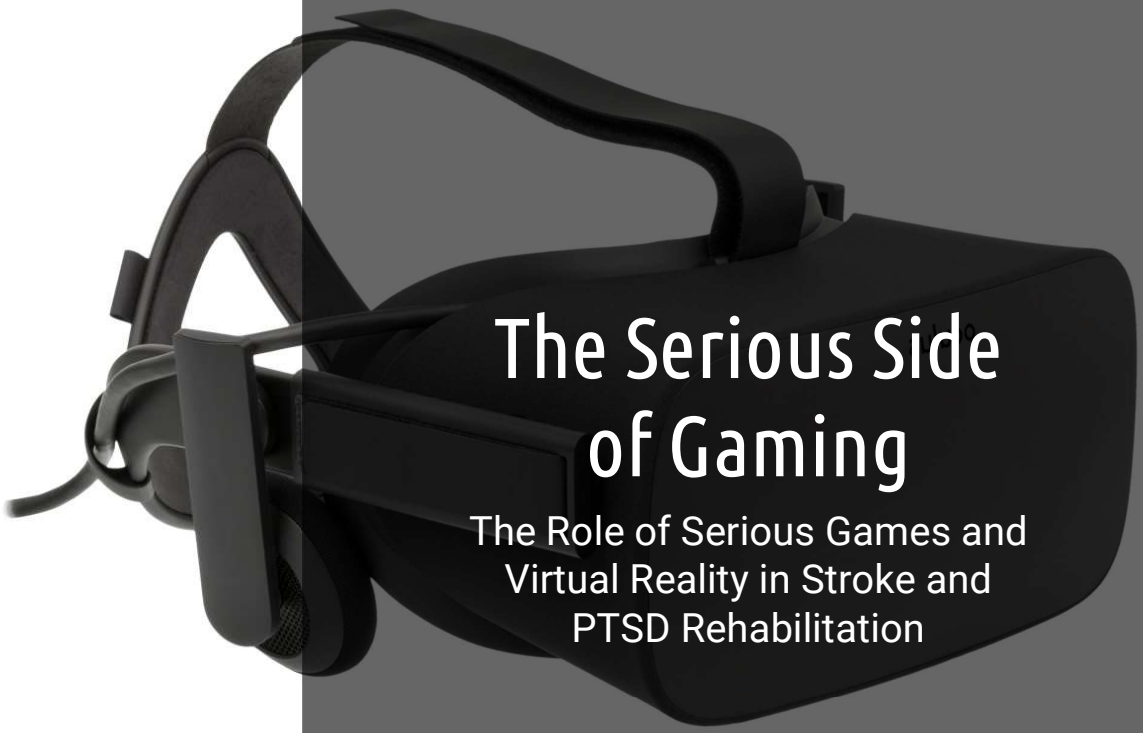

The Serious Side of Gaming

The Role of Serious Games and Virtual Reality in Stroke and PTSD Rehabilitation

Barry O'Connor [N0813926]

ISYS10301 Research Report Assignment

1 Introduction

There has been an upward trend with regard to the usage and development of games and virtual reality (VR) for more serious purposes. Serious games represent a method of learning, training and testing that is more engaging for the user and more efficient when more conventional methods prove labour or resource intensive. E-learning is a great example of this, allowing the user to learn in a fun way, often independently, without the need of a teacher.

This report will focus on the use of these technologies in stroke rehabilitation and their use within the US military for Post-Traumatic Stress Disorder (PTSD) rehabilitation.

Serious Games

The term "serious games" has been adopted to describe the type of game which has a serious aim, such as training or education, rather than one of pure entertainment.

2 Stroke Rehabilitation

Impact

Stroke has steadfastly remained the second greatest cause of death globally in the last 15 years (World Health Organisation, 2018). Incidence increases with age yet improvements in healthcare have seen mortality rates decline (Hollander, et al., 2003) resulting in increasing demand for rehabilitation.

2.1 Rehabilitation Engagement

Patients who survive the initial injuries of stroke face the diminishment of motor function, spasticity and weakness ("paresis") in the affected limb (Li, 2017) requiring support throughout the rest of their lives. This rehabilitation process relies on Neuroplasticity, the brain's ability to adapt and rewire after injury. Motor Learning Strategies (MLS) facilitate this process however they are goal oriented, highly repetitive and challenging for the patient, both physically and mentally. This can sometimes lead to frustration and the possibility of disengagement from the process.

2.2 How Can Serious Gaming Help?

Gaming frameworks can help keep patients engaged and motivated. Figure 1 shows research into patient motivation levels when using a given game framework (Hossain, et al., 2016). The study size was small but demonstrates a high level of motivation and belief that the games would support further rehabilitation.

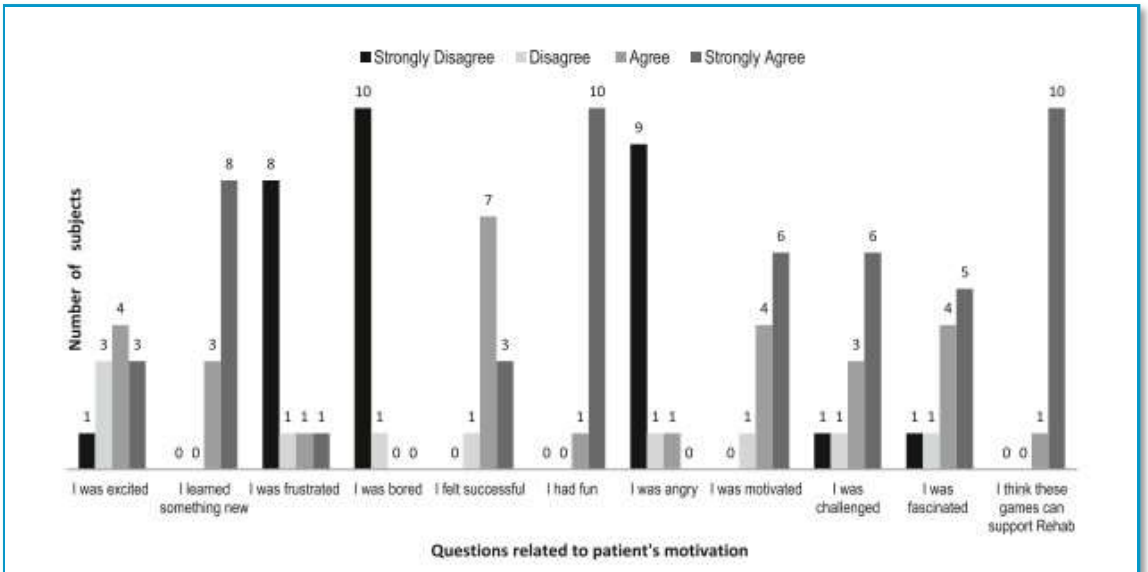

Fig 1: Motivation levels after using a gaming framework for MLS (Hossain, et al., 2016)(p669)

Studies have concluded that the use of serious gaming has specifically aided patients in improving balance, posture and fine motor control (Fulk, 2005; Holden, 2005). This is echoed in research into framework effectiveness over traditional rehabilitation with specific regard to upper limb and balance/movement function (Tăut, et al., 2017). Remarkably, this study demonstrates increased effectiveness dependant on the immersive quality of the game. Table 1 shows that fantasy or realistic settings had greater effect as did the inclusion of teamwork or social aspects. This strongly suggests that the creativity of the setting and the positive reinforcement from teamwork or cooperation within the setting have a measurable, positive impact on patient engagement.

Studies on VR are generally positive (Saposnik & Levin, 2011; Cameirão, et al., 2012), given that VR commands much of the user's attention span and provides immediate feedback on movements. However, these have been carried out on a small number of patients and seem to indicate that wider research would be beneficial.

2.3 What is Needed?

Research is positive overall, the technology is equal to or slightly better than traditional methods in specific areas making counterpoint difficult. There are however many similar frameworks yet the greatly varying needs of patients are often not considered, resulting in what feels like generic solutions. This only benefits patients whose needs match the framework and leads to claims that therapists don't understand the technologies and their potential. Therapist involvement from the outset would logically result in better understanding and a more flexible framework structure, ultimately allowing more patients to benefit.

Commonly available devices like the Nintendo Wii Balance Board, Wiimote, PlayStation EyeToy or VR headsets could allow therapy without the need for therapist supervision. This would be better suited to patients whose MLS requirements match the range of movements these devices emulate but may offer substantial savings both in terms of workload and healthcare costs.

Moderator	Category	No of Studies	Effect Size (Cohens' d)
Competition	*Present*	12	0.7
	Absent	44	0.5
	Mixed	5	0.6
Type of Competition	*Direct*	4	0.9
	Indirect	9	0.7
	Mixed	4	0.5
Type of Activity	*Individual*	54	0.5
	Individual + group	7	0.9
Realism of the Scenario	*Abstract*	24	0.5
	Fantasy	4	1.5
	Realistic	23	0.4
	Mixed	10	0.6

Table 1: Calculated effect size of varying game characteristics.
Adapted from (Tăut, et al., 2017)(p109)

3 PTSD Rehabilitation

Impact

As of June 2015, 138,197 active service members have been diagnosed with Post Traumatic Stress Disorder (PTSD) (Fischer, 2015). Kok (see Rizzo and Shilling 2017, p. 2) records a total of 13.2% of troops involved in recent conflicts meeting the criteria for PTSD

3.1 Mental Health Issues Among Troops

Combat places enormous demands on even the most well-trained troops, testing their physical and mental limits and exposing them to potentially traumatic events. Being away from the typical social support network of partner, family and friends for long acts as a stressor and can put additional strain on their mental health (Macgregor, et al., 2012). For those involved in explosive blasts while in combat, the effects on the brain can be profound yet external signs of injury may not exist, making diagnosis difficult.

Research suggests that time outside combat also allows for "Dwell time" where troops dwell on negative experiences. Table 2 demonstrates increased occurrence of PTSD among those with 2 deployments, while conversely showing less likelihood of other mental health issues.

Disorder	**1 Deployments** (n=49,328), **No.**(%)	**2 Deployments** (n=16,376), **No.**(%)
PTSD	609 (1.2)	347 (2.1)
PTSD only	333 (0.7)	225 (1.4)
PTSD with other mental health disorder	276 (0.6)	122 (0.7)
Other mental health disorder	3094 (6.3)	936 (5.7)
Mood disorder	535 (1.1)	136 (0.8)
Substance abuse disorder	1177 (2.4)	284 (1.7)
Adjustment disorder	604 (1.2)	227 (1.4)
Anxiety disorder	434 (0.9)	161 (1.0)
Other	838 (1.7)	243 (1.5)

Table 2: The effects of dwell time on the mental health of US Marines.
Adapted from (Macgregor, et al., 2012)(pS57)

3.2 How Can Serious Gaming Help?

This escalating problem has caused the US Department of Defence to invest significantly into finding treatment options for PTSD, including the use of VR. This enables the creation of scenarios that would otherwise be too costly, impractical or even impossible to recreate in a real-world setting, offering a flexible and relatively inexpensive method of therapy.

The work of Rizzo & Shilling (2017) centres around Prolonged Exposure. This therapy exposes the patient to the traumatic event, just as gradual exposure is used to overcome phobias. Troops with PTSD often block out the trauma and cannot wilfully imagine the events, these can be recreated in a Virtual Reality Exposure Therapy (VRET). BRAVEMIND is one such VRET, created in 2004 and developed using the Unity Games. The software evolved through military testing and early versions proved promising enough for it to gain funding in 2011 from the US Army for an updated, expanded version. Rizzo was personally involved in many of the studies following trials of the VRET and concludes that all, except one, suggested that the VRET is equally as effective as traditional Prolonged Exposure therapy.

3.3 What is Needed?

Army funding in these technologies is based positive results from traditional therapies and the VR versions of those therapies. The approach is more results driven than stroke rehabilitation, enabling researchers to concentrate specifically on a discrete set of projects. This seems to be accomplishing more yet there is also significant scope for further research.

4 Conclusions

Both serious games and VR need to be viewed for what they are: a tool. In the right hands, they have the potential to benefit patients, enabling more patient-oriented therapy which is also less demanding on therapists' time. It is not difficult to imagine a patient using a VR headset at home and accessing a pre-rendered therapy, tailored exactly to their physical needs, with guidance via a set of pre-recorded vocal cues. More involved, therapist-led sessions, could use video phones, meaning the therapist could guide the therapy session without the need to leave their offices while the patient has the benefit of the familiar, reassuring surroundings of their own home. This could mean a therapist would spend less time overall with each patient, while maintaining quality, gaining feedback from the software itself. This approach could offer cost saving benefits to large, high-demand healthcare organisations.

The US Army approach concentrates on what is known to work at least in preliminary tests and enables testing and feedback from troops. This cuts out a lot of the saturation in terms of similar products and focuses the efforts of researchers in contrast to stroke rehabilitation solutions, where many frameworks are variations on the same basic ideas. Instead of having 20 solutions to the same problem, the focus is directed into a smaller number of already promising solutions and the research into those solutions appears to be of greater depth. This seems to have given projects such as BRAVEMIND a much more solid basis to build upon in the future.

Word Count: 1491

5 Bibliography

Cameirão, Mónica S; Badia, Sergi Bermúdez I; Duarte, Esther; Frisoli, Antonio; Verschure, Paul F. M. J., 2012. The combined impact of virtual reality neurorehabilitation and its interfaces on upper extremity functional recovery in patients with chronic stroke. *Stroke,* 43(10), pp. 2720-8.

Fischer, H., 2015. *A Guide to U.S. Military Casualty Statistics: Operation Freedom's Sentinel, Operation Inherent Resolve, Operation New Dawn, Operation Iraqi Freedom, and Operation Enduring Freedom.* [Online] Available at: https://fas.org/sgp/crs/natsec/RS22452.pdf [Accessed 25 November 2018].

Fulk, G., 2005. Locomotor Training and Virtual Reality-based Balance Training for an Individual with Multiple Sclerosis: A Case Report. *Journal of Neurologic Physical Therapy,* 29(1), pp. 34-42.

Holden, M. K., 2005. Virtual environments for motor rehabilitation: review. *Cyberpsychology & behavior,* 8(3), p. 187–211.

Hollander, M.; Koudstaal, P. J.; Bots, M. L.; Grobbee, D E; Hofman, A.; Breteler, M. M. B., 2003. Incidence, risk, and case fatality of first ever stroke in the elderly population. The Rotterdam Study. *Journal of Neurology, Neurosurgery & Psychiatry,* 74(3), pp. 317-321.

Hossain, M; Hardy, Sandro; Alamri, Atif; Alelaiwi, Abdulhameed; Hardy, Verena; Wilhelm, Christoph, 2016. AR-based serious game framework for post-stroke rehabilitation. *Multimedia Systems,* 22(6), pp. 659-674.

Li, S., 2017. Spasticity, Motor Recovery, and Neural Plasticity after Stroke. *Frontiers in Neurology,* 8, p. 120.

Macgregor, A. J., Han, P. P., Dougherty, A. L. & Galarneau, M. R., 2012. Effect of dwell time on the mental health of US military personnel with multiple combat tours. *American journal of public health,* 102(Suppliment 1), pp. S55-9.

Rizzo, A. '. & Shilling, R., 2017. Clinical Virtual Reality tools to advance the prevention, assessment, and treatment of PTSD. *European Journal of Psychotraumatology,* 8(sup 5).

Saposnik, G. & Levin, M., 2011. Virtual reality in stroke rehabilitation: a meta-analysis and implications for clinicians. *Stroke,* 42(5), pp. 1380-6.

Tăut, Diana; Pintea, Sebastian; Roovers, Jan-Paul W R; Mañanas, Miguel-Angel; Băban, Adriana, 2017. Play seriously: Effectiveness of serious games and their features in motor rehabilitation. A meta-analysis. *NeuroRehabilitation,* 41(1), pp. 105-118.

World Health Organisation, 2018. *The Top 10 Causes of Death.* [Online] Available at: http://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death [Accessed 13 November 2018].