BrightArm™ Therapy for Patients with Advanced Dementia:

A Feasibility Study

G. Burdea, B. Rabin, D. Rethage
Bright Cloud International Corp
Highland Park, NJ, USA.
president@brightcloudint.com

F. Damiani
Roosevelt Care Centers
Roosevelt Dr., Edison, NJ, USA
frank.damiani@rooseveltheath.org

J. S. Hundal
JFK Johnson
Rehabilitation Institute,
Edison, NJ, USA
jhundal@jfkhealth.org

C. Fitzpatrick
Haddonfield, NJ, USA
instrumentalchanges@gmail.com

***Abstract*—Virtual reality use in cognitive rehabilitation of advanced dementia has been sparse. Three residents of a Dementia Ward participated in a feasibility study of the BrightArm™ system. They played custom games targeting several cognitive domains including short-term and working memory. Clinician observation revealed a positive effect on emotive state, with technology well accepted by all participants.**

Keywords—BrightArm; dementia; emotive state; Alzheimer's

I. INTRODUCTION

Age-related cognitive decline and Alzheimer's disease (AD) are both associated with the elderly. While early-stage AD results in changes in personality and difficulty with executive function [1], later stage is associated with memory deficits, especially episodic memory [2]), working memory, executive functioning, language, attention, affect and visuo-spatial functioning. 2012 AD prevalence was 5.4 million Americans, of whom 5.2 million were 65 years or older [3]. The primary form of AD symptom management is medications. While there are no AD interventions that can be classified as disease modifying [4], early therapeutic interventions can be effective in improving cognitive function, depression, and delaying institutionalization. Since AD is a progressive disease, therapies change with time, however after stage 2 AD patients are generally institutionalized.

Virtual rehabilitation has been known to increase focusing and improve emotive state [5]. An important question is whether persons with cognitive impairments can learn how to navigate and interact within virtual environments [6]. A controlled study showed that VR navigation differentiated older normal controls from those with early stage AD [7]. Prior research seems to utilize VR for assessment and cognitive rehabilitation of individuals with MCI or with early-stage AD. By contrast the present feasibility study uses VR integrative rehabilitation for *advance stage* AD.

II. PARTICIPANTS AND THE EXPERIMENTAL SYSTEM

All three participants in this pilot study were residents in the Dementia Ward at the Roosevelt Care Center (Edison, NJ).

A. Medical History

Participant 1 was 88-year-old, right handed, White female with 12 years of education and a history of dementia without behavioral disturbance. An earlier fall resulted in a fracture of her left shoulder, thus her left arm was trained during this study. *Participant 2* was 72-year-old, right handed, White female with 12 years of education and a history of Alzheimer's disease. She had sustained a right hand wrist fracture, thus her right arm was trained. *Participant 3* was 84-year-old, right handed, White female with 14 years of education, unspecified schizophrenia. She played the games with her right arm.

B. Data Collection Instruments

The study protocol was submitted for IRB approval in spring 2011 and training took place at the Roosevelt Care Center. The study used an A-B-A protocol, with clinical evaluations done by a neuropsychologist consultant at baseline (A) and post-therapy (A), while game performance was sampled at each session (B). Standardized measures were used in the emotive/cognitive evaluations, and non-standardized measures related to performance on each game (score).

C. Experimental System

The experimental system consisted of the BrightArm rehabilitation table, and custom therapeutic games played uni-manually. The BrightArm consists of a motorized low-friction rehabilitation table that is wheelchair accessible and provides gravity offloading to the patient's arm resting on a computerized forearm support [8].

Each session started with range and grasp strength baselines, used to fine tune the training games that day. *Memory Island* exercise trained short term visual memory. Cards were placed face down on an island and participants were asked to turn them face up and generate pairs. *Pick-and-Place* exercise involved working memory and pattern matching. The easier level asked the participants to pick up a ball with their hand avatar and place the ball on a matching-colored target while following the shortest path between the two (the actual path taken was traced). At higher level of difficulty the participants had to choose the ball matching the color of the target, before moving to the target.

Research supported by an IRS Therapeutic Discovery Grant

D. Experimental Protocol

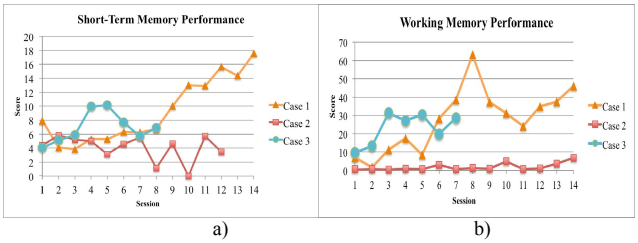
Due to shortage of staff the participants sat in the training room for about three hours. Each took turns playing on BrightArm, while the other two observed. Their blood pressure was taken before and immediately after training. Over the course of 5 weeks, sessions progressed from 20 to 40 minutes of games. An occupational therapist verbally hinted (as needed) to game solutions, and sometimes assisted movement for Participant 1. A Licensed Clinical Social Worker with long AD experience sat in most training sessions observing the participants. Participant 3 had 7 sessions before she was dropped from therapy due to high blood pressure.

III. OUTCOMES

Standardized measures did not reveal changes in cognitive function after therapy. Game performance was measured transparently during training and subsequently converted into scores (Fig. 1). Over the course of the therapy, each Participant showed different performance trends. In *Memory Island* Participant 1 showed consistent improvement over the 14 sessions. Participant 2 struggled (long duration of play and large ratio of attempts to matches). Participant 3 demonstrated immediate improvement over the course of her therapy. The three Participants showed similar trends in *Pick-and-Place* as well. Participant 1 demonstrated overall improvement, with most progress occurring during sessions 5-8. With intact working memory, Participant 1 picked correct color balls and moved immediately to the matching target. Participant 2 was not able to reduce the time she needed to pick or drop balls below 20 seconds and struggled to remember what to do. Her path to target was winding and tentative, despite cognitive aids and prompting by the therapist (Fig. 2). Patient 3 reached average pick and drop times of 3 seconds early on.

A. Technical Acceptance

Participant 1 had less inhibited responses post study and her composure was much more relaxed. Pre-therapy Participant 2 was significantly impaired, with flat affect and lack of autonomy. Post-intervention she had much brighter affect and felt much more comfortable with the system. She did not miss any session, despite facing the most challenges in the group. Participant 3 was also extremely motivated by the therapy and cheered the other two participants. Her mental involvement in the other participants' therapy (as opposed to apathy) was a possible cause for her gradual increase in blood pressure. Another possible cause was the length of passive exposure to game play, something to be avoided in the future.



a) b)

Fig. 1 Participants' game performance: a) *Card Island*; b) *Pick-and-Place*. © Bright Cloud International. Reprinted by permission.

IV. DISCUSSION

The present study had a low *n*, and limited length. Therefore the implications of our findings on future virtual cognitive rehabilitation of advanced dementia are difficult to discern. However, there was a trend towards improvement with Participant 1. Participant 2, who was at the lowest end of severely impaired in all domains, did not show any meaningful change in standardized measures. Her affect and motivation did exhibit a notable improvement. Participant 3, who was the least impaired at baseline, was discharged from treatment secondary to abnormal rise in blood pressure. One potential consideration for future research is to monitor the length of VR exposure and how it relates to blood pressure.

Overall implications may be that severely impaired individuals with late stage dementia (as in Stage 4 AD) are unlikely to benefit from VR cognitive intervention, while their affect may be improved. There is reason to believe that intervening at the earlier stages may yield meaningful positive results. One has to note the improvement in game play (Fig. 1). It may be that game performance is more sensitive than standardized measures, with the caveat of possible practice effects. It is important to continue this line of research to see if games can be used as diagnoses tools. The participants' acceptance of the technology gives hope for future VR use in advance dementia.

REFERENCES

[1] M. Storandt, Cognitive Deficits in the Early Stages of Alzheimer's disease, *Curr Dir Psy Care*. vol. 7, *13*, pp. 198-202, 2008.

[2] C. Gold and A. Budson, Memory loss in Alzheimer's disease: implications for development of therapeutics. *Expert Rev Neurother*, vol. 8, *12*, pp. 1879-1891, 2008.

[3] Alzheimer's Association, 2012 Alzheimer's Disease Facts and Figures, *Alzheimer's & Dementia,* Vol.8, *2*, 72 pp., 2012.

[4] G. Silverstrelli, A. Lanari, L. Parnettu, et al., Treatment of Alzheimer's disease: From pharmacology to a better understanding of disease pathophysiology. *Mech Ageing Dev,* 127, pp. 148-157, 2006.

[5] G. Burdea, Virtual Rehabilitation- Benefits and Challenges, *Meth Med,* vol. 42, *5*, pp. 519-523, 2003.

[6] A. Rizzo and G. Bockwalter, Virtual Reality and Cognitive Assessment and Rehabilitation: The State of the Art, in *Virtual Reality in Neuro-Psycho-Physiology,* G. Riva (Ed), pp. 123-155, 1998.

[7] L.A. Cushman, K. Stein, C.J. Duffy, Detecting navigational deficits in cognitive aging and Alzheimer disease using virtual reality. *Neurology*, vol. 71, *12*, pp. 888-895, 2008.

[8] B. Rabin, G. Burdea, D. Roll, J. Hundal J, F. Damiani F et al. Integrative rehabilitation of elderly stroke survivors: the design and evaluation of the BrightArm. *Disab Rehab – Assist Tech*, Vol. 7(4), pp. 323–335, 2012.

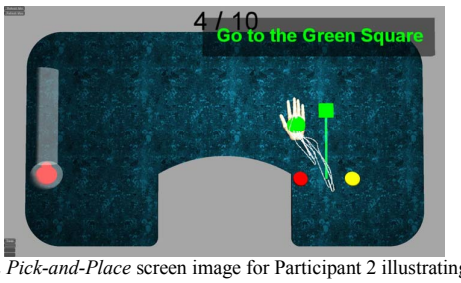


Fig. 2 *Pick-and-Place* screen image for Participant 2 illustrating diminished working memory. © Bright Cloud International Corp. Reprinted by permission