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# Therapeutic effectiveness of a virtual reality game in self-awareness after acquired brain injury

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**Abstract.** Self-awareness deficits can manifest as a consequence of acquired brain injury decreasing the motivation and the adherence to the treatment. We present a multitouch system that promotes the role-playing and the self-assessment strategies and challenges the participants in a competitive context. This paper presents an initial clinical trial to study the effectiveness of the virtual system in the rehabilitation of the self-awareness skills. According the evolution of the participants in the Self-Awareness Deficits Interview and in the Spanish Social Skills Scale, the participants improve the perception of their deficits and disabilities.

**Keywords.** Self-awareness, virtual rehabilitation, acquired brain injury

## Introduction

Acquired brain injury (ABI) produces a heterogeneous combination of deficits involving motor, cognitive, and psychopathological skills. The knowledge of the ABI patients about their own impairments and their implied limitations is known as ‘self-awareness’. The self-awareness disorders can have implications in motivation, social integration, and professional reinsertion [1, 2], which can dramatically affect the rehabilitation process. The aim of the holistic rehabilitative strategies is therefore not only to restore or compensate the deficits derived from the injury but also to instill awareness of them, in such a way that the patients know their own limitations. The rehabilitation of self-awareness focuses on pedagogic lessons to awaken in the patients the self-assessment ability [3] or in role-playing strategies to evidence their limitations [4].

In the last decade, there are an increasing number of studies reporting the clinical benefits of introducing virtual reality (VR) systems in the rehabilitation programs of cognitive and psychological deficits [5]. VR can provide motivating and controlled

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environments with enhanced and multiple sensory feedback [6]. The benefits of the VR have been combined with traditional rehabilitative strategies with promising results. However, the great majority of the VR systems are single user and do not consider the self-awareness deficit.

In this paper, we present a new tool to treat the self-awareness deficit in ABI patients. The system uses VR multitouch technology to allow patients to interact with others using natural interactive metaphors.

## Methods

### *Participants*

10 ABI patients from the total pool of patients that were attending a neurorehabilitation program at a large metropolitan hospital were considered in this study. Inclusion criteria were: 1) age  $\geq 18$  and  $\leq 75$  years; 2) chronicity  $> 6$  months; 3) Mini-Mental State Examination [7]  $> 23$ ; 4) Fairly good language comprehension: Mississippi Aphasia Screening Scale [8]  $< 45$ . Patients with severe dementia or aphasia were excluded.

The final sample included 7 males and 3 females with a mean age of  $41.10 \pm 15.29$  (mean  $\pm$  std), a chronicity of  $402.20 \pm 147.68$  days and  $11.80 \pm 4.26$  years of education.

### *Instrumentation*

The developed system consists of a 42" LCD television that has been horizontally fixed in the top of a table-like structure. A multitouch overlay, which transforms the television into a multitouch screen, is mounted over the screen. The structure has 4 legs without stretcher to allow wheelchair users to interact with the system (**¡Error! No se encuentra el origen de la referencia.**).



**Figure 1.** Different views of the developed multitouch table.

All the participants are distributed in groups of one or two participants, up to a maximum of 4 groups, corresponding to the 4 sides of the table. The session is conducted by a therapist. The software application consists of a board game where the participants compete for reaching the top in first place. To move forward in the game, the participants throw a virtual dice, move their counter and then are required to answer

a question, which can be related to knowledge (anatomical and pathological matters, red cards), reasoning (situational exercises, blue cards), action (role-playing exercises, green cards), or cohesion (jokes and sayings, yellow cards) (Figure 2).



**Figure 2.** Snapshots of the self-awareness game. The left image shows the board of the game. The right image shows a question card with the text “Imagine that after a stroke you have problems to move the left side of your body (left arm and leg). How would you put your sockets on?”

### Intervention

All the participants underwent one hour session per week during 8 months and were assessed at the beginning and at the end of the program with the Self-Awareness Deficits Interview (SADI) [9] to know the participants’ awareness of their deficits, functional limitations, and the implications in their future plans, and with the Social Skills Scale (SSS) [10], which is a Spanish scale that assesses the participants’ behavior in specific situations. The SADI is a 3 items questionnaire and the SSS is a 33 items questionnaire. Both tests are formulated like a 4-point Likert scale.

### Results

With regards to the SADI, at the beginning 4 participants had problems perceiving their deficits, 7 participants had difficulties perceiving their disability, and 7 participants had difficulties in making future plans. After the treatment, all the participants perceive their deficits properly, only 2 participants still had difficulties perceiving their disability, and 5 participants (50%) had difficulties establishing realistic goals.

Regarding the SSS, at the beginning 6 participants showed altered levels in social skills (one of them showed a specially altered level). After the rehabilitation program only two participants showed altered levels, while the rest of the participants presented normal skills.

**Table 1.** Results of both scales expressed in number of participants

Scale	Initial assessment		Final assessment	
	Altered	Normal	Altered	Normal
SADI				
Difficulties perceiving deficits	4	6	0	10
Difficulties perceiving disability	7	3	2	8
Difficulties making realistic plans	7	3	5	5
SSS				
Percentile < 2 (Very altered)		1		0
Percentile > 2 and < 16 (Altered)		5		2

## Conclusions

This paper describes a virtual board game to rehabilitate the self-awareness deficits produced by ABI. The game combines anatomical, situational, role-playing, and cohesion exercises within a competitive context. The game runs on a big multitouch screen that enables multiuser practices. The system also allows the therapists to supervise and guide the sessions, and to involve all the participants in a discussion after each question. The design of the system is based on the basis that social interaction should facilitate general cognitive functioning [11]. The system also provides objective data of the evolution of the patients.

According to the scores in the SADI and the SSS tests, the system has provided successful results in the rehabilitation of the self-awareness and the social cognition deficits, which makes the system a valid and useful therapeutic tool. However, the realistic future planning is still a therapeutic challenge in the rehabilitation therapy.

Even though the results in both scales support the clinical effectiveness of this new virtual therapy, new studies must be carried, either controlled or comparing with other rehabilitation programs. Future studies will take this consideration into account and will also address the usability of the system for both therapists and patients.

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