Contributo

1. Dati proponente contributo

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Sito	

2. Riferimento del contributo al tavolo tematico

Scienze della Vita

3. Sintesi del contributo

SISTEMA DI REALTÀ VIRTUALE IMMERSIVA PER IL RIMEDIO COGNITIVO E SOCIALE DEI PAZIENTI CON PSICOSI SCHIZOFRENICA

PREMESSA:
Nell'ambito dei disturbi psichiatrici, la psicosi schizofrenica rappresenta una delle patologie più gravi ed invalidanti che risente ancora una forte stigmatizzazione e una pesante discriminazione. Si tratta di un disturbo con un'incidenza tra 0.8 e 1% della popolazione ed una prevalenza di poco superiore negli uomini rispetto alle donne. È caratterizzata dalla presenza di un quadro sintomatologico complesso che comprende l'alterazione della maggior parte delle funzioni psichiche, significativi deficit cognitivi e la perdita del senso di realtà. I deficit cognitivi sono responsabili di un funzionamento psicosociale scadente, di un'insoddisfacente qualità della vita e di una scarsa aderenza ai programmi terapeutici e riabilitativi, considerati come la principale causa della disabilità e dei costi indiretti della malattia.
CONTRIBUTO:
Il riconoscimento dell'esistenza di un rapporto significativo tra deficit cognitivi e funzionali, e la possibilità di considerare i deficit cognitivi come la chiave per capire quelli funzionali, ha aperto nuove prospettive nel trattamento e nell'outcome della terapia con i pazienti psicotici. Tale costatazione ha favorito lo sviluppo di molti programmi di rimedio cognitivo computerizzati e non, basati su differenti approcci e focalizzati sul trattamento dei deficit cognitivi. Il trattamento dei deficit cognitivi si è visto essere l'aspetto centrale nel recupero delle capacità sociali e lavorative di questi pazienti e, quindi, nella loro possibilità di reinserimento sociale.
L'U.O.C. di Psichiatria dell'A.O.U.P. "P. Giaccone " di Palermo sta sperimentando dei sistemi di realtà virtuale immersiva per il rimedio cognitivo ed il potenziamento delle social skills dei pazienti con psicosi schizofrenica che cominciano a riscuotere interesse e risonanza in ambito internazionale. Tale successo è connesso alla facile applicabilità e immediatezza di utilizzo che si coniuga, da un lato, con ridotti costi strumentali e, dall'altro, con risultati efficaci in termini riabilitativi, di benessere psico-sociale e di miglioramento della qualità della vita.
Dalle recenti evidenze scientifiche emerge che l'applicazione della RV in riabilitazione cognitiva ha numerosi vantaggi rispetto agli strumenti tradizionali:

- riprodurre situazioni complesse della vita quotidiana, situazioni ambientali e sociali, in grado di stimolare il soggetto in maniera simile al contesto reale;
- monitorare tramite l'imaging o la registrazione diretta dell'attività cerebrale mentre si è impegnati in svariati comportamenti interattivi;
- offrire un controllo preciso sul grado di esposizione agli scenari terapeutici;
- personalizzare gli scenari in base alle esigenze del singolo paziente e anche la capacità di fornire terapie che, altrimenti, sarebbero impossibili;
- permettere al paziente di acquisire una maggiore consapevolezza dei propri vissuti emotivi e degli effetti dei propri comportamenti;
- fornire maggiore aderenza al trattamento psicofarmacologico mediante la spinta motivazionale insita nell'aspetto ludico-interattivo dei sistemi di realtà virtuale immersiva.

Riteniamo che sviluppare tale settore possa avere numerose risvolti positivi sia in termini di *empowerment* individuale, di azione di supporto indiretta sul sistema familiare, che di Comunità locale con conseguente riduzione dello stigma e possibilità di reinserimento lavorativo. Da non sottovalutare, inoltre, le ricadute connesse alla riduzione dei costi della malattia per il SSN.

4. Allegati

1. ALLEGATO 1: LA PAGLIA F., LA CASCIA C., RIZZO R., SIDELI L., FRANCOMANO A., LA BARBERA D. (2013). “Cognitive Rehabilitation of Schizophrenia through Neurovr Training”, in Annual Review of Cybertherapy and Telemedicine- Studies in Health Technology and Informatics, 191: 158-162. B.K. Wiederhold and G. Riva (Eds.) IOS. Press. Doi:10.3233/978-1-61499-282-0-158; ISSN: 0926-9630; ISBN:978-1-61499-281-3. INDEX: PubMed ID: 23792865; SCOPUS; ISI.

2. ALLEGATO 2: LA PAGLIA F., LA CASCIA C., RIZZO R., RIVA G., LA BARBERA D. (2012). “Assessment of Executive Functions in Patients with Obsessive Compulsive Disorder by Neuro VR”. Studies in Health Technology and Informatics, 181(181), 98-102. B.K. Wiederhold (Eds) IOS Press, Doi:10.32/978-1-61499-121-2-98; ISSN: 0926-9630, ISBN: 978-1-61499-120-5. INDEX: PubMed ID: 22954836; SCOPUS; ISI.

3. ALLEGATO 3: CIPRESSO P., LA PAGLIA F., LA CASCIA C., RIVA G., ALBANI G., LA BARBERA D. (2013). Break in volition: a virtual reality study in patients with obsessive-compulsive disorder. Experimental Brain Research 03/2013. Springer Verlag (Eds). INDEX: PubMed ID: 23535833; SCOPUS; DOI: 10.1007/s00221-013-3471-y; ISSN: 0014-4819; ISI; Impact Factor 2012: 2.221

ALLEGATO 1

Assessment of executive functions in patients with obsessive compulsive disorder by NeuroVirtual Reality

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Abstract. Executive functions are often impaired in obsessive compulsive disorder (OCD). We used a Virtual Reality (VR) version of the Multiple Errand Test (MET) inside a virtual supermarket, in order to evaluate the executive functions in daily life in 10 OCD patients and 10 controls. It is performed in a shopping setting where there are items to be bought and information to be obtained. The specific goal of this study was to implement a tool for the assessment of executive functions.

Keywords. Virtual Reality, Multiple Errands Test (MET), Executive functions, Obsessive-compulsive Disorder

Introduction

The executive functions are a set of mental processes which include problem solving, planning, working memory, inhibition, mental flexibility, initiation and monitoring of actions. Deficits in these functions are called "dysexecutive syndrome" and they are common in neurological patients with frontal lobe damage due to traumatic brain injury or stroke [1]. Individuals who have an impairment of executive functions show problems of starting and stopping activities, a difficulty in mental and behavioral shifts, an increased distractibility and difficulties in learning new tasks [2]. This syndrome may be present in different clinical disorders, such as dementia, attention and hyperactivity disorder, schizophrenia [3] and obsessive compulsive disorder.

Obsessive compulsive disorder is a psychiatric condition which is characterized by recurrent, intrusive thoughts, impulses and images, often associated with compulsive behaviors that are repetitive, time consuming and often ritualized [4].

From the neuropsychological point of view, patients with obsessive compulsive disorder (OCD) show deficit of executive functions, which are characterized by the

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impairment of several skills such as attention, planning, problem-solving and behavioral control [5]. Further, OCD is often associated with impairments of visuospatial skills [6], and of memory functioning, including visual, verbal, and numerical [7].
According a recent review [8], the executive functions which seem to be representative of the perseverative and repetitive behaviours observed in patients with OCD are set-shifting and response inhibition. Set-shifting refers to the ability to shift attention among different features of a stimulus in response to a changing feedback.
The assessment and the rehabilitation of executive functions under typical clinical or laboratory conditions are unsatisfactory for several reasons. In such settings, planning, multi-tasking or problem solving are usually assessed by pen and paper tasks rather than being presented in an actual or simulated way [9]. Increasing the ecological validity of neuropsychological assessment is important since this will increase the likelihood that patient's cognitive and behavioural responses will replicate the response that would occur in real-life situation [10].
The Multiple Errands Test (MET) developed by Shallice & Burgess [2], is instruments used to assess executive functions in real life settings; it consists of tasks abide by certain rules. It is performed in an actual shopping mall-like setting where there are items to be bought and information to be obtained.
Recent research shows that Virtual Reality can offer new possibilities for the assessment of executive functions providing an additional support to the traditional paper and pencil tasks [11, 12].
The present study is aimed at analyzing the executive functions in patients affected by obsessive compulsive disorder through a neuropsychological battery and a Virtual Reality (VR) version of the Multiple Errands Test (MET) [13, 2] based on the NeuroVR software, as proposed by the Applied Technology for Neuropsychology laboratory, Istituto Auxologico Italiano of Milan [14].

Methods

We recruited 10 patients suffering from obsessive compulsive disorder diagnosed according to DSM IV-TR criteria (M=6, F=4; mean age=32,8 years, std.dev.=10,8) and 10 healthy controls (M=6, F=4; mean age=37,2 years, std.dev.=8,3) (table 1). Patients were randomly selected from the outpatient Unit of Psychiatry of Palermo Universitary Hospital.

Table 1: Population characteristics

	Experimental group	**Control group**
	n = 10	*n* = 10
Age (Mean ± SD)	32,80 ± 10,779	37,20 ± 8,324
(range)	19 ± 53	28 ± 53
Gender (M, F)	6, 4	6, 4

Patients were excluded from the study if they had a severe cognitive impairment (MMSE<19), a severe motor impairment which did not allow subjects to perform the

procedure, auditory language comprehension difficulties (Token Test<26,5), object recognition impairments (Street Completion Test<2,25), excessive state and trait anxiety (STAI>40) and excessive depression state (Beck Depression Inventory>16).
The control group consisted of subjects without motor and cognitive impairments. In particular, exclusion criteria were: cognitive deficit evaluated by MMSE (cut off: 24); motor impairment which does not allow subjects to perform the virtual procedure; sensory deficits.
We used a complete neuropsychological battery for the assessment of executive functions, in the experimental group, including: Frontal Assessment Battery-FAB, to assess the presence and the severity of a dysexecutive syndrome affecting both cognition and motor behavior; Trail Making Test (form A and B), to investigate the visual attention and task switching; Phonemic and Semantic Fluencies, for object denomination; Tower of London, for the capacity of planning, and Corsi's memory span and supra-span, Digit span, Short Story recall and word recall tests, for memory evaluation.
After a neuropsychological evaluation, we used the Virtual Multiple Errands Test (V-MET), both in cases and in controls. In this version, after a training session, the subjects were requested to select and to buy various products presented on shelves with the aid of a joy-pad.
In particular, subjects were invited to buy some items following a defined shopping list (e.g. a chocolate bar or a product in sale) and to obtain some information (e.g. the closing time of the supermarket) following specific rules:

- you must complete all tasks but you can choose any order;
- you are not allowed to enter any aisle unless you need items to complete part of your task;
- you are not allowed to go into the same aisle more than once;
- you are not allowed to buy more than two items for item category;
- take as little time as possible to complete this exercise without rushing excessively;
- do not speak to the person observing you unless this is part of the exercise.

While completing the Multiple errands test procedure, time of execution, total errors, partial tasks failures, inefficiencies, rule breaks, strategies and interpretation failures were measured.

Results

We applied the *Mann-Whitney Test* to evaluate the performance differences at the virtual test (V-MET) among cases and controls. The execution time for the whole task was higher in patients with OCD compared to controls, suggesting that patients with OCD need more time in planning than controls. The same difference was found in the partial errors during the task; in particular, there was a significant difference in the mean rank of the partial errors for the sub-tests 6 (buying two products from the refrigerated products aisle, Asym. Sig. = 0.025) and partial errors 7 (going to the beverage aisle and asking about what to buy, Asym. Sig. = 0.024). Furthermore, the mean rank for inefficiency (Asym. Sig. = 0.08) and for interpretation failures is higher for controls (Asym. Sig.=0.01), while the values of divided attention (Asym. Sig.=0.02)

and the of self correction (Asym. Sig. =0.07) seems to be lower in controls. We think that obsessive patients tend to work with greater diligence and observance of rules than controls.
Among patients, Spearman correlation coefficients were used to examine the relationship between the neuropsychology tests and the scores of virtual version MET for each group (table 2).

Table 2. Correlations between neuropsychological tests and the variables of the virtual MET

	Errors 5		**Inefficiencies**		**Sustained attention**		**Maintained sequence**		**No Perseveration**	
	r	**p**	**r**	**p**	**r**	**p**	**r**	**p**	**r**	**p**
FAB			.628	.05						
TMT (B)	-.645	.04			.817	.00				
TMT (BA)	-.674	.03			.820	.00				
Phonemic Fluencies									.671	.03
ToL			.736	.01			-.772	.00		
Digit Span									.688	.02
Corsi's mem.span			.789	.00						
Corsi's supra-span			.859	.00						

The Frontal Assessment Battery correlates with the inefficiencies variable (Sig.=0.05); the Trail Making Test significantly correlates with some VMET's variables: sustained attention, partial errors in performing of task n. 5 (buying a product on sale); the Fluence Phonemic correlates with the absence of perseveration; the Tower of London correlates with inefficiency and with maintenance of the tasks sequence; the Digit span correlates with the absence of perseveration; the Corsi's memory span and the Corsi's supra span correlates with the inefficiencies.

Conclusions

Our results provide initial support for the feasibility of using the VMET as an assessment tool of executive functions.
Further, the significant correlation found between the VMET and the neuropsychological battery support the ecological validity of VMET as an instrument for the evaluation of executive functions in patients with OCD.
The results of the present study are limited by the small sample size. Further studies are needed to clarify the relationship between traditional tests and the emerging tools based on virtual environment. For these purposes, analyses of comparable samples of OCD subtypes (e.g. washers, checkers, gamblers) could be relevant because the heterogeneity of the disorder can lead to different results for each subtype.

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VOLITION

Break in volition: a virtual reality study in patients with obsessive-compulsive disorder

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Abstract Research in obsessive-compulsive disorder (OCD) produced inconsistent results in demonstrating an association between patients' symptom severity and their cognitive impairments. The process involved in volition aspects of behavioral syndromes can be extensively analyzed using specific tests developed in virtual environments, more suitable to manipulate rules and possible breaks of the normal task execution with different, confusing or stopping instructions. The study involved thirty participants (15 OCD patients and 15 controls) during task execution and the relative interferences. At this purpose, the virtual version of Multiple Errands Test was used. Virtual reality setting, with a higher ecological validity respect to a classic neuropsychological battery, allowed us to take into account deficits of volition and the relative dysexecutive functions associated with OCD patients. The proposed paradigm also allows the development of innovative prototypes of coevolving technologies based on new theories and models and deeper understanding of human behavior.

Keywords Obsessive-compulsive disorders · Virtual reality · Multiple Errands Test · Cognitive assessment · Executive functions · Disorders of volition · Break in volition

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Introduction

Obsessive-compulsive disorder (OCD) affects about the two percent of the worldwide population and is recognized to have a number of social, work and personal impairments. World Health Organization highlighted that OCD is into the top twenty causes of disability in the 15–44 age range.

Obsessive-compulsive disorder is usually stable in time; however, this disorder presents a high heterogeneity in both the symptom and the comorbidity among individuals. In particular, many other disorders into the neurological or psychiatric sphere showed comorbidity with OCD.

The Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV-TR) of the American Psychiatric Association, identifies OCD as one of the six anxiety disorders. OCD patients showed impaired cognition, in particular low levels of cognitive inhibition (Muller and Roberts 2005). It seems that serotoninergic dysfunction and dopamine play a key role in OCD (Morein-Zamir et al. 2010a). Brain abnormalities have been showed in OCD patients in the prefrontal cortex, and in particular in the orbitofrontal cortex, in the parietal cortex and in the striatum (Fineberg et al. 2008; Menzies et al. 2008; Chamberlain et al. 2008; De Geus et al. 2007). Impairment in volitional suppression of simple actions seems to indicate that an intermediate marker of brain dysfunction in OCD can be provided by response

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inhibition deficits (Fineberg et al. 2005; Chamberlain et al. 2005). This marker, or endophenotype, can be crucial in classification and etiology of OCD and could also provide important cues for possible treatment strategies (Morein-Zamir et al. 2010b).

Researches that are focusing on the association between OCD patients' symptom severity and their neuropsychological impairments have produced inconsistent results, at the moment (Abramovitch et al. 2011).

Abramovitch and colleagues affirmed that to control for potential confounding variables during an experiment and to use a computerized neuropsychological battery may contribute to find an association between obsessive symptoms and cognitive impairments.

The lack of ecological validity can also be an important criticism for experimental tasks and traditional neuropsychological tests (Goldstein 1996; Sbordone 1996).

Classic tasks in experimental settings request simple responses to single events, where tasks in naturalistic settings are more complex and multistep, requiring also the inhibition of inappropriate or irrelevant actions within several sub-tasks (Chan et al. 2008).

At this purpose become critic to increase ecological validity of a neuropsychological battery, where an assessment need to take into account aspects of patient's cognitive and behavioral responses that reflect real-life situations (Burgess et al. 2006). However, unfortunately, an effective assessment of executive functions during typical daily life is too difficult. More it is to consider that such an assessment become also more difficult involving patients in the procedure (Rand et al. 2009).

Today, thanks to the advances in technologies, virtual reality (VR) came to age to represent a valid chance to partially reach the ecological validity of real-life situations through direct exposure. VR is a sort of human computer interface system where the participants actively interact in a computer-generated tridimensional world (Schultheis et al. 2002).

VR has been extensively used in clinical research and practice, also recently (Repetto et al. 2013; Riva 2009; Albani et al. 2012; Villani et al. 2012; Pallavicini et al. 2013), being very suitable to mimic real situations, but in a fully controlled setting. In fact, nothing that obsesses the patients can "really" happen to them in the virtual environment.

The core background of using a virtual version of MET lies in the possibility of using technology to manipulate the quality of personal experience structuring it by using a goal, rules and a feedback system: The goal provides subjects with a sense of purpose focusing attention and orienting his/her participation in the experience. The rules, by removing or limiting the obvious ways of getting to the goal, push subjects to see the experience in a different way. The feedback system tells players how close they are to achieving the goal and provides motivation to keep trying. Another related way in using virtual version of MET is by augmenting it to achieve multimodal and mixed experiences. Technology allows multisensory experiences in which content and its interaction is offered through more than one of the senses. It is even possible to use technology to overlay virtual objects onto real scenes.

These processes are at the core of the relationship between the user and the environment. In particular, the study claims that the manipulation of the self allowed by this relationship may be used to develop new clinical approaches to assess OCD disorder.

The use of VR for manipulating volition

Virtual reality might be a powerful tool inducing embodiment for a replacement of our behaviors (Slater et al. 2010). The sense of ownership for one's own body and mind depends on a series of mechanisms, among which the most important are:

1. Spatiotemporal correspondence between efferent motor commands and their sensory feedback, inducing a sense of agency for one's own body movements (Jeannerod 2007)
2. Spatiotemporal correspondence between multisensory (visual, somatosensory, auditory, vestibular) signals coming from one's own body (Blanke 2012)
3. Constant automatic monitoring of interoceptive feedback from inside one's own behaviors (Craig 2009).

Manipulating each of these components has the potential to alter the representation of one's own behaviors, and more importantly in the context of VR simulation, this can also lead to the embodiment of a virtual surrogate self.

In a VR scenario, for instance, it has been shown that subjects attribute to themselves movements of an avatar if those are temporally synchronized with their own movements (Slater et al. 2009b). In contrast, a temporal delay between movements executed by the subject and by the avatar is known to reduce the feeling of being within a VR environment and of indentifying with an avatar (Slater et al. 2009a). Multisensory illusions such as the rubber hand illusion or the full body illusion can be obtained when tactile stimuli from one's own body and visual stimuli from its fake replacement are administered synchronously, and not when they are administered out of synchrony (Blanke 2012). Moreover, proprioceptive cues need to be congruent with visual cues about body position. Such mechanisms based on the contrast between multisensory congruent and incongruent stimulations (e.g., synchronous vs. asynchronous visuo-tactile stimulation of one's own and avatar's body) can also be exploited in the context of virtual reality exposure therapy.

A first progress beyond the state of the art that arose from this study is a better understanding of the neurological link between the multisensory/sensorimotor and behavioral mechanisms and the higher level mechanisms involved in the construction of the self. The experimental research also demonstrates whether and how much different situations induce embodiment for the self and, as importantly, disembodiment of the real body.

The use of VR for manipulating social volition

As underlined by (Mantovani and Riva 1999, 2001), the meaning of the presence experience in an environment, real or simulated, leads individuals to perceive themselves, objects, and eventually other people not only as situated in an external space but also as immersed in a sociocultural scenario connecting objects, people and their interactions. Individuals experience "reality" through interpretive grids that are generated by the preexisting social structures and live in a "reality" that is usually a social space in which individuals learn to perceive, categorize and use environmental affordances in ways that are meaningful and socially recognizable.

For this reason, the study also explores how the self and its volition is linked to culture and social factors: trying "narrative" and "extended" aspects of volition, respectively. No other study has explored these factors extensively.

Aims of the study

In particular, this study aims to analyzing the effect of three specific breaks in volition on both OCD patients and a control group.

Break in volition consists of breaking the normal task execution with different, confusing or stopping instructions during a series of normal task execution required to induce the volition to perform a specific action (for example, to buy a product). This action normally requires to pay attention to and to elaborate different information present at the same time (divided attention).

Our hypothesis is that breaks in volition affect OCD patients more than controls and that divided attention has a strong role in the process involved in volition aspects of behavioral syndromes.

Aim of this study was also to evaluate relationship between volition-induced deficit and cognitive behavior in non-OCD patients. In particular, we explored some domains such as decision making, attention and visual memory of patients during their shopping in a virtual supermarket.

We used a not immersive virtual version of the Multiple Errands Test, an assessment of executive functions in daily life which consists in performing tasks according to predefined rules, so that there are items to be bought and information to be obtained (Shallice and Burgess 1991; Cipresso et al. 2011; Raspelli et al. 2010) developed using NeuroVR software (Riva et al. 2011).

Materials and methods

Participants

The thirty participants consisted of 15 OCD patients (Mean age 34.27 $\pm$ 10.42) diagnosed by a clinical psychologist or psychiatrist as meeting the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV 2000) criteria for OCD and 15 controls (Mean age 39.33 $\pm$ 16.27). All the participants were experienced in the use of PC and were trained for the use of the joy pad within the virtual environment used for the experiment. Participants were asked not to drink caffeine or alcohol and not to smoke prior to the experimental test to avoid any effects of these substances on tests execution and performances.

Ethics statement

The study was approved by the Scientific Review Board of the "U.O. di Psichiatria dell Azienda Universitaria Ospedaliera Policlinico 'Paolo Giaccone' di Palermo" and was in accordance with the Declaration of Helsinki. All participants gave written informed consent to the experimental procedure according to the rules of the Scientific Review Board.

All participants' data were memorized in encrypted and password-protected files, following the criteria to protect personal health information (El Emam et al. 2011) and using PsychoPass method (Cipresso et al. 2012) to generate and share passwords information among colleagues.

Protocol

Participants who met the experimental criteria were contacted face-to-face, via email and/or telephone to schedule a meeting at the Department of Psychiatry of the University of Palermo.

They were welcomed by a specialized psychiatric, who assisted them during the sessions. The experimenters were instructed to maintain a neutral vocal tone and a neutral behavior, while the participants executed the tests. Once arrived at the Department, participants were asked to sit down in front of a computer and were told about the general goals of the clinical protocol, the procedures to be used, and the concerns for their involvement in the study.

The protocol was composed of two counterbalanced part for the assessment of generic and specific cognitive functions. In particular, a part involved the use of a validated classic neuropsychological battery and the other part involved the use of a validated VR-based test.

Specifically, subjects were requested: to select and buy various products presented on shelves with the aid of a joy pad; to recall some information acquired during the session such as, for instance, the list of all products seen, or the time of closure of the supermarket.

The main rules to follow were: to perform all tasks, without preference of order; do not be back in the corridor already visited; do not buy more than one product of the same category; to spent as less time possible to complete the session.

Neuropsychological battery

A Mini-Mental State Evaluation (MMSE) was administered to assess the general cognitive level. Specific tests were selected for cognitive assessment. In particular, a "Digit Span Test" to assess short-term memory; a "Short Story Recall Test" to assess the long-term memory; a Trail Making Test (Forms A, B and B-A) for the assessment of selective attention; a Frontal Assessment Battery (FAB), a bedside cognitive and behavioral battery to assess frontal lobe functions; a Corsi span and a Corsi Block Task for the assessment of spatial memory; a phonemic fluency test and a semantic fluency test to assess the semantic memory; a disyllabic words test to assess the word-length effect; and a Tower of London test for the assessment of executive functions. Scores of the tests were corrected for age, education level and gender where appropriate.

Exclusion criteria were MMSE <24; Token Test <26.5; Street Completion Test <2.25; State and Trait Anxiety Index >40; Beck Depression Inventory >16.

VMET

To create the protocol in the virtual environment, we used NeuroVR 2.0, a free software where the user can choose the appropriate psychological stimuli/stressors from a database of objects (both 2D and 3D) and videos, and easily place them into the virtual environment (Riva et al. 2011). The scene created has been visualized in the player using non-immersive displays.

The virtual version of MET (VMET) (Raspelli et al. 2012) was composed by a virtual supermarket where users have a list of specific task, such as to buy products contained on shelves, like in a real supermarket. VMET has been already used in clinical study involving patients (Raspelli et al. 2009, 2012; Carelli et al. 2009).

The products were presented in categories including beverages, fruits and vegetables, breakfast foods, hygiene products, frozen foods, garden products and animal products. Navigation through the aisles of the virtual supermarket was by the means of a joy pad.

All users were trained for the virtual reality use in another environment, specifically designed for training needs.

VMET scoring

In the VMET procedure, there are a number of score to be recorded, namely time of execution, seven types of partial errors, total errors, partial tasks failures, inefficiencies, rule breaks, strategies and interpretation failures (Raspelli et al. 2012).

For partial task failures, the scoring range was from 8 (no errors) to 16 (great errors). As for the partial task failures, the specific items were "searched item in the correct area"; "maintained task objective to completion"; "maintained sequence of the task"; "divided attention between components of task and components of other VMET tasks"; "organized materials appropriately throughout task"; "self corrected upon errors made during the task"; "no evidence of perseveration" and "sustained attention throughout the sequence of the task (not distracted by other stimuli)."

The analyzed variables were the execution times for the entire task; errors in executing the tasks, with a scoring range from 11 (the subject has correctly done the tasks) to 33 (the subject has totally omitted the tasks); inefficiencies, with a scoring range from 8 (more inefficiencies) to 32 (no inefficiencies); rule breaks, with a scoring range from 8 (more rule breaks) to 32 (no rule breaks); strategies, with a scoring range from 13 (more strategies) to 52 (no strategies); interpretation failures, with a scoring range from 3 (more interpretation failures) to 6 (no interpretation failures) and partial task failures, with a scoring range from 8 (no errors) to 16 (more errors).

In particular, breaks were classified according to the following definitions:

1. Break in time: to go to the shopping chart after 5 min.
2. Break in choice: to buy two products instead of just one.
3. Break in social rules: "to go into a specific place and to ask the examiner what to buy."

Data analysis

Data were analyzed with the aid of the statistical software SPSS, version 17 (Statistical Package for the Social Sciences—SPSS for Windows, Chicago, Illinois, USA). Comparisons between patients and controls were done by using a series of one-way analyses of variance (ANOVAs).

Results

Neuropsychological battery

Table 1 shows the results of OCD patients compared with normative data. Results showed intact cognitive levels in these patients, with the exception of TMT B and TMT B-A having valued slightly under the normative data, indicating a lower divided attention with respect to normal.

Breaks in volition

Three specific errors' breaks examined within the VMET procedure to account for the specific differences between OCDs and controls in breaking volition. As can be seen in Table 2, patients showed higher levels of breaks. In particular, break in time [$F(29,1) = 23.036$, $p < .001$]; break in decision [$F(29,1) = 28.767$, $p < .001$] and break in social interference [$F(29,1) = 10{,}392$, $p < .004$]. More, divided attention (between components of task and components of other VMET tasks) was found different between groups [$F(29,1) = 5.119$, $p < .032$], being higher for OCDs than controls.

Discussion

The general aim of this study was to investigate the effects of breaks in volition on OCD patients. At this purpose, we used a virtual version of the Multiple Errands Test and assessed three breaks during the normal executions of standard tasks.

Table 1 Neuropsychological battery in OCDs

Test	Mean	Std. deviation	Normative data
MMSE	26.28	2.71724	>18
FAB	15.43	1.30379	>14.4
Trail making task A	59.80	21.153	<68
Trail making task B	192.53[a]	128.234	<177
Trail making task B-A	132.27[b]	117.640	<111
Phonemic fluency	27.00	9.063	>23
Semantic fluency	33.53	10.602	>30
Tower of London	21.73[c]	6.861	Not available
Digit span	5.07	1.15907	>4.25
Disyllabic words	17.37	24.4573	>8.50
Corsi span	4.68	.78181	>4.25
Short story	13.87	4.4339	>10.50
Corsi block task	16.14	7.08060	>10.25

[a] Non-pathological level; pathological level: >282

[b] Non-pathological level; pathological level: >186

[c] Normally considered non-pathological level

Table 2 Descriptives of the Virtual Multiple Errands Test (VMET) scores

Test	Group	N	Mean	Std. deviation	Std. error
Break in time	Patients	15	13.40	2.354	.608
	Controls	15	8.73	2.939	.759
	Total	30	11.07	3.532	.645
Break in choice	Patients	15	9.40	1.352	.349
	Controls	15	7.40	.507	.131
	Total	30	8.40	1.429	.261
Break in rules	Patients	15	9.87	1.552	.401
	Controls	15	8.20	1.265	.327
	Total	30	9.03	1.629	.297
Divided attention	Patients	15	10.4000	2.89828	.74833
	Controls	15	8.4667	1.59762	.41250
	Total	30	9.4333	2.50080	.45658

Results showed a clear presence of difficulties of OCD patients in interfacing these breaks compared with the controls. These seem to reflect deficits in the attention of these patients. In particular, the higher complexity of the required tasks including the breaks leaded to higher levels of divided attention, however, not pathological, in OCD patients.

Thus, even if our OCD patients sample reported no one pathological level from cognitive assessment through the neuropsychological assessment, a more extensive research using virtual reality, at an higher level of ecological validity, showed impairments in complex task executions where the strategies required to overcome the breaks in volition were higher than those available when OCD occurs.

Attention as a requirement for consciousness is a theme highly debated at the moment (Cohen et al. 2012); however, it is clear from our experiment that breaks in volition through experimental manipulation, accounting for a higher complexity in attention, are able to lead to higher divided attention scores and lower performance where a deficit in volitional controls exists, such as for OCD patients.

Virtual reality literature includes many descriptions of users reacting to a virtual environment in instinctual ways that suggest they believe, at least for a short time, that they were "immersed" and even "present" in the synthetic experience. Following the definitions introduced by Slater, Steed and Chrysanthou (Slater et al. 2002): "Presence is a state of consciousness, a state of being [in an environment]… while immersion is related to the quantity and quality of sensory data that is from that environment" (p. 22). Specifically, immersion is generally understood to be a product of technology that facilitates the production of the multimodal sensory "input" to the user (Burdea et al. 1996), while presence is defined as the psychological perception of being "there," within a virtual environment (Heeter 1992).

These considerations seem to suggest that volition aspects of behavioral syndromes can be better analyzed where a higher ecological validity exists. Virtual environment partially account for this exigency, taking into account the possibility to define the extent to which the volition can be "broken," through rules manipulations and specific tasks.

The relationship between the user and the environment was based on the "inter-reality" paradigms that integrate assessment and treatment into a hybrid, closed-loop empowering experience bridging physical and virtual worlds:

- Behavior in the physical world influences experiences in the virtual world: For example, the effects of the patient's therapeutic efforts are reflected on the self, providing a motivating feedback.
- Behavior in the virtual world influences experiences and the patients' experience in the real world: For example, the therapy in virtual reality being done through an avatar which is embodied by the patient, the estimation of self-consciousness factors can be used to adjust the rehabilitation program. Our claim is that advanced technologies (such as virtual worlds) bridge virtual experiences (fully controlled by the therapist, used to learn healthy behaviors and coping skills, and to modify self and volition) with real experiences (the therapist can identify critical situations and assess clinical changes) opening a promising way to exploit the symbiotic relationship between a patient and her/his volition.

The proposed paradigm will allow the development of innovative prototypes of coevolving technologies based on new theories and models and deeper understanding of human behavior.

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ALLEGATO 3

Cognitive rehabilitation of schizophrenia through NeuroVR training

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Abstract. Cognitive difficulties are prevalent in people with diagnosis of schizophrenia and are associated with poor long-term functioning. In particular, memory, selective, divided and sustained attention and executive functions are altered by this disease.Weused a Virtual Reality environment (developed via theNeuroVr2.0 software) for the rehabilitation of shifting, sustained attention and action planning functions using tasks reminiscent of daily life tasks.Test and retestshowed significant differences in the assessed cognitive dimensions.

Keywords. Virtual Reality, Schizophrenia, Cognitive Rehabilitation, Executive functions.

Introduction

Cognitive impairmentis a core feature of schizophrenia, with converging evidence showing that it is strongly related to functioning in areas such as work, social relationships, and independent living[1]. Furthermore, cognitive functioning is a robust predictor of response to psychiatric rehabilitation[2, 3].We developed - via the NeuroVr 2.0 software - a Virtual Reality (VR) cognitive task, for rehabilitation of shifting, sustained attention and action planning functions (problem solving, planning, working memory, inhibition, mental flexibility, initiation and monitoring of actions).

Methods

The study included two clinical samples of patients suffering from schizophrenia disorder diagnosed by DSM IV. The experimental group consisted of 6 patients treated with pharmacological therapy (mean age=31 years, std.dev.=14.6), while the control group was composed by 6 patients treated with Integrated Psychological Treatment (IPT)(mean age=35 years, std.dev.=9.9) and with pharmacological therapy. Patients were selected from the outpatient Unit of Psychiatry of Palermo Universitary Hospital. The experimental group received a cognitive training based on virtual reality; the control group received theIntegrated Psychological Treatment(IPT).

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Before and after training we assessed the cognitive and executive functions,both in cases and controls,through following tests: Mini Mental State Examination (MMSE), Frontal Assessment Battery (FAB), Trial Making Test (TMT),Tower of London (ToL), Memory Battery, Wisconsin Card Sorting Test (WCST), Stroop Test.
The cognitive procedure, conceived as a hierarchical sequence of tasks (starting from a single-task condition and ending with successive multiple tasks), has been implemented in a virtual "valley", "beach", and"supermarket".In the valley and in the beach, the participant were asked to identify and select a target stimulus, differentiating it from others similar (e.g.,pick up only pink flowers, or identify and pick up only glass bottles and differentiate it betweenthose withdifferent material).In the supermarket, participant were requested to select and buy various products following specific rules.
The treatment was implemented in 10 weekly individual sessions. Each session lasted90 minutes. During the training, time of execution, total errors, inefficiencies, rule breaks, and strategies applied were measured.

Results and conclusions

Given the limited sample size, we used non-parametric tests to analyze the effect of the treatmenton cognitive performances in the experimental group and the control group (pre-treatment vs. post-treatment).At baseline, groups were similar in terms of gender, age, education level, and degree of cognitive impairment.Both VR training and IPT were associated with improved performance in the divided attention task. Furthermore, VR training was related with reduced cognitive deficits and improved planning (Table1).

Table 1. Results at Wilcoxon test

Test-retest	Experimental (n=6)	Control (n=6)
MMSE	z= -2.020, p= 0.043*	z= -0.210, p= 0,833
ToL	z=-2.032, p= 0.046*	z=-1.841, p= 0.066
FAB	z= -1.826, p= 0.068	z= -1.787, p= 0.074
TMT-B	z= -2.023, p= 0.043*	z= -2.207, p= 0.027*

*Significant p<0.05

After the executive function training (virtual supermarket) the experimental group showed significant improvements in: decreased errors (20.33±2.7 vs.15±2.36; Wilcoxon ztest=-2.02, p= .043); reduced time of execution(10.47±3.31vs. 4.42±1.91;Wilcoxon z test = -2.20, p= .028); increased observance of rules (17.33±3.9vs. 22.33±34; Wilcoxonz test = -2.21, p= .027).
In addition, after theattention training (virtual valley and beach),the experimental group showed improvements in: reduced time of execution (54.00±28.71 vs. 25.56±13.26; Wilcoxon z test= -2.20, p= .028);decreased perseverative errors; improvement in sustained attention.
These preliminary data suggest that virtual reality training may improve cognitive functioning in psychotic patients, such as others rehabilitative programs.

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