Cognitive remediation using virtual reality and an electrophysiological marker of attention for promotion of cognition and everyday functioning among people with psychotic disorder: A case study

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***Abstract*— One of the ways in which psychotic disorders affect every day functioning and well-being is through their impact on cognition. Various cognitive interventions have been developed to improve cognition, but none that were primarily designed for hospital settings. This case study demonstrates feasibility of Virtual Reality [VR] based cognitive remediation with ongoing monitoring for attention of a hospitalized person with psychosis. The intervention and its contribution to cognitive, functional and illness-related outcomes is described.**

Keywords*— *Psychotic disorders, cognitive interventions, Virtual Reality, ongoing monitoring for attention

I. INTRODUCTION

Psychotic disorders are a major health condition often characterized by cognitive and functional impairment. They often result in long-lasting personal and social consequences [1]. Cognitive functions of attention, memory and executive functions are consistently found to be impaired in psychosis and affect every day functioning [2]. Participation in everyday activities is an important dimension of well-being and recovery from mental illness [3]. Thus, assessment, monitoring and improvement of cognitive and everyday functions are a focus of interest [4]. Pharmacotherapy is often found to be ineffective regarding the cognitive dimensions of psychosis, which implies the need for effective interventions for cognitive impairment [5]. Various cognitive and functional interventions have been developed for people with psychotic disorder, however, most of these have focused on community settings, thus limiting their implementation in inpatient settings [2]. Usage of computer and VR based cognitive interventions today are common and have several advantages: accessibility, cost-effectiveness, innovativeness, their ability to motivate patients, and validity in various populations with cognitive impairment. VR provides adaptive responses based on individual performance, as well as real-time feedback, and enables training in simulated environments that closely mimic everyday real-life situations when real life practice is otherwise unavailable [e.g. for legal issues [6]. In addition, interventions delivered using computer-aided technology have shown moderate to large effect sizes on various domains of cognition and functional ability compared to pen and paper cognitive training [7,8]. Moreover, several computer-based cognitive interventions have been reported as having beneficial, long-lasting effect on the cortex structures [5]. However, feasibility of such an intervention as early as during acute psychiatric hospitalization and its contribution to improvement of cognition and daily functioning parameters for persons with psychotic disorders has yet to be well established. This work presents lessons learned from a case-study of VR based cognitive remediation training with ongoing, real-time monitoring of electrophysiological index of sustained attention (SA).

II. CASE PRESENTATION

A.V. is 27 years old man, diagnosed with schizoaffective disorder 7 years ago and with ADHD in middle school. The clinical signs' presentation includes positive and negative symptoms of psychosis, as well as cognitive and functional impairments.

Setting: Acute-care inpatient ward of Beer Yaakov- Ness Ziona- Maban Mental Health Center, Israel.

Intervention: A.V. participated in cognitive remediation training using Functional Brain Trainer (FBT, Intendu Ltd.) software and adapted protocol (20 min sessions x 10 sessions over 4 weeks). FBT is a VR computer-based platform using motion-based adaptive camera. It provides simulation of several functional environments to train

various aspects of attention, working memory and planning while automatically controlling task complexity to enable 80% response success rate. During the intervention, a physiological marker of SA was obtained using an EEG wireless device with two dry electrodes (MindWave) and real-time signal decoding system - the Brain Engagement Index (BEI) (BrainMARC, NeuroSky Inc) [9].

Main Outcome Measures: A.V. completed the following assessments: Cognistat, Trail Making Test (A and B) and Category Fluency Test for different aspects of cognition; Observed Tasks of Daily Living Test for functional capacity; self-report questioner for dimensions of participation in everyday activities; and Positive and Negative Syndrome Scale for symptoms severity.

Results: The pre-post outcomes show an improvement in cognitive functions, such as multi-tasking, inhibition, working memory, attention and cognitive flexibility, as measured on the FBT (Fig. 1) and on shifting, memory and attention based on standard tests (Fig. 2).

Fig. 1 Learning curve as it has been measured on the FBT.

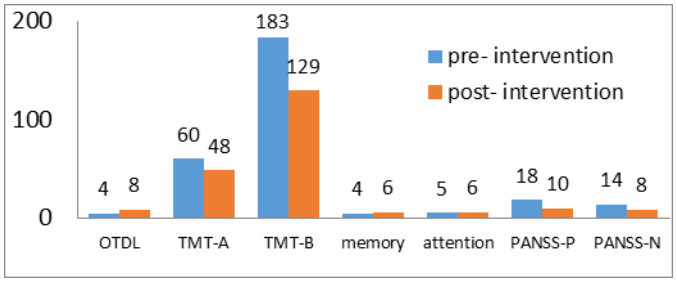

Fig. 2 Pre – post in standard evaluations.

In addition, improvement in functional capacity and participation dimensions were observed. VR training contributes to A.V.'s high level of motivation and enjoyment through the intervention. Several patterns of association between the BEI marker of SA, task complexity and level of performance were found demonstrating interdependence and complex interplay between these factors.

Discussion: This case study demonstrates the feasibility of VR based cognitive training with inpatients with psychosis in an acute facility. This case demonstrates the potential to improve cognitive, functional and illness-related outcomes using adaptive cognitive training via VR simulation of functional environments amongst persons with psychosis. Also of note, VR appeared to overcome common obstacles to engagement with psychiatric interventions, such as amotivation and anhedonia. Usage of computer technologies enables the synchronization of intervention parameters with physiological markers, such as SA, revealing patterns of dependence of functional outcomes on attention rather than on the task complexity. In this way, usage of computer-based intervention enables data collection that is compatible with additional systems, such as EEG, expanding the understanding of complex phenomena and improving interventions that promote cognition, everyday functioning, wellbeing and recovery among people with psychosis.

Conclusion: This case study supports the feasibility of computerized and VR cognitive remediation during the acute stage of psychosis, demonstrating the intervention's contribution to cognitive, functional and illness-related outcomes. This work represents a case study, so the results are presented in descriptive form. A study with a larg sample size and a control group would offer statistical data that would indicate whether our results are more widely applicable. Additionally, future studies can focus on implementation of a more comprehensive intervention, and examine the long-term effects on cognitive and functioning measures.

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