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Investigation of Social Cue Perception in Schizophrenia using Virtual Reality

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Abstract: Background/Problem: *An impairment in social skills is one of the few criteria that all individuals diagnosed with schizophrenia must meet Successful social skills require the coordination of many abilities, including social perception, which involves the decoding and interpretation of social cues from others. Previous studies on social perception in schizophrenia have focused on interpreting the emotions from facial expressions. There are some reports showing the potential of virtual reality (VR) in social skills training. This study developed VR for assessing the social perception including an interpretation of non-facial expressions. In addition, the suitability of VR for determining a schizophrenia patient's social perception ability was evaluated.*

Method/Tools: *For an effective social perception test, VR consisting various situations and contents may be needed. Therefore, the VR Behavior & Facial Data Base architecture (VRBFDB) was used for the easy and fast VR composition. The contents can be divided into two areas "interpretation of the relevant cue test" and "Emotion Recognition test." The "Interpretation of the relevant cue test" is composed of the recognition of a non-verbal social situation as well as the recognition of a verbal social situation, and the "Emotion Recognition test" is composed of happy, sad, angry and surprise facial expression recognition.*

There were 17 subjects (12 males and 5 females) and 17 controls (12 males and 5 females). This study obtained the data from the VR, a questionnaire, and the subject's symptoms. The VR data included the participant's response results, reaction time, presence and computer experience . The questionnaire data included age, education, gender, intelligence (K-WAIS) etc. The symptom data was measured using the PANSS (Positive and Negative Syndrome Scales).

Results/Conclusion: *According to the results, schizophrenia subjects perform significantly worse on the VR test than normal subjects, and some parameters the correlated with previous clinical test.*

INTRODUCTION

"Social skills" are interpersonal behaviors that are normative and/or socially sanctioned. They include items such as dress and behavior codes, rules about what to say and what not to say, and stylistic guidelines about the expression of affect, social reinforcement, interpersonal distance etc [1]. Impairment in social skills is one of the criteria that all individuals diagnosed with schizophrenia must meet [2]. These deficits make it difficult for many clients to establish and maintain social relationships, fulfill social roles or to have their needs met [1].

Successful social competence is based on a distinct set of component skills [3]. These components can be roughly divided into two broad sets: expressive skills (speech content, paralinguistic features, and nonverbal behavior) and social perception skills (interpretation of the relevant cues, emotion recognition). However, regardless of the individual's ability to emit socially skillful responses, he or she cannot be effective without an accurate social perception that involves the decoding and interpretation of various social cues in others [1]. Previous research on social perception in schizophrenia

focused on the interpretation of emotion from the facial expressions. Although facial expression is admittedly an important social cue, the restrictive focus on the interpretation of this single nonverbal cue was too narrow given the breadth of the social deficits in schizophrenia [4].

There are many social cue elements that substantially contribute to socially skillful behavior. And social cue perception is the most fundamental requirements for accurate social perception [1]. These social cues can be divided into verbal or nonverbal social signals [4]. Many chronic clients exhibit poor interpersonal behavior precisely because their focus of attention is primarily internal, and is only intermittently and selectively directed outward. Another aspect of social perception involves the accurate perception of emotion. Emotion is frequently communicated by a subtle combination of verbal and nonverbal cues. Given that the emotion states of an interpersonal partner are critical factors in determining the appropriate response, a socially skilled individual must be able to 'read' the emotional cues. Such personal perception and analysis enhances accurate communication and is essential for the effective resolution of conflict and distress [1].

The existing social perception and social skill training method rely upon role-play, either acted out or observed through the use media and materials [5, 6]. Typically, it involves the use of a puppet or videotape [7]. However, despite the success of some social skills training programs in enhancing skill acquisition within a training setting, it has limitations in the transfer of training and the generalization of skills to the natural environment [8]. Moreover, it does not focus on social perception, which is a basic and primitive aspect of social skills.

Recently, there have been some reports on the potential of virtual reality (VR) in social skills training [7, 9, 10]. Virtual environments (VE) allow the users to interact with a three-dimensional computer-based world incorporating impressive graphics and design. The users can move through a VE in real time using a joystick or mouse. They can interact with the objects in a scene and are typically represented as a humanoid "avatar" [9]. The cardinal feature of VR is the provision of a sense of actual presence in the stimulated environment [11, 12]. In addition, complete control over the content is possible, and the performance data can be stored in a database. VR provides patients with added motivation by adding gaming factors in a

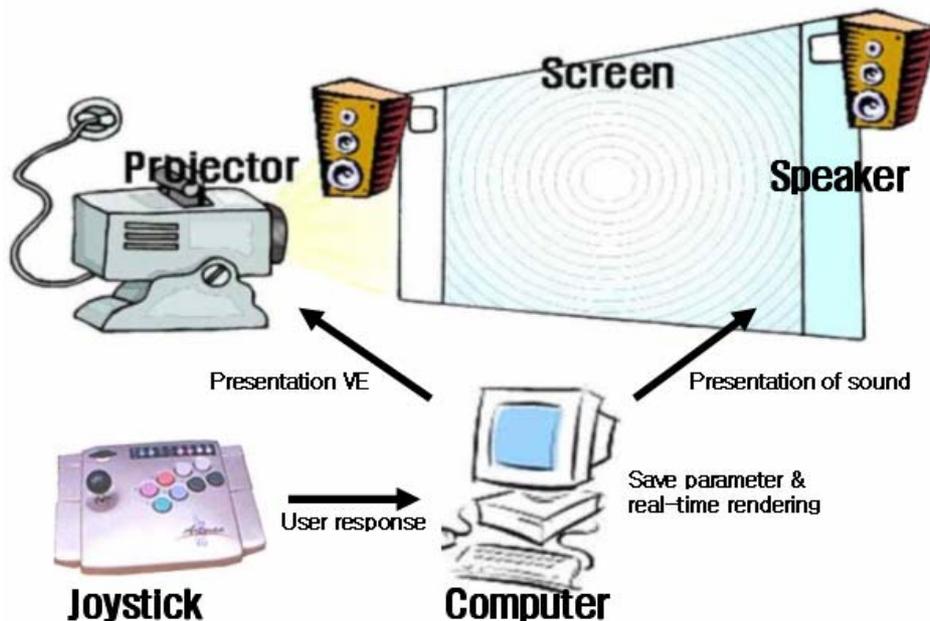


Figure 1. Hardware for virtual reality

safe virtual environment that eliminates the risks caused by errors [13].

This study developed a VR Behavior & Facial Data Base architecture (VRBFDB) for an easy and fast VR composition. The VRBFDB was used to design VR social perception contents including the interpretation of verbal cue perception, non-verbal cue perception, and the recognition of emotion. It was hypothesized that schizophrenia subjects would perform significantly worse on the VR test than normal subjects.

MATERIALS AND METHODS

System

The VR system consisted of a Pentium IV PC, DirectX 3D Accelerator VGA Card, Projection Screen, and Joystick (Dahoon DHU-1500), which could be used as an easy response to allow the patients to perform the virtual reality scenario comfortably. The PC, which is fitted with a 3D Accelerator VGA Card, generates real-time virtual images for the subject. Figure 1 shows the hardware for the VR.

VRDFDB

A VR software framework, called a VR Behavior and Facial Data Base (VRBFDB) was set up to provide a variety of VR scenarios. The VRBFDB is composed of an avatar database (14 avatars) as well as a motion and facial ex-

pression database. The motion and facial DB includes 93 behaviors and 7 facial expressions. 14 avatars designed by the 3D Max Studio could be used in different situations by applying a different texture map, which affects the avatar's clothes, hair style, and skin color. Seven facial expressions were implemented using a morphing technology. Primitive facial expressions (happy, sad, angry, smile, surprising, embarrassing, and bored) were controlled by the parameters to express complicated and subtle facial expression. Ninety-three behaviors are made by a biped, which is used to represent the avatar's action. Each behavior could be attached to any avatar, which was already made, and the avatar's animation, which was matched with each scenario, could be made.

According to the VR scenario, the avatars, behaviors, and facial expressions, which are needed in the scenario, were integrated and then exported in .Med files. The necessary environment in the scenario was exported to a .Map file, which was used in the A6 Game Studio Engine. The exported avatar, which included the behaviors and facial expression, was merged with the .Map file and rendering by an A6 Game Studio rendering engine. Figure 2 shows the VRBFDB architecture.

Virtual environment and task

VR is designed to assess the social perception. During the experiment, the subjects perform VR and he/she chooses whether it is suitable or unsuitable (Likert type scale: 5 point). The VR is

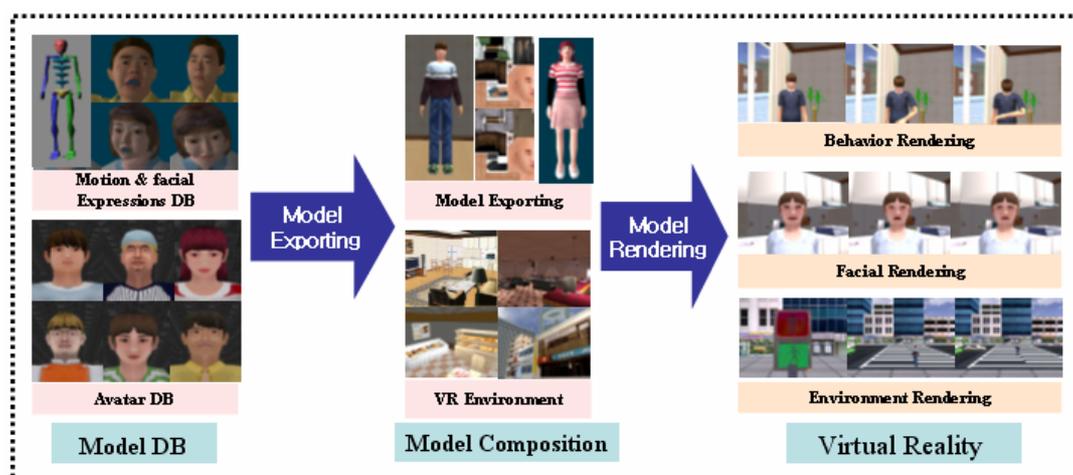


Figure 2. VR Behavior & Facial Data Base Architecture (VRBFDB)

| | |
|--------------------------------|--|
| Interpretation of relevant cue | Nonverbal social cue (8) - Recognize avatar’s physical gesture - Recognize traffic signal - Unusual street situation - Suitable/Unsuitable behavior according to situation |
| | Verbal social cue (6) - Polite/rude dialog - Suitable/Unsuitable greeting |
| Emotional Recognition | Happy situation (6) - Recognize happy facial expression - Recognize happy situation |
| | Sad situation (4) - Recognize sad facial expression - Recognize sad situation |
| | Angry situation (6) - Recognize angry facial expression - Recognize angry situation |

Table 1. The contents of the VR social perception tool.

composed of an ‘Interpretation of Relevant Cue (IRC)’ and ‘Emotional Recognition (ER)’. Table 1 shows the contents of the VR. The IRC is composed nonverbal and verbal social cues. The ER is composed a happy situation, a sad situation and an angry situation. In the nonverbal social cue perception, the physical gesture and social situation was selected because they can be used as virtual ‘avatar’ and virtual ‘context’. In addition, the VR contents for verbal social cue were composed of a basic verbal component (for example suitable or unsuitable greeting and polite or rude expression). In the emotion recognition, happy, sad, angry emotion recognition contents were designed. During the emotional recognition contents, the patients must recognize the emotion considering the avatar’s facial expression and context.

EXPERIMENT (SUBJECTS, PROCEDURES, MEASUREMENT)

Subjects.

The subjects consisted of 17 inpatients (12 males and 5 females) diagnosed with schizophrenia, and 17 control subjects (12 males and 5 females) (Table 2). The patients’ mean total PANSS (Positive and Negative Syndrome Scale) was 77.12 (SD 8.43), the positive and negative PANSS means were 18.00 (SD 2.83) and 20.18 (SD 3.26) respectively.

There were no significant differences between the patient and control groups. The score on the patient’s computer using the experience was checked as (1) very strange, (2) strange, (3) common, (4) experienced, and (5) very experienced.

| | Patient group (n=17) | Control group (n=17) |
|---------------------------|----------------------|----------------------|
| Age (years) | 30.41 ± 5.36 | 30.05 ± 6.07 |
| Sex (M:F) | 12 : 5 | 12 : 5 |
| Computer-using experience | 3.41 ± 1.23 | 3.82 ± 1.13 |

Table 2. Subject

| | Patient group (Schizophrenia) | Control group (Normal) |
|--------------------------------|----------------------------------|---------------------------|
| Interpretation of relevant cue | 3.49 ± 0.75** | 4.20 ± 0.40 |
| Emotional Recognition | 3.32 ± 0.35** | 3.92 ± 0.32 |
| Nonverbal social cue | 3.44 ± 0.97** | 4.24 ± 0.42 |
| Verbal social cue | 3.54 ± 0.63** | 4.17 ± 0.54 |
| Happy situation | 3.49 ± 0.59** | 4.38 ± 0.29 |
| Sad situation | 3.34 ± 0.62** | 3.93 ± 0.57 |
| Angry situation | 3.13 ± 0.31* | 3.47 ± 0.49 |

* p<0.05, **p<0.01 between patients group and control group

Table 3. Results of the Parameters from the virtual Environment

Procedure.

Prior to the experiment, the subjects were asked to complete the form containing the patient's name, age, education and computer experience, and were examined using the psychological tests (ITQ, K-WAIS). In addition to this test, the patients were examined using the Positive and Negative Syndrome Scale (PANSS). During the experiments, the subjects first read the instruments and completed a pretest to use the joystick. In the VR tasks, the subjects observed randomized VR contents and response according to their feelings. After the VR tasks, the subjects were asked to complete the form PQ (Presence Questionnaire) and VRQ (Virtual Reality Questionnaire). The form contains esti-

mations about their presence, experimental environment and virtual reality.

Measurements.

This system measured various parameters while the subject experienced the VR system. As shown Table 3, the interpretation of the relevant cue, the emotion recognition, the nonverbal social cue, the verbal social cue, the happy situation, the sad situation, and the angry situation were measured. The interpretation of the relevant cue and emotion recognition were calculated according to their subcomponent in table 1.

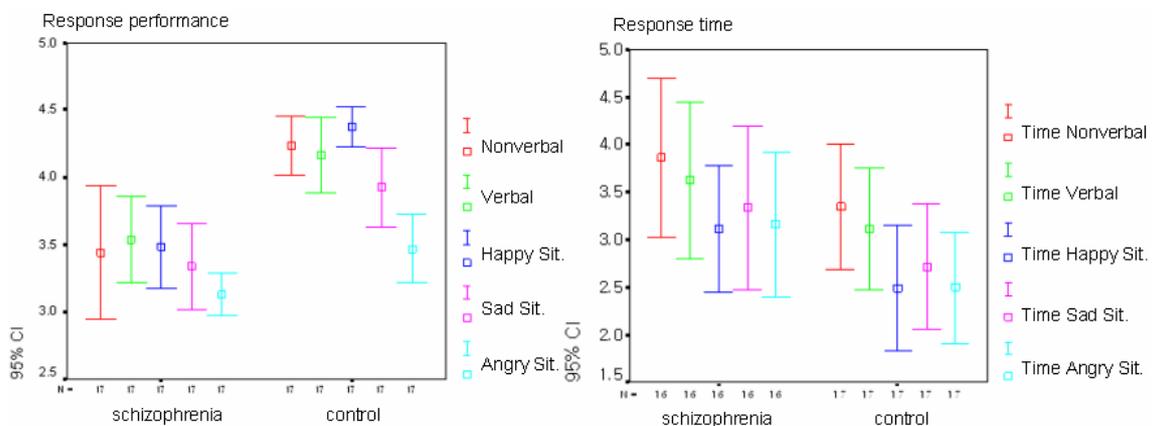


Figure 3. The mean comparison between the patient and normal group. (a) VR response comparison. (b) VR response time comparison.

RESULTS

According to Table 3, the VR parameter in the patient and control groups was significantly different ($p < 0.05$ or $p < 0.01$). In addition, there was no significant deference between the groups (patient and control group; see Table 1). The seven parameters in Table 3 show a significant difference between the patient and normal groups when using this program as an assessment tool.

The results given in Figure 3 show a mean comparison between the patient and normal groups. Figure 3a shows that the schizophrenia group’s social perception ability was significantly poorer than the normal group. In particular, the schizophrenia group’s nonverbal social cue perception ability was poorer than the verbal social cue perception ability. In the normal group, the nonverbal social cue perception ability was greater than the verbal social cue perception ability. Figure 3b shows the response time of the schizophrenia patient occurred later than that of the normal group. However, there was no statistically significant difference and no tendency difference.

In order to assess the relationship between the social perception ability and symptoms, the Spearman’s correlation between the performance on VR and PANSS was computed. There is no significant difference between the social

perception component and the PANSS total scores (positive, negative and general score). The result shown in Table 4 shows a correlation between the social perception component and the PANSS individual scores. However, more conservative criteria are needed when interpreting the correlation in the PANSS individual score. As the correlation was significant at the .01 level, the verbal cue perception (Auditory) showed a negative correlation with delusions, the recognition of a happy facial expression had a negative correlation with conceptual disorganization, and the recognition of an angry facial expression had a negative correlation with stereotyped thinking.

DISCUSSION

VR was developed using the VRDFDB for a fast and easy composition. This study examined the social perception between a schizophrenia group and a normal group using the developed VR.

There are many advantages in VRDFDB. First, it can be fast developing. The user only selects the behavior and facial expression according to a suitable sequence in a predefined Data Base. The fast development may be an essential component in a VR Social perception tool because social perception requires various situations. Second, VRDFDB can be easily modified. Previous VR systems were difficult to modify

| | PANSS (Positive and Negative Syndrome Scale) | | | |
|----------------------------------|--|----------------------------|-----------------------------|----------------------|
| | Delusions | Conceptual Disorganization | Suspiciousness /Persecution | Stereotyped thinking |
| Behavior Cue perception | .107 .684 | -.010 .968 | .504* .039 | -.028 .914 |
| Verbal Cue perception (Auditory) | -.659** .004 | -.497* .042 | .113 .665 | -.166 .525 |
| Recognize happy facial | -.388 .124 | -.638** .006 | .253 .327 | -.435 .081 |
| Recognize sad facial | -.008 .976 | -.574* .016 | .092 .727 | -.400 .111 |
| Recognize angry facial | -.293 .254 | -.602* .011 | .021 .935 | -.634** .006 |

*. Correlation is significant at the .05 level

** . Correlation is significant at the .01 level

Table 4. Correlation analysis with PANSS

during the developing period. However, VRDFDB can be modified easily by simply selecting another behavior and a facial change parameter. On the other hand, VRDFDB has some problems. First, it has limited behaviors and facial expressions. In a one-time DB composition, there are 14 avatars with 93 behaviors and 7 types of facial expressions. Despite this, there is still a large number. However, more avatars and behaviors are needed for sufficient social perception content. Second, it is still a programmer-level architecture. Indeed, only a programmer can develop VR using our architecture. Ideally, everyone including clinicians could make VR, but in view of current VR research this is impossible until now.

The results of the VR social perception tasks require more research in clinical aspects. However, some results are statistically significant or concur with previous reports. First, according to the result shown in figure 3 and table 3, the social perception abilities in schizophrenia and normal groups were significantly different. This result confirms the previous research using VR that the schizophrenia patient's social perception ability is worse than normal subjects [14]. Second, contrary to the tendency of a normal performance task between nonverbal and verbal social perception, there was a reverse tendency within the schizophrenia patient group, which partially correlated with Toomey's research [15]. Third, although a correlation between Positive and Negative Syndrome Scale (PANSS) and virtual reality parameters was found, more research will be needed to confirm the clinical significance.

This paper used VRDFDB for the fast and easy construction of a virtual environment, and tested the possibility of a social perception system using VR. Although a more profound discussion about the virtual reality parameters will be needed to explain the clinical result, a VR system can be used to assess a schizophrenia patient's social cue perception ability by comparing the performance between a normal and schizophrenia group in a given virtual reality task. In future, VR will be used to train and assess the social problem-solving ability or social skills on the whole.

REFERENCE

1. Alan S. Bellack, Kim T. Mueser, Susan Gingerich, & Jule Agresta (1997). *Social Skill Training for Schizophrenia*. New York: The Guilford Press.
2. American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*. 4th ed.. Washington DC. American Psychiatric Association.
3. Morrison R. L. (1990). Interpersonal dysfunction. In A. S. Bellack, M. Hersen, & A. E. Kazdin (Eds.), *International handbook of behavior modification and therapy (3rd ed., pp. 503-522)*. New York: Plenum Press
4. Rosemary Toomey, David Schulberg, Patrick Corrigan & Michael F. Green (2002). Nonverbal social perception and symptomatology in schizophrenia. *Schizophrenia Research*. 53:83-91.
5. Cartledge G., & Milburn J.A. (1978). The case for teaching social skills in the classroom: A review. *Review of Education Research*. 1:133-155.
6. Michelson L., & Wood R. (1980). *Behavioral assessment and training of children's social skills*. *Progress in Behavior Modification*. New York: Academic Press.
7. Howard S. Muscott & Timothy Gifford (1994). Virtual Reality Applications for Teaching Social Skills to Students with Emotional and Behavioral Disorders. 1994 VR Conference Proceedings.
8. Goldstein A.P. (1998). PREPARE: A prosocial curriculum for aggressive youth. In H.S. Muscott (Ed.), *Prosocial skills training for children with emotional disturbances (ED) and behavioral disorders (BD): The journey of 1,000 miles begins with the first few steps (Special issue)*. *Perception*, 24(1): 20-25.
9. S. Parsons & P. Mitchell (2002). The potential of virtual reality in social skills training for people with autistic spectrum disorders. *Journal of Intellectual Disability Research*, 46:430-443.
10. A. Leonard, P. Mitchell & S. Parsons (2002). Finding a place to sit: a preliminary investigation into the effectiveness of virtual environments for social skills training for people with autistic spectrum disorders, *International Conference Disability Virtual Reality & Associated Technique*. 249-258.
11. Witmer BG, Singer MJ. (1998). Measuring presence in virtual environment: a presence

questionnaire. *Presence*. 7:225-40

12. Kwanguk Kim, Jaehun Kim, Jeonghun Ku, Deongyoung Kim, Won Hyek Chang, Dong Ik Shin, Jang Han Lee, In Young Kim & Sun I. Kim (2004). A virtual reality assessment and training system for unilateral neglect. *CyberPsychology & Behavior* 7:742-749.

13. Jang Han Lee, Jounghun Ku, Wongeun Cho, Wonyoung Hahn, In Y. Kim, Sang-min Lee, Younjoo Kang, Deog Young Kim, Taewon Yu, Breda K. Wiederhold, Bark D. Wiederhold, & Sun I. Kim (2003). A virtual reality system for the assessment and rehabilitation of the activities of daily living. *CyberPsychology & Behavior*. 6:383-388.

14. David L. Penn, Mark Ritchie, Jennifer Francis, Dannis Combs & James Martin (2002). Social perception in schizophrenia: the role of context. *Psychiatry Research*. 109: 149-159.

15. Rosemary Toomey, Larry J. Seidman, Michael J. Lyones, Stephen V. Faraone, & Ming T. Tsuang (1999). Poor perception of nonverbal social-emotional cues in relatives of schizophrenia patients. *Schizophrenia Research* 40: 121-130.

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