Can Virtual Reality be Used to Investigate Persecutory Ideation?

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Abstract: The use of virtual reality permits individuals' reactions to standard controlled environments to be studied. It may therefore provide a means for understanding the interpretations of experience relevant to clinical disorders. The use of this technology for understanding persecutory ideation has not been investigated. A pilot study was undertaken to examine whether individuals have persecutory thoughts about virtual reality characters under controlled conditions and if there are factors that predict the occurrence of such thoughts.

Twenty-four nonclinical participants entered a neutral virtual environment that contained computer-generated people. The participants completed dimensional assessments of items related to psychiatric symptoms and their thoughts about the virtual characters.

Positive views about the virtual characters were common. However, a number of participants had ideas of reference and ideas of persecution about the virtual characters. Individuals who had persecutory thoughts about the virtual characters had significantly higher levels of interpersonal sensitivity and anxiety.

The study provides direct evidence that individuals attribute mental states to virtual reality characters. Important for the study of clinical phenomena, some individuals have thoughts of a persecutory nature about virtual characters. Additionally, the findings indicate that feelings of interpersonal vulnerability and anxiety may directly contribute to the development of persecutory ideation in response to essentially neutral contexts. Virtual reality may prove to be a valuable methodology for developing an understanding of persecutory ideation.

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There is evidence that people react in virtual (computer-generated) environments as if they are real. Most strikingly, individuals with conditions such as fear of heights, flying phobia, PTSD, and claustrophobia have been successfully treated by exposure-therapy in virtual environments (Rothbaum et al., 2000; Rothbaum et al., 2001; Botella et al., 2000). The effects of exposure in virtual reality (VR) are comparable with exposure in the real environment. In a step towards the treatment of the fear of public speaking, it has been shown that computer-generated people (avatars) can elicit anxiety (Slater et al., 1999; Pertaub et al., 2001, 2002). Evidence suggests that human responses to virtual characters are similar to their responses to real people. It is therefore reasonable to investigate whether avatars can trigger persecutory ideation. The use of virtual reality has the potential to develop theoretical understanding of persecutory delusions, which is one of the most common symptoms of psychosis. Personal characteristics associated with persecutory thoughts could be investigated by the assessment of individuals entering the same virtual environment; experimentally altering the virtual environment has the potential to lead to the discovery of environmental factors associated with persecutory thoughts.

This exploratory investigation aims to study whether nonclinical individuals have thoughts of a persecutory nature in virtual reality. Two additional concerns influenced the study design. The study of persecutory ideation in virtual reality will be of most clinical relevance if the participants experience such thoughts in their daily lives. A virtual environment is therefore needed that elicits persecutory ideation in some (but not all) participants. It is also of interest to

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examine whether, drawing upon the theoretical literature, there are cognitive factors that predict the occurrence of persecutory ideation in virtual reality. In our multifactorial model of persecutory delusions, it is posited that emotional processes may have a direct role in the development of persecutory ideation (Freeman et al., 2002; Freeman and Garety, in press). Therefore, the assessment of emotional processes is incorporated into the study design. We predicted that a small proportion of individuals would experience thoughts of persecutory content in a neutral virtual environment, and that these individuals would have higher levels of trait paranoia and emotional distress than individuals who did not have persecutory thoughts in the virtual environment. In a neutral virtual environment, the virtual characters do not exhibit any hostile or persecutory behavior.

METHODS

Participants

Twenty-four individuals without a history of mental illness were recruited by advertising within University College London. Participants were students ($n = 21$) or administrative staff ($n = 3$). An equal number of males and females were recruited.

Materials

The virtual environment was displayed in an immersive projection system with 4 projection walls (3 walls and the floor) referred to as a CAVE (Fakespace Systems; Iowa; Cruz-Neira et al., 1993). The specific system was a ReaCTor (Trimension, Burgess Hill, West Sussex, UK). An Intersense tracker monitors the participants' head position and orientation. Participants also carry a tracked (Intersense, Burlington, MA) joystick in their right hand and wear lightweight CrystalEye (StereoGraphics, San Rafael, CA) glasses that deliver a stereo view of the virtual world, which surrounds them on 4 sides. They can move through the virtual environment with a combination of walking and whole body turning, and by pressing a button on the joystick, which moves them forwards in the virtual space in the direction in which they are pointing.

Procedure and Task

Consent was obtained for participation. To prevent priming of reactions, participants were not informed that the study was specifically examining persecutory thoughts. Individuals were first trained in the use of the VR equipment, then they were asked to enter the virtual environment. Their instructions were: Please explore the room, and try to form some impression of what you think about the people in the room and what they think about you. A neutral library scene was selected because this study was conducted with a university population. Although the virtual room was clearly a library, to allow participants to make their own decisions

about the room it was never referred to as a library during the study. There were five avatars in the library; three sat at one desk, and two were at another desk on the other side of the room (Fig. 1). Occasionally, the avatars showed potentially ambiguous behavior (*e.g.,* smiling, looking, talking to each other). After 5 minutes, participants were told to leave the virtual room. All participants then completed a questionnaire and a short semistructured interview concerning their experiences in the virtual environment. The study design also took account of the possibility that persecutory thoughts may be primed by the study questionnaires. Half of the participants completed questionnaires after coming out of the virtual environment. The other participants completed questionnaires before and after entering the virtual environment. Male and female participants were balanced in each of these two conditions, and individuals were paid for their participation.
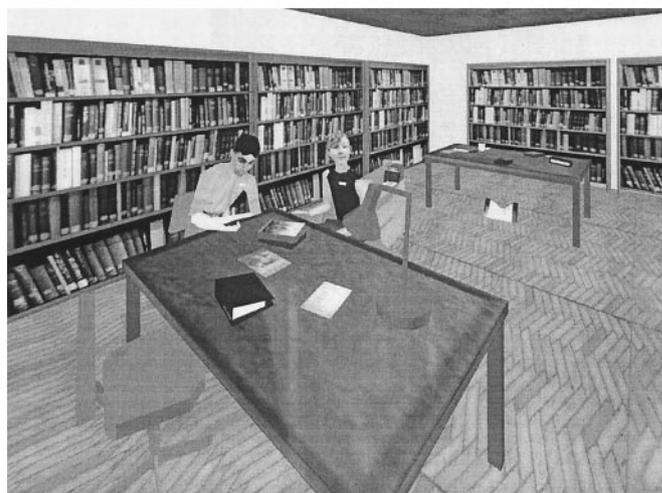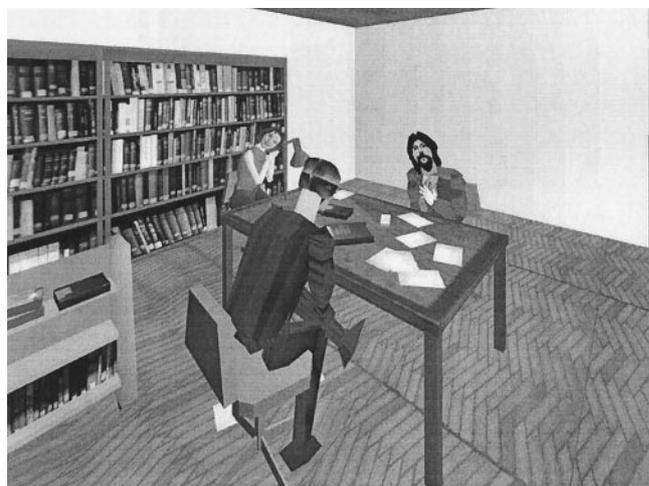

FIGURE 1. The scenario—virtual people in the library.

Measures

Brief Symptom Inventory (BSI) (Derogatis, 1993). The BSI is a short form of the SCL-90-R. It is a 53-item self-report measure designed to assess 9 symptom dimensions over the past 7 days: Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism. A total score is also obtained (the Global Severity Index). Each item on the BSI is rated on a five-point scale of distress (0–4), and symptom dimension scores are converted to standardized *t*-scores.

Paranoia Scale (Fenigstein and Vanable, 1992). The 20-item self-report Paranoia Scale was developed to measure paranoia in college students, and includes items assessing both ideas of persecution and reference. Each item is rated on a five-point scale. Scores can range from 20 to 100, with higher scores indicating greater paranoid ideation.

Spielberger State Anxiety Questionnaire (Spielberger et al., 1983). This 20-item self-report questionnaire is a measure of state anxiety. Each item is rated on a 1–4 scale. Scores can range from 20 to 80, with higher scores indicating higher levels of anxiety. Half the participants completed the anxiety measure questionnaire before and after entering the virtual environment to monitor whether any distress was caused by the procedure. The remaining participants completed the questionnaire only after leaving the virtual room.

VR-Paranoia. There is no questionnaire available that measures situation-specific persecutory ideation. Therefore, a 15-item self-report VR-Paranoia questionnaire was devised specifically for the study and was used to assess the participants' views of the avatars (see Appendix). The persecutory items were derived from the definition of persecutory delusions outlined by Freeman and Garety (2000). Three areas are assessed: persecutory thoughts about the avatars (VR-Persecution, questions 1–5), ideas of reference about the avatars (VR-Reference, questions 6–10), and positive beliefs about the avatars (VR-Positive, questions 11–15). Each item is rated on a 4-point scale (0–3; Do not agree, Agree a little, Agree moderately, Totally Agree). Scores can range from 0 to 15 for each subscale, with higher scores indicating greater endorsement of items.

Semi-structured interview and observer rating of persecutory ideation. A semi-structured interview was conducted with participants to hear spontaneous impressions of the virtual environment. The interview also provided an opportunity for participants to report any distress associated with the VR environment. The interview was videotaped. The interviews were rated for persecutory content on a 6-point scale by the first author, a clinical psychologist experienced in the assessment of persecutory delusions.

Sense of presence questionnaire. Presence refers to the extent to which the participant experiences a sense of being in the virtual world. The questionnaire used assesses presence on three main criteria—the sense of "being there" in the environment depicted by the computer displays, a sense of having visited a place rather than just having seen images, and the extent to which the virtual world dominated behavior relative to the virtual world rather than the real world in which the participants were really located. This same questionnaire has been used before (*e.g.*, Slater et al.,1998). It consists of 6 questions each rated on a scale of 1 to 7, with higher numbers indicating greater reported presence. A score of 6 or 7 on a question is coded as 1 and all other scores as 0. The total score can therefore range between 0 and 6.

Statistical Analysis

All analyses were conducted using SPSS for Windows (version 10.0) (SPSS, 2000). All significance test results are quoted as two-tailed probabilities. Associations were examined by Pearson's product moment correlation coefficients. Group differences were examined by t-tests.

RESULTS

Participants

There were no missing data for any of the assessments. The mean age of the participants was 26, SD = 6. The Paranoia Scale mean score was 31.8, SD = 10.8, minimum = 20, maximum = 61. There was no significant difference between male and females scores on the Paranoia Scale, $t(16.25) = 1.70, p = 0.11$. The level of trait paranoia was low compared with Fenigstein and Vanable's (1992) report of a mean score of 42.7, SD = 10.2, in a large college population. The mean BSI score was 56.2, SD = 11.4.

Persecutory Ideation in the Virtual World— Does it Occur?

Participants endorsed items in the VR-Paranoia questionnaire (see Table 1), indicating that opinions about the characters of the avatars were formed. It can be seen in Table 1 that positive views of the avatars were most frequent, but that some individuals had ideas of reference and ideas of persecution about the avatars. As an illustration of the results, for the item 'Someone in the room had it in for me' the majority of participants did not agree (*n* = 15), while some people agreed a little (*n* = 5), agreed moderately (*n* = 3) or

TABLE 1. Scores on the VR-Paranoia Questionnaire

	Mean	SD	Minimum–Maximum scores
VR-Persecution	2.3	2.2	0–7
VR-Reference	4.0	2.6	0–10
VR-Positive	6.0	4.1	0–13
VR-Total score	12.3	4.6	5–23

agreed totally ($n = 1$). For the item 'They were talking about me behind my back' many did not agree ($n = 11$), a significant proportion agreed a little ($n = 8$), and some people agreed moderately ($n = 3$) or totally ($n = 2$). For the item 'They were friendly towards me', some people did not agree ($n = 4$), some agreed a little ($n = 10$) or moderately ($n = 9$), and 1 person agreed totally. Table 2 displays a selection of the comments made by the participants.

As would be expected, VR-Persecution scores were significantly correlated with VR-Reference scores, $r = 0.48$, $p = 0.017$, and negatively correlated with VR-Positive scores, $r = -536$, $p = 0.007$. The blind ratings of persecutory ideation from the recorded interview significantly correlated with VR-Persecution scores, $r = 0.591$, $p = 0.002$. There were no significant differences in VR-Persecution scores between males and females, or between participants who had questionnaires before the task and participants who had questionnaires only after the task, $p > 0.1$. A moderate degree of immersion or sense of presence in the virtual room was reported by participants (mean sense of presence score = 2.3, SD = 2.0, minimum = 0, maximum = 6). To monitor the occurrence of any emotional distress, anxiety was measured using the Spielberger State Anxiety Questionnaire before and after virtual reality for the participants who also had questionnaires before and after entering the library scene. There was no evidence of an increase in anxiety from entering the virtual environment (pretest anxiety mean = 34.79 SD = 8.22, posttest anxiety mean = 31.82, SD = 6.98, mean change score = -2.91, SD = 5.61).

Predictors of Persecutory Ideation in VR

Persecutory thoughts about the avatars (VR Persecution) did not significantly correlate with the Paranoia Scale scores (see Table 3). There was a tendency for higher VR-Persecution scores to be associated with higher BSI-Paranoia scores, $p = 0.077$.

Virtual reality persecution scores were correlated with the remaining BSI dimension scores, Spielberger State Anxiety score, and the sense of presence score. Two correlations were significant ($p < 0.05$): BSI-Interpersonal sensitivity and BSI-Anxiety. Higher levels of interpersonal sensitivity and anxiety were associated with higher levels of persecutory ideation in virtual reality. The 2 variables were then entered into a regression analysis with VR Persecution scores as the dependent variable. The model was significant; $F (2, 21) = 5.731$, $p = 0.010$, adjusted R square = 0.291. Only BSI-Interpersonal Sensitivity remained significant in the regression analysis, $t = 2.258$, $p = 0.035$.

DISCUSSION

The study provides empirical evidence that people attribute mental states to virtual reality characters. Thus, people in virtual environments sometimes think that computer-generated characters have intentions towards them. The participants in this study typically ascribed benevolent intentions to the avatars, but interesting for the study of psychiatric conditions, some individuals had thoughts of a persecutory nature about the avatars, although the characters were behaving in a neutral manner.

What makes people vulnerable to perceiving persecutory intent in the avatars? The results of this investigation suggest that vulnerability partly arises from anxiety and interpersonal sensitivity, both of which have associations with trait paranoia. Interpersonal sensitivity was the most significant predictor of persecutory ideation in the virtual environment. Interpersonal sensitivity is described as centering on feelings of personal inadequacy and inferiority, particularly in comparison with others. Self-deprecation, self-doubt, and marked discomfort during interpersonal interactions are characteristic manifestations of this syndrome. In addition, individuals with high scores on I-S report acute self-consciousness and negative expectations concern-

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TABLE 2. A Selection of Comments Made About the Avatars (Each Comment is From a Different Participant)

Positive
  'Friendly people just being friendly and offering a smile'
  'People were nicer than real people'
  'Part of a game (flirting but being shy)'
  'It was nice when they smiled, made me feel welcome.'
  'They looked friendly - that was my overall impression'
  'I smiled and chuckled'
Negative
  'They were very ignorant and unfriendly'
  'Sometimes appeared hostile, sometimes rude'
  'It was their space: you're the stranger.'
  'They were telling me to go away'
  'One person was very shy and another had hated me'
  'The two women looked more threatening'
  'Some were intimidating'

TABLE 3. Correlations between Persecutory Ideation, Interpersonal Sensitivity, and Anxiety (N = 24)

Measure	1	2	3	4	5
1. VR-Persecution					
2. Paranoia Scale	.156				
3. BSI - Paranoia	.368	.729**			
4. BSI - Inter. sensitivity	.562**	.506*	.652*		
5. BSI - Anxiety	.443*	.276	.488*	.490*	
6. Spielberger Anxiety	.173	.574*	.337	.473*	.326

$*p < .05$; $**p < .01$

ing interpersonal behavior with others and others' perceptions of them, Derogatis (1994). Therefore, vulnerability to persecutory thoughts may stem from feelings of vulnerability about the self, particularly in the context of self-focus, which is consistent with our theoretical model that postulates that emotional processes contribute directly to the development of persecutory thoughts (Freeman et al., 2002).

The results are consistent with other research findings. Martin and Penn (2001) reported a study of paranoia in students. Higher levels of paranoid ideation were associated with depressed mood, social anxiety and avoidance, evaluation apprehension, self-monitoring, and lower self-esteem. Several studies have found that individuals who go on to develop schizophrenia have higher levels of anxiety, interpersonal sensitivity, and social isolation in childhood (Jones et al., 1994; Malmberg et al., 1998). Allan and Gilbert (1997) reported an interesting connection between interpersonal sensitivity and paranoia: they found a high correlation between submissive behavior and paranoid ideation and interpersonal sensitivity. It is also of note that hypersensitivity to others' evaluations has been incorporated into clinical conceptualisations of paranoid personality disorder (Turkat and Maisto, 1985). Thus, the investigation of the direct contribution of self-focus, feelings of vulnerability, and submissive behaviors to the development of persecutory ideation is an area worthy of further study.

It was surprising to find that no measures assessing situation-specific or state persecutory ideation are available. A questionnaire was designed with items with definite persecutory content derived from a definition of persecutory delusions. The items were chosen to have face validity, and scores significantly correlated with the assessor ratings from interview, although no further psychometric evaluation was conducted. The clinical nature of the questionnaire items might account for the absence of the predicted correlations with the trait measures of paranoia: the trait measures include items with content that is less obviously persecutory. Future studies would benefit from the development of a reliable and valid measure of situation-specific persecutory ideation.

The virtual reality methodology shows promise. Even in a group low in trait paranoia, findings of interest were obtained when they viewed a neutral scene. Studies with a group high in trait paranoia might yield results that are more pronounced. Manipulation of anxiety levels before entering the virtual environment would also be of interest. Assessing both anxious and persecutory ideation in virtual reality and examining differential predictors would be a strong study design. Exploring persecutory ideation in other virtual environments, such as buses and street scenes, may be very informative. An important issue not examined in the study is whether the persecutory ideation reported by the participants are on a continuum with the experiences of patients with persecutory delusions. In the future, virtual environments

may be used clinically to assist patients to evaluate persecutory thoughts and reduce them. We also note that only a proportion of the variance is accounted for by emotional and interpersonal sensitivity. Our model indicates that the positive symptoms of psychosis arise from an interaction of psychotic and emotional processes (Garety et al., 2001; Freeman et al., 2002). Assessing both processes typically associated with emotional disorder and processes traditionally associated with psychotic disorders would be valuable. For example, assessment could be made of probabilistic reasoning (Garety et al., 1991), attributional style (Kinderman and Bentall, 1997), and theory of mind (Frith, 1992). We believe that the use of virtual reality has a clear potential to enhance the theoretical understanding of persecutory delusions.

Appendix
Items in the VR-Paranoia Questionnaire

1. They were hostile towards me.
2. They would have harmed me in some way if they could.
3. Someone in the room had it in for me.
4. They were trying to make me distressed.
5. They had bad intentions towards me.
6. They were talking about me behind my back.
7. They were saying negative things about me to each other.
8. They were watching me.
9. They were looking at me critically.
10. They were laughing at me.
11. They were friendly towards me.
12. They were pleasant people.
13. They were trustworthy.
14. They had kind intentions towards me.
15. I felt very safe in their company.

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