Anxiety Provocation and Measurement Using Virtual Reality in Patients with Obsessive-Compulsive Disorder

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Abstract

The current study is a preliminary test of a virtual reality (VR) anxiety-provoking tool using a sample of participants with obsessive-compulsive disorder (OCD). The tasks were administered to 33 participants with OCD and 30 healthy control participants. In the VR task, participants navigated through a virtual environment using a joystick and head-mounted display. The virtual environment consisted of three phases: training, distraction, and the main task. After the training and distraction phases, participants were allowed to check (a common OCD behavior) freely, as they would in the real world, and a visual analogy scale of anxiety was recorded during VR. Participants' anxiety in the virtual environment was measured with a validated measure of psychiatric symptoms and functions and analyzed with a VR questionnaire. Results revealed that those with OCD had significantly higher anxiety in the virtual environment than did healthy controls, and the decreased ratio of anxiety in participants with OCD was also higher than that of healthy controls. Moreover, the degree of anxiety of an individual with OCD was positively correlated with a his or her symptom score and immersive tendency score. These results suggest the possibility that VR technology has a value as an anxiety-provoking or treatment tool for OCD.

Introduction

Anxiety disorder can be treated quite effectively with cognitive behavioral therapy. According to the emotional processing theory of Foa and Kozak, a successful exposure therapy leads to new and more neutral memory structures that "overrule" the old anxiety-provoking memories. The basic assumption of this theory is that the new exposure provokes anxiety and induces anxiety variation.

Virtual reality (VR) is a new exposure tool based on real-time computer graphics technology. Successful virtual experience allows users to feel as though they are physically immersed in the virtual environment. This sensation is achieved by shutting out real-world stimuli so that only computer-generated stimuli can be seen and heard. According to ideal anxiety therapy theory, the exposure should be graduated, repeated, prolonged, safe, convenient, and economical. Despite that VR does not perfectly conform to the ideal anxiety therapy theory, computer-generated VR exposure therapy could be a viable in vivo alternative to exposure. If a virtual environment can elicit fear and activate the anxiety-provoking structures, then it can function as an alternative mode of inducing exposure.

There is some established VR work in anxiety disorder, including acrophobia, fear of flying, and eating disorders. Moreover, the number of studies assessing the effectiveness of VR has increased rapidly, empowered by progress in computer technology that introduced greater sophistication and possibilities to VR treatment. Specifically, Rothbaum et al. and North et al. reported successful results using VR treatment for people with anxiety. In this sense, VR can be useful in research on obsessive-compulsive disorder (OCD), which can be characterized as a highly disabling anxiety disorder with persistent and recurrent obsessive thoughts and compulsive and ritualized behaviors. OCD reveals a variety of symptoms, such as checking, contamination, and symmetry. Checking is one of the most common forms of ritualistic behavior in OCD. OCD was typically treated with medication or cognitive behavioral therapy, such as exposure response prevention (ERP).
There are several reasons we applied VR to patients with OCD. First, because VR appears to alleviate anxiety in patients with phobic disorders, it may also be useful in the treatment for OCD. Second, most people with OCD are ashamed of their uncontrollable, repetitive behavior and are concerned about what others think of them. VR can reduce the individuals’ embarrassment by protecting their privacy. Moreover, by replacing the traditional “boring” testing procedure with a “fun” game in a virtual environment, we may be able to overcome the low motivation and lack of concentration during the test. Lastly, VR allows a careful measurement of how the VR performance task may be broken down by quantifying patterns of behavior within the virtual environment.

In the current preliminary study, we sought to provide the validation of VR as a tool for inducing anxiety variation in people with OCD. Here, we hypothesized that (a) the degree of anxiety and anxiety variation tendency in people with OCD would be different from that of matched healthy controls in the virtual environment, and that (b) anxiety reports from those with OCD would be linked to VR characteristics based on established assessment tools.

Method
Participants
Participants were outpatients in the Yongdong Severance Hospital in Korea, and healthy controls were recruited via local advertisements and were screened with a medical health questionnaire. The tasks were administered to 33 patients with OCD and 30 healthy controls. Two groups were matched by age, gender, IQ, and VR experience. DSM–IV diagnoses were made by a certified consulting psychiatrist using an extended clinical interview supplemented by the Mini International Neuropsychiatric Interview. All participants provided written informed consents and were paid with $15 per hour for participation.

Virtual reality
Hardware. An IBM-compatible computer and an SVGA color head-mounted display with a 3-degrees-of-freedom tracker were used for testing. Participants used a joystick and tracker to move through the virtual environment. The view on the screen was a first-person perspective. A speaker con-
nected to the computer provided auditory feedback for the participants.

Software. The VR environments resembled the average Korean home and were designed to induce the checking impulse (see Figure 1 for screenshots from the virtual environment). All participants completed the three phases of the experiment: training, distraction, and the main phase. In the training phase, we asked participants to perform several activities in their surrounding as a preparation for the distraction and main phases. The VR scenario was made by psychiatric doctors, social workers, and VR experts to induce immersion and check participant anxiety. Participants were given the following directions: “Now, you will spend a day in a virtual environment. Like a usual day in real life, you will get up in your home and get ready for work. During the simulation, you will receive some instructions from the computer program. When this happens, respond and act as you would in a real situation.” In the scenario, participants turned on a switch, opened a window, opened the front door, turned on the gas valve and burner, and operated a water supply according to the predefined storyline of the computer program.

In the distraction phase, tasks were assigned to redirect the individual’s attention. The participant was asked to do a simple task unrelated to the task in the main phase. The task was to take an umbrella, pocket book, cellular phone, wristwatch, and bag into the house. As soon as those objects were taken, they vanished immediately from the virtual environment.

The main phase followed the training and distraction phases. In this phase, tasks were introduced by a panel saying, “Let’s check everything before you leave. If you are finished checking, then you should go out and go to the elevator at the end of the corridor.” In the virtual environment, participants were allowed to check freely, and all processes were recorded. The situation for inducing anxiety is as follows: lighting switch, opening the window, opening the front door, turning on the gas valve and burner, and running water supply. After participants completed all checks and came to the elevator, they were asked if they wanted to end the task.

Measurements

The Yale-Brown Obsessive Compulsive Scale (Y-BOCS), the most widely used clinician-administered interview for assessing the severity of OCD, was administered.11 The Global Assessment of Functioning (GAF) is a numeric scale (1–100) used by mental health clinicians and doctors to rate social, occupational, and psychological functioning.12 To measure participants’ quality of life, the World Health Organization Quality of Life (WHOQOL) questionnaire was used.13 The Immersive Tendency Questionnaire (ITQ),14 Simulator Sickness Questionnaire (SSQ),15 and Presence Questionnaire (PQ)14 were also administered. The Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI) were used for measuring depression and anxiety.16,17 Number of checking behaviors in virtual environment is a new parameter of VR in this experiment. It was defined as the number of reported operations that were performed for checking rituals. Checking time in virtual environment is a VR parameter in this experiment defined as the duration of time spent performing checking behavior in the virtual environment.

Statistical analysis

Mixed-model ANOVA was used with a test as a within-subjects factor and with a group as a between-subjects factor. Paired t tests were performed to determine pretest and posttest differences in anxiety as well as group differences. Correlation analysis was performed to determine associations between anxiety in the virtual environment and another measurement of a participant’s pathological characteristics.

<table>
<thead>
<tr>
<th>ITQ</th>
<th>SSQ</th>
<th>Presence</th>
<th>Y-BOCS</th>
<th>GAF</th>
<th>WHOQOL</th>
<th>BDI</th>
<th>BAI</th>
<th>C-Time</th>
<th>C-Beh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety before</td>
<td>0.432*</td>
<td>0.017</td>
<td>0.036</td>
<td>0.320</td>
<td>−0.255</td>
<td>−0.144</td>
<td>0.279</td>
<td>0.500**</td>
<td>0.229</td>
</tr>
<tr>
<td>checking</td>
<td>0.012</td>
<td>0.923</td>
<td>0.841</td>
<td>0.060</td>
<td>0.152</td>
<td>0.424</td>
<td>0.116</td>
<td>0.003</td>
<td>0.220</td>
</tr>
<tr>
<td>Anxiety after</td>
<td>0.340</td>
<td>0.147</td>
<td>−0.044</td>
<td>0.348*</td>
<td>−0.148</td>
<td>−0.280</td>
<td>0.329</td>
<td>0.445**</td>
<td>0.357*</td>
</tr>
<tr>
<td>checking</td>
<td>0.053</td>
<td>0.416</td>
<td>0.808</td>
<td>0.047</td>
<td>0.411</td>
<td>0.114</td>
<td>0.062</td>
<td>0.009</td>
<td>0.041</td>
</tr>
</tbody>
</table>

OCD, obsessive-compulsive disorder; ITQ, Immersive Tendency Questionnaire; SSQ, Simulator Sickness Questionnaire; Y-BOCS, Yale-Brown Obsessive Compulsive Scale; GAF, Global Assessment of Functioning; WHOQOL, World Health Organization Quality of Life-Brief; BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory; C-Time, Checking Time; C-Beh, Number of Checking Behaviors.

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.
Results

Comparison of anxiety in VR between participants with OCD and healthy controls

There were no significant differences in age, gender, IQ, and VR experience between the two groups. According to the result of mixed-model ANOVA, the Group X Test interaction was marginally significant, $F(1, 61) = 3.718, p = 0.058$. There was significant main effect for pretest and posttest anxiety, $F(1, 61) = 26.036, p < 0.001$ and group (OCD or control), $F(1, 61) = 12.58, p < 0.05$. Figure 2 depicts the paired t test results for both groups before and after the checking. Both pretest and posttest anxiety in those with OCD were significantly higher than in the controls: $t(61) = −3.650, p < 0.01$, and $t(61) = −2.671, p < 0.01$ respectively. Moreover, decrease in anxiety in people with OCD was greater than in the controls: $t(32) = 4.638, p < 0.01$, and $t(29) = 2.496, p < 0.05$, respectively.

Comparison of checking behavior in VR between OCD and control groups

As shown in Table 1, the OCD group revealed significantly longer checking time than did controls ($p < 0.01$). Checking behavior values in participants with OCD were greater than in those in the control group, although those were not statistically significant.

Relation between anxiety in VR and another measure of participants with OCD

As shown in Table 2, there was a significant relation between anxiety and other measures for those with OCD. ITQ, Y-BOCS, BAI, and checking time in the virtual environment revealed a significant correlation with anxiety in the VR. In fact, the anxiety in VR revealed a significant correlation with immersive tendency, OCD symptoms, a traditional anxiety measurement tool, and checking time during the simulation.

Discussion

In this study, we used VR as an anxiety-provoking tool for participants with OCD. This is a small step in the use of VR in the treatment of OCD. The results in this study suggest that the anxiety of those with OCD is higher than that of healthy controls in the VR, and the rate of decrease in anxiety is more rapid for those in the OCD group than for the controls. The results suggest that VR is valuable method for anxiety provocation.

Because the VR is not a real experience, validating whether participants’ responses in VR are similar to those in the real world is necessary to use VR as an ERP tool. Because we did not have any objective criteria to prove this similarity, the current study identified the difference between the OCD and control groups in the same anxiety situation and analyzed the correlation with established tools.

According to this study, the OCD group reported higher anxiety in the virtual environment than in the control, and the anxiety decrease for them was higher than for the controls. Subsequent analysis showed that participants who checked more than one time reported higher anxiety than did other participants (checking 1 time, preanxiety: 40.5, postanxiety: 20.8; checking more than 2 times, preanxiety: 45.5, postanxiety: 29.6). This result suggests the possible connection between anxiety and checking behavior in people with OCD.

We attempt to find the reason for a higher anxiety decrease in the OCD group (Table 1). Previous research suggests that compulsive behaviors and rituals are performed in response to obsessive thoughts in order to reduce distress. The basic principal of ERP treatment is breaking the connection between anxiety and obsessive behavior. As shown in Table 1, the OCD group and the control group presented a differences in checking time and checking behavior. OCD characteristics can account for these differences in behavioral and anxiety.

Correlation analyses confirmed that anxiety is correlated with the participant’s symptoms and other components as well as with one of the VR components (i.e., ITQ). That is, both the VR component and the participant component affected the anxiety of those with OCD.

A possible limitation of this study was the measurement of anxiety. In the present study, we used a one-item visual analog scale (VAS). This is an easy way to reduce distraction during the participant’s immersion in VR. However, one-item VAS has limitations in reliability and validity. Fortunately, in this study, VR anxiety has a high correlation with the validated BAI (correlation coefficients are 0.003 and 0.009). Therefore, despite limitations, our anxiety measure can meaningfully evaluate anxiety in individuals with OCD. Further research with more reliable and valid measurement (e.g., State-Trait Anxiety Inventory, STAI; Subjective Units of Distress SUDS) could resolve the possible limitation of this study. Furthermore, the study would have been strengthened by the use of a measure of real-world adherence. Compulsive behaviors are usually performed to reduce the distress of associated obsessive thoughts in the real world. To prove the possibility of VR as an anxiety-provoking tool, we attempted to measure the real-world application using a similar environment with this virtual environment. This study is the first step in the treatment of OCD using VR. These VR profiles could serve as better diagnoses and treatment for people with OCD.

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Disclosure Statement

The authors have no conflict of interest.

References

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