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## Interactive Media in Training and Therapeutic Intervention

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## Relationship between Social Response to Virtual Avatar and Symptom Severity of Patients with Schizophrenia

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**Abstracts:** *A virtual avatar has been used for various applications that require communication among persons, or to train or educate people by demonstrating human-like behavior. Recently, much research has shown an enhancement of virtual avatar technology, with the avatar perceived as a real person. As a result, the technology could begin to be used for observing human behavior to a virtual avatar. This paper concerns whether a virtual avatar could acquire patients' behavioral characteristics during experiencing a virtual task which is composed of approaching and conducting a short conversation. For this, we designed a virtual avatar that was standing in a virtual room, with eleven schizophrenic patients assigned the task of approaching the virtual avatar, initiating a conversation, and providing answers to the avatar's questions. To measure behavioral parameters in the virtual environment, we acquired the interpersonal distance and the verbal response time. In addition, we rated patients on the Positive and Negative Syndrome Scale (PANSS) in order to investigate a relationship between patients' symptomatic characteristic and behavioral parameters. Results of this study revealed that the interpersonal distance was negatively correlated with the negative syndrome scale, which is a subscale of PANSS ( $r=-0.687$ ,  $p=0.02$ ). By contrast, the verbal response time was not correlated with any other subscale of PANSS. However, after analyzing this variable with sub-items of the negative syndrome of PANSS, two positive correlations were found: one with blunted affect ( $r=.638$ ,  $p=.035$ ) and the other with poor rapport ( $r=.615$ ,  $p=.044$ ). The negative correlation between the distance and negative symptom severity observed in this study is consistent with studies that investigated the relationship between schizophrenic patients' interpersonal distance and their symptoms. The positive correlation between the verbal response time acquired and subscales in PANSS in this study could be explained by the definition of these subscales. Therefore, this positive correlation means that the less a patient's emotional response, intimacy, and relationship making with a virtual avatar, the slower they answer the avatar's question. Inferring from these results, we conclude that the virtual avatar could be perceived as a real human by schizophrenic patients, the avatar could facilitate the schizophrenic patients' behavioral characteristics, and the avatar could be used as a tool for assessing the behavioral characteristics of patients with schizophrenia.*

### INTRODUCTION

Virtual Reality (VR) has the potential to provide a realistic three-dimensional world generated by computer graphics, with which the user can interact, so that he or she can navigate within and manage the virtual world and obtain computerized objective scores. Due to its capacity to provide realistic three-dimensional environments to users, VR has already been applied to many fields such as industry, the military, entertainment and medicine. In particular, many medical applications have emerged because of its ability

to provide a realistic, interactive, immersive, and safe environment; this complements the fact that it provides a flexible and controlled experimental and therapeutic environment. It has been applied to several types of mental disorders such as illness,<sup>1-3</sup> and attention deficit disorders (ADD)<sup>1,4</sup> for assessing patients' cognitive functions<sup>5</sup> and for providing training for stroke patients' activities of daily living (ADL).<sup>6</sup> VR has also been used to assess and investigate human characteristics in three-dimensional envi-

ronments such as for navigation,<sup>7</sup> and spatial memory.<sup>8</sup>

Moreover, recent technological advances in avatars enable computer-generated entities to mimic both the appearance and behaviors of humans. Thus, Virtual Environments (VEs) can be more realistic and social, because VEs can be populated by representations of people as well as objects. Recent improvements in graphic and animation technology have made it possible for the avatars used in these visual images to appear increasingly human-like. Studies have shown that people report feeling some level of presence in almost all mediated environments and even respond socially to computer-generated human-like entities.<sup>9</sup>

In addition to these results, several studies have shown that human behavioral characteristics, such as proximity and social influence could be investigated using a virtual avatar or a social situation populated with several avatars.<sup>10,11</sup> These studies support the hypothesis that a VE populated with avatars could influence human behavior and emotion.

From these studies showing the capacity and potential of VR, we can predict that VR could also be useful for investigating the interpersonal behavior of patients with mental illness. In particular, we are interested in applications to schizophrenia because it is one of the most devastating psychiatric disorders, as it seriously affects the higher mental functions, such as thinking, feeling and perceiving.<sup>12</sup> The Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV), states that schizophrenia involves problems in one or more major areas of functioning (e.g., interpersonal relations, work or self-care).<sup>13</sup> It is also characterized by symptoms such as hallucinations or disorganized thinking, the loss of goal-directed behaviors, and deterioration in social role functioning. Due to these deficits, patients with schizophrenia have a negative effect on their partners in interpersonal or social interaction and they suffer when living with others. Although investigating the interpersonal behavioral characteristics of patients with schizophrenia is necessary to understand and treat them, currently only subjective materials such as videotaping or clinical observation are available for assessing pa-

tients' interpersonal behavior characteristics during an interaction. The problems of those methods for assessing the patient's behavior concern the difficulty in establishing a controlled experimental situation and observing behavior consistently.

Due to these needs, in this study, we aimed to develop a method for assessing the interpersonal behavioral characteristics of patients with schizophrenia using VR technology. VR technology has many advantages in providing a realistic environment, and allows us to investigate how schizophrenic patients perceive and react to a virtual avatar. It also allows an investigation of whether interpersonal behavior toward a virtual avatar is similar to behavior in response to a human.

For accomplishing the goal of this study, a virtual room, in which a virtual avatar is standing, was designed and a short conversation task was assigned to the patients. And, as objective parameters from patients' virtual experience, the interpersonal distance and the verbal response time were chosen because they are representative factors to represent a relationship between people and play an important role in conversation as well as social life.<sup>14</sup> And, PANSS of the patients were also acquired in order to investigate the relationship between their symptom and the behavioral parameters. Through the investigation of the relationships among these parameters, we expected that the patients react to the virtual avatar in the same way as to human and the virtual environment and the virtual avatar could be a tool for assessing the interpersonal behavior characteristics of the patients with schizophrenia.

## MATERIALS AND METHOD

### *Subjects*

We recruited 11 patients, 5 male and 6 female, diagnosed with schizophrenia, for this experiment. They were inpatients at the Severance Mental Health Hospital in Korea and were able to perform a task and to control an interface such as a joystick. Their mean age was  $29.54 \pm 8.95$  years (mean  $\pm$  SD) and their PANSS score were  $21.81 \pm 4.62$  (mean  $\pm$  SD) for negative symptoms,  $19.45 \pm 3.67$  (mean  $\pm$  SD) for posi-

tive symptoms and  $40.91 \pm 5.54$  (mean  $\pm$  SD) for the general psychopathology score.

*Apparatus*

The apparatus for this experiment was composed of a personal computer (PC), a large screen, a beam projector, and a joystick, which were used by the subjects to experience a VE. The VE consisted of a room and a male-shaped virtual avatar that had eye blink and breathing motions, but no facial expressions and no gestures. The VE and avatar were rendered on a PC using “3D Game Studio” (Conitec Datasystems Corporation), which is a commercial 3D game engine, and projected onto a big screen through a beam projector. This method was chosen because a patient with schizophrenia may feel discomfort when wearing a head mounted display (HMD) and tracker. The subjects moved forward and backward by pushing or pulling the lever on the joystick, and initiated conversation by pressing the talk button on the joystick.

*Task Description*

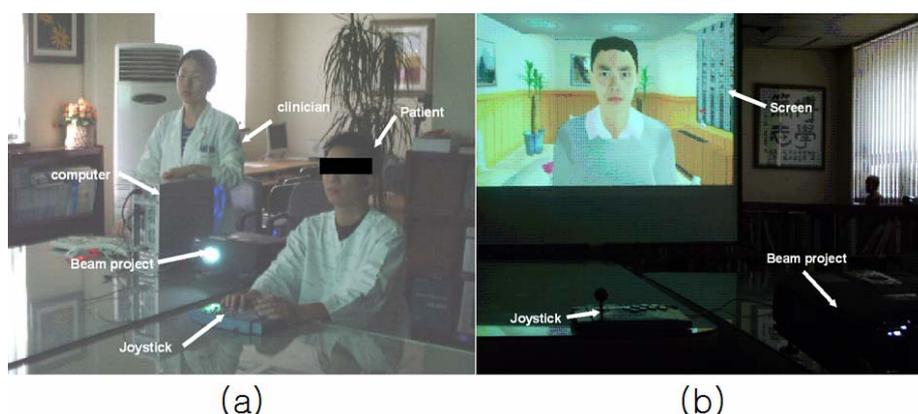
We designed the task so that the participant had to initiate and conduct a short conversation with a virtual avatar. Therefore, a subject had to approach a virtual avatar standing in front of the subject by pushing the lever of the joystick forward and try to talk to the virtual avatar by pressing the talk button on the joystick. In order to initiate the conversation, subject had to press

the “talk” button then say “hello”. After initiation, the avatar and the subject exchanged questions and answers. In order to do this, we generated a fixed simple scenario for a short conversation and the clinician controlled the scenario according to the subject’s verbal response (for a detailed script, see Fig. 2).

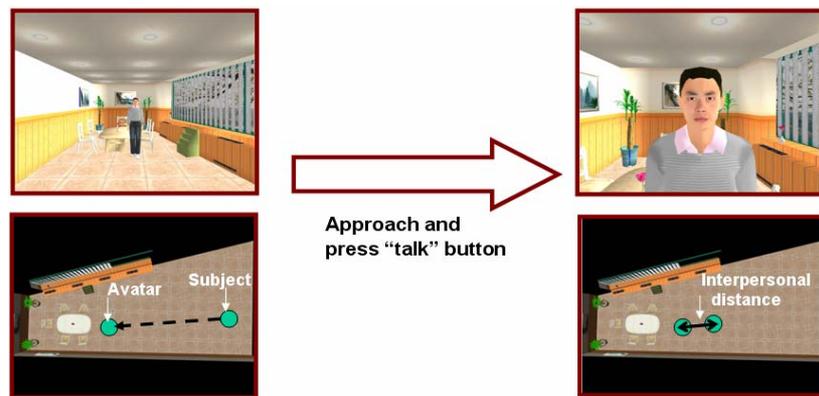
*Measurements*

For VR-based measurements, we required the interpersonal distance and the verbal response time and saved them during the task. We defined former as a virtual distance between a subject and the avatar at the moment that the subject approached and pressed the “talk” button to initiate a conversation. It is reasonable for the distance to be regarded as the interpersonal distance, since the distance means the comfortable distance for having a conversation with the virtual avatar. We defined the verbal response time as the time elapsed following the moment that the avatar asked the subject a question until the point that the subject commenced the answer.

The PANSS, used to measure the severity of the patients’ positive and negative symptoms, allowed assessment of the relationship between symptoms and behavioral characteristics. It is composed of three subscales: the negative syndrome scale, positive syndrome scale, and general psychopathology scale. In more detail, each subscale is determined by assessing several representative schizophrenic symptoms.



**Figure 1.** Scene of an experiment (a) and a virtual avatar standing in a virtual room (b). A subject is sitting on a chair, a screen is located in front of the subject and the subject controls a joystick to move and respond.



**Script for a short conversation**

Subject : Hello ?  
 Avatar : Hello. Nice to meet you. What is your name?  
 Subject : My name is XXX. What is your name?  
 Avatar : My name is OOO. How old are you?  
 Subject : I'm 28 years old. How about you?  
 Avatar : I'm 29 years old.



**Figure 2.** Diagrammatic representation of the task and parameters, and a script for a short conversation for this task.

For example, the negative syndrome scale has seven characteristics of schizophrenia, which are blunted affect, emotional withdrawal, poor rapport, passive apathetic social withdrawal, difficulty in abstract thinking, lack of spontaneity & flow of conversation and stereotyped thinking.<sup>15</sup>

**RESULTS**

The mean and standard deviation of the interpersonal distance was 104.86 (SD=60.39) in virtual unit, which did not convert to a real unit, because only the relative difference among patients was of interest. And, when we investigated the relationship between the distance and PANSS subscales, the distance was significantly negatively correlated with the negative syndrome score, which is one of the PANSS subscales (n=11, r=-0.687, p=0.02), but we saw no correlations with other subscales, such as positive syndrome and general psychopathology score.

The mean and standard deviation of the verbal response time was 4.64 seconds (SD=1.40). And, when we investigated the correlation between the verbal response time and PANSS scores and its subscales, there was no significant correlation with positive and negative

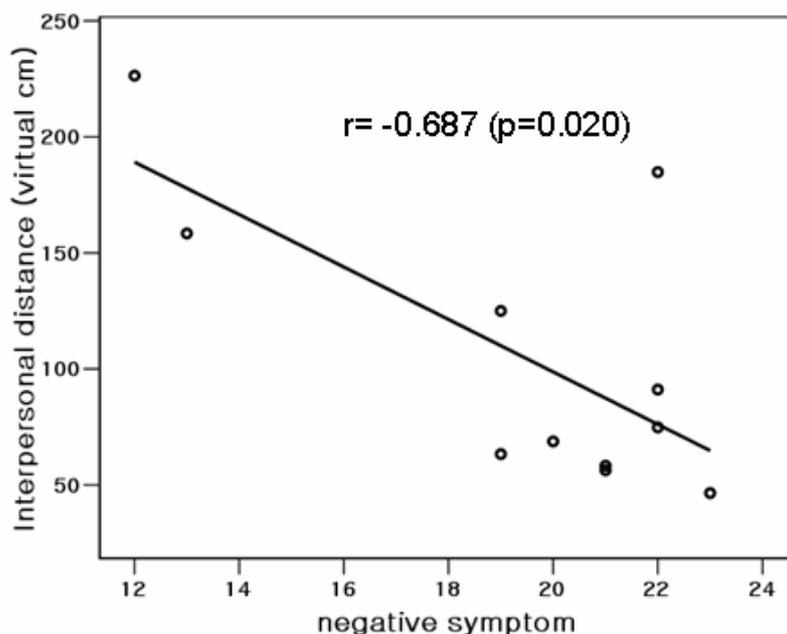
symptoms and the general psychopathology score.

However, there were two significant correlations; namely, between verbal response time and blunted affect characteristic (n=11, r=.638, p=.035), and between verbal response time and poor rapport (n=11, r=.615, p=.044).

**DISCUSSION**

This study investigated social response between patients with schizophrenia and a virtual avatar so that we could find the patients' behavioral characteristics to a virtual avatar.

The negative correlation observed in this study is consistent with studies that investigated the relationship between schizophrenic patients' interpersonal distance and their symptoms. In particular, our results of a negative correlation are consistent with a study conducted by Nechamkin et al. showing relationships between the distance and clinical symptomatology, as measured by the PANSS subscales scores.<sup>16</sup> In that study, there was no correlation between positive syndrome scores and any type of interpersonal distances measured with family, friends, and hostile and neutral images, while negative syndrome scores exhibited moderate



**Figure 3.** The correlation between patients’ negative syndrome scale and the interpersonal distance.

to high negative correlations with the distances measured using hostile and neutral images. Explaining our results based on the Nechamkin’s study, patients with schizophrenia perceived the avatar as a neutral or hostile human image. It is reasonable to assume that the patients with schizophrenia probably perceived the avatar as a neutral image of a real person because the avatar did not show any facial expressions and gestures, which means that the avatar showed no emotion to the patients.

The additional parameter we acquired and analyzed in this study was the subject’s verbal response time, which was defined as the time elapsed between the patient’s response and the avatar’s question. Correlation analysis revealed positive correlations between verbal response time and both the blunted affect and poor rapport scales, which are sub-items of the PANSS negative syndrome. The blunted affect score represents the amount of emotional change, which is characterized as the reduction of facial

Subscales in the negative symptoms of PANSS	Correlation value (p value)	
N1: Blunted affect	.638*	.035
N2: Emotional withdrawal	.404	.218
N3: Poor rapport	.615*	.044
N4: Passive/apathetic social withdrawal	.078	.820
N5: Difficulty in abstract thinking	.400	.222
N6: Lack of spontaneity & flow of conversation	-.090	.792
N7: Stereotyped thinking	-.109	.749

\* : correlation is significant at the 0.05 level (2-tailed)

Table 1. The correlation between the verbal response time and the subscales in the negative symptoms of PANSS.

expression, emotional modulation, and gesture during communication. By contrast, the poor rapport score represents the amount of intimacy to an interviewer or the level of deficit in forming a relationship, which is characterized as distancing a human relationship and the reduction of verbal and nonverbal communication.<sup>15</sup>

The positive correlation between the verbal response time acquired and subscales in PANSS in this study could be explained by the definition of these subscales. Therefore, this correlation means that the less a patient's emotional response, intimacy, and relationship making with a virtual avatar, the slower they answer the avatar's question. When this fact is considered in view of a virtual avatar, this could be additional evidence to show that a patient with schizophrenia responds to a virtual avatar in the same way as to a real person.

## CONCLUSIONS

Our objective for this study was to investigate whether VR is a suitable tool for extracting and assessing the patient's behavioral characteristics. In order to do this, we investigated the behavioral and verbal response characteristics by observing the interpersonal distance between the schizophrenic patients and a virtual avatar, and the duration from the time the avatar asked a question to the time the subject answered, respectively.

This study provided evidence supporting the position that the patients respond to the virtual avatar as if they were really standing near it and conversing. It is also supported by data showing that the patients' behavioral characteristics to a virtual avatar vary in accordance with their symptoms, and these characteristics are the same as those to a real person. This indicates that virtual avatar could draw patient's social response in an objective manner. Therefore, this study could be meaningful because it may provide the method and rationale for applying VR techniques to training or assessing the behavioral and/or cognitive characteristics of patients with schizophrenia.

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