2008). The various impairments can be divided into the categories of cognitive, motoric and speech impairment, where the cognitive part of the rehabilitation has a clear relation to both the motoric and the speech relearning aspects of stroke rehabilitation (Ahmad, Mozelius & Ahlin, 2019).

Motoric rehabilitation deals with problems using various body parts, while speech rehabilitation is related to language and communication issues. Both these impairments can severely the ability to read, write, communicate and also stroke patients' cognitive capacity (Seniów, Litwin & Lesniak, 2009, Veerbeek et al., 2014, Pollock et al., 2014, Toussignant et al., 2018). All three types of rehabilitation ought to be based on an active everyday treatment schedule, which could be challenging to provide due to the cost of specialised therapists. An effective alternative to the traditional long-term rehabilitation could be the use of various TES. However, if a TES based relearning should be successful and effective there must be high quality standards for both usability and for a design that is appealing to the target group.

3 SPEECH RELEARNING

Speech and language impairments are very common after stroke, and one out of three stroke survivors suffer from these disabilities (Tousignant et al., 2018, Greener et al., 1999). People with these impairments face immense challenges in communication as their capabilities to speak and listen are affected. The intensity of these deficiencies may vary from patient to patient where some people can understand and speak a few words only, while others can communicate almost fluently with some minor problems (Egaji et al., 2019).

After the stroke, the relearning process of speech skills has always been challenging for patients and medical caregivers. A patient needs to perform relearning exercises that can be very difficult with an already impaired physical condition and medical caregivers have to spend a lot of time in order to help the patient with those exercises (Ahlin et al., 2019). To achieve better efficiency and fast recovery, these interventions are recommended to start as soon as possible after the stroke (Ahmad et al., 2019).

After an initial examination and treatment at the hospital, the patients are usually referred to the rehabilitation centre, where the speech therapists make a long-term or a short-term relearning plan depending on the patients' level of disability (Egaji et al., 2019). Several studies showed that intensive and long-term therapy is needed for an effective relearning of speech and language skills (Øra et al., 2018). However, the resources needed for that kind of intervention are not enough in the rehabilitation centres and the speech therapists complain that they do not have enough time for the required therapies of an increasing number of patients (Ahlin et al., 2019). Technology-enhanced relearning exercises can play a vital role in this context.

The use of technology in different types of rehabilitation processes has been discussed for almost last two decades and these technologies have shown some potential benefits such as better accessibility, improved quality of life, possibilities of independent living and healthier social life (Zhang et al., 2016, Tousignant et al., 2018, Rizzo and Kim, 2005). However, the implementation of these technologies has certain challenges that need to be addressed. One challenge is the lack of adaptability and interest in technology, especially the older population who are not grown up with computers and smartphones seem not to be comfortable with the use of software applications (Ahmad and Mozelius, 2019). The use of new tools is always difficult for people who already face the communication problem due to speech and language deficiencies (Simic et al., 2016). In order to make TES accessible and useable for the patients, they should be actively involved in the development process (Roper et al., 2018).

4 THE IMPORTANCE OF TAILOR-MADE SPEECH RELEARNING SOFTWARE

As for all other tools used for rehabilitation, it is of great importance that TES solutions for speech relearning are tailor-made for the target group. There are today few digital speech relearning tools available

that are based on both stroke survivors' and speech therapists' needs. Furthermore, the TES tools should better also have built-in adaptability to meet the stroke patients' individual needs

A user-centred design and development seems essential, with a dual focus on both stroke patients and speech therapists as users. Some examples from the speech therapists' wish list are interactive pictures and video-clips where they can demonstrate the content and the training instructions. The design needs to focus on variation, with content and a graphic design that is relevant for adults and older adults. Another requirement is that the TES tools also should be accessible for patients' relatives and friends, who often play an important role in successful speech rehabilitation after stroke.

The current habit of reusing language learning software for primary school students ought to be broken. This is a short-sighted strategy that in a narrow perspective might save some costs, but goes against the grain of fundamental healthcare principles. At the same time, it can be offending for someone in her seventies to carry out exercises in a game designed for lower primary school. Furthermore, a backstory with exercises related to stroke survivors' daily tasks would also support the rehabilitation alignment between speech relearning and cognitive relearning.

Finally, stroke patients' often limited energy for relearning should better be used on the actual relearning. The software must have user-friendly navigation and intuitive usability, considering the fact that many stroke patients also suffer from visual impairments. This should also include the hardware in TES solutions, where new interfaces on laptops, tablets and mobile phones can be difficult to navigate. What already is in use, and can be further extended is the concept of Bring Your Own Device (BYOD). In a wider definition, BYOD could be described as "the practice of people bringing their own laptops, tablets, smartphones, or other mobile devices with them to learning or work environments" (Johnson et al. 2016, p. 36).

5 CONCLUSION

In light of recent studies on speech and language recovery, this position paper emphasized on the importance of customized digital solutions that are explicitly built according to the patients' current physical and cognitive condition. Since the rehabilitation exercises for speech impairments can be performed in the home environment with the help of tailor-made software applications, patients will be able to live independently and their quality of life will

also be increased. However, these software applications should be user-friendly and patients should feel a sense of enjoyment by using TES. Therefore, a user-centred design approach should be adopted for the development of suggested TES.

6 RECOMMENDATION

Authors' recommendation is a long-term strategy where some initial costs should be spent on design, development and evaluation of TES for speech relearning. This should be carried out in collaboration between researchers, speech therapists and stroke patients. The approach should be iterative and user-centred, with both speech therapists, stroke patients and patients' families and friends as end-users. An interesting add-on feature would be a built-in analysis of each patients' learning progression. Further details for the design and development are described more in detail here below in the next section.

7 FUTURE WORK

The study highlighted the importance of tailor-made software applications to perform exercises for relearning speech skills after a stroke. Naturally, the next step would be to develop the suggested software application. In order to achieve the desired results, a user-centred design approach should be adopted. A typical user-centred design consists of five basic steps: Interviews and observations with different stakeholders, identifying the requirements, gathering the ideas for prototype design, designing and developing the prototype, and usability testing (Dorrington et al., 2016). The requirements should be gathered incorporation with researchers, software developers, medical caregivers, and the patients for designing an interactive and user-friendly software application.

The role of user experience (UX) designer and/or UX researcher is very important in a user-centered design approach. A UX designer needs to work parallel both with users (patients and speech therapists in the current context) as well as with the software development team (Almughram et al., 2017). Therefore, UX designers should be involved in the process of designing a prototype and the software engineers should work closely with them.

Finally, a comprehensive usability testing should be conducted for the developed software application. The input from the user experience will not only be helpful to increase the ease of use and to provide better interaction with the suggested TES, but it will

also give the researchers a better understanding of the disabilities and limitations of stroke survivors.

REFERENCES

Ahmad, A., Mozelius, P. and Ahlin, K., 2019. Testbed requirements for technology enhanced stroke rehabilitation to support independent living.)^(Eds.):'Book Testbed requirements for technology enhanced stroke rehabilitation to support independent living'(INSTICC Press, 2019, edn.).

Ahmad, A. and Mozelius, P., 2019, January. Critical factors for human computer interaction of ehealth for older adults. In Proceedings of the 2019 the 5th International Conference on e-Society, e-Learning and e-Technologies (pp. 58-62).

Ahlin, K., Ahmad, A. and Mozelius, P., 2019. Determining Testbed Requirements for Technology Enhanced Speech Rehabilitation after Stroke-the Informed Co-workers' View Point. In IARIA GLOBAL HEALTH International Conference on Global Health Challenges.

Almughram, O. and Alyahya, S., 2017, June. Coordination support for integrating user centered design in distributed agile projects. In 2017 IEEE 15th International Conference on Software Engineering Research, Management and Applications (SERA) (pp. 229-238). IEEE.

Broeren, J., Bjorkdahl, A., Claesson, L., Goude, D., Lundgren-Nilsson, A., Samuelsson, H., ... & Rydmark, M. (2008). Virtual rehabilitation after stroke. Studies in health technology and informatics, 136, 77

Christophorou, C., Kleanthous, S., Georgiadis, D., Cereghetti, D.M., Andreou, P., Wings, C., Christodoulou, E. and Samaras, G., 2016. ICT services for active ageing and independent living: identification and assessment. Healthcare technology letters, 3(3), pp.159-164.

de Veer, A.J., Peeters, J.M., Brabers, A.E., Schellevis, F.G., Rademakers, J.J.J. and Francke, A.L., 2015. Determinants of the intention to use e-Health by community dwelling older people. BMC health services research, 15(1), p.103.

Dorrington, P., Wilkinson, C., Tasker, L. and Walters, A., 2016. User-centered design method for the design of assistive switch devices to improve user experience, accessibility, and independence. Journal of Usability Studies, 11(2), pp.66-82.

Egaji, O.A., Asghar, I., Griffiths, M. and Warren, W., 2019, August. Digital Speech Therapy for the Aphasia Patients: Challenges, Opportunities and Solutions. In Proceedings of the 9th International Conference on Information Communication and Management (pp. 85-88)

Greveson, G., & James, O. (1991). Improving long-term outcome after stroke--the views of patients and carers. Health trends, 23(4), 161-162.

Greener, J., Enderby, P. and Whurr, R., 1999. Speech and language therapy for aphasia following stroke. Cochrane Database of Systematic Reviews, (4).

Johnson L, Adams Becker S, Cummins M, Estrada V, Freeman A, Hall C (2016) NMC Horizon Report: 2016 Higher Education Edition. Austin, TX: The New Media Consortium.

Palmcrantz, S., Borg, J., Sommerfeld, D., Plantin, J., Wall, A., Ehn, M., ... & Boman, I. L. (2017). An interactive distance solution for stroke rehabilitation in the home setting–A feasibility study. Informatics for Health and Social Care, 42(3), 303-320.

Mozelius, P., Ahlin, K., & Ahmad, A. (2019). A game-based approach for motoric stroke rehabilitation: defining the requirements. In ECGBL 2019 (Vol. 13).

Pollock, A., Baer, G., Campbell, P., Choo, P. L., Forster, A., Morris, J., Pomeroy, V. M.,Langhorne, P. 2014. Physical rehabilitation approaches for the recovery of function and mobility following stroke. Cochrane Database of Systematic Reviews, (4).

Rizzo, A. S.,Kim, G. J. 2005. A SWOT analysis of the field of virtual reality rehabilitation and therapy. Presence: Teleoperators & Virtual Environments, 14(2), 119 - 146.

Roper, A., Davey, I., Wilson, S., Neate, T., Marshall, J. and Grellmann, B., 2018, October. Usability Testing-An Aphasia Perspective. In Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility (pp. 102-106).

Simic, T., Leonard, C., Laird, L., Cupit, J., Höbler, F. and Rochon, E., 2016. A usability study of internet-based therapy for naming deficits in aphasia. American Journal of Speech-Language Pathology, 25(4), pp.642-653.

Seniów, J., Litwin, M., & Leśniak, M. (2009). The relationship between non-linguistic cognitive deficits and language recovery in patients with aphasia. Journal of the Neurological Sciences, 283(1-2), 91-94.

Tousignant, M., Macoir, J., Martel-Sauvageau, V., Boissy, P., Corriveau, H., Gosselin, S., Dubois, M.F., Tousignant, M. and Pagé, C., 2018. Satisfaction with in-home speech telerehabilitation in post-stroke aphasia: an exploratory analysis. Journal of the International Society for Telemedicine and eHealth, 6, pp.e 11-1.

Veerbeek, J. M., van Wegen, E., van Peppen, R., van der Wees, P. J., Hendriks, E., Rietberg, M., & Kwakkel, G. (2014). What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. PloS one, 9(2), e87987.

Zhang, H., Shen, Z., Lin, J., Chen, Y. and Miao, Y., 2016. Familiarity design in exercise games for elderly. Int J Inf Technol, 22, pp.1-19

Øra, H.P., Kirmess, M., Brady, M.C., Winsnes, I.E., Hansen, S.M. and Becker, F., 2018. Telerehabilitation for aphasia–protocol of a pragmatic, exploratory, pilot randomized controlled trial. Trials, 19(1), p.208. Smith, J., 1998. *The book*, The publishing company. London, 2nd edition.