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## CHAPTER 6

# Virtual reality based cognitive behavioral therapy for patients with generalized social anxiety disorder: *a pilot study*

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## Abstract

**Background:** Patients with a generalized social anxiety disorder (SAD) avoid various social situations and can be reluctant to engage in *in vivo* exposure therapy. Highly personalized practicing can be required before patients are ready to perform *in vivo* exposure. Virtual reality (VR) based therapy could be beneficial for this group.

**Aims:** To assess the feasibility and potential effect of VR based cognitive behavioral therapy (VR-CBT) for patients with severe generalized SAD.

**Methods:** Fifteen patients with generalized SAD attended to maximally sixteen VR-CBT sessions. Questionnaires on clinical and functional outcomes and diary assessments on social activity, social anxiety, and paranoia were completed at baseline, post-treatment and six-month follow-up.

**Results:** Two patients dropped out of treatment. Improvements in social anxiety and quality of life were found at post-treatment. At follow-up, depressive symptoms had decreased, and the effect on social anxiety was maintained. Concerning diary assessments, social anxiety in company and paranoia were significantly reduced by post-treatment. These improvements were maintained at follow-up. No increase was observed in social activity.

**Conclusion:** This uncontrolled pilot study demonstrates the feasibility and treatment potential of VR-CBT in a difficult-to-treat group of patients with generalized SAD. Results suggest that VR-CBT may be effective in reducing anxiety as well as depression, and can increase quality of life.

# 1. Introduction

People with a social anxiety disorder (SAD) experience extreme anxiety in social situations in which they have to interact with other people and are exposed to potential criticism <sup>1</sup>. The generalized form of SAD is the most disabling and pervasive form <sup>2</sup>, which is characterized by avoidance of a broad range of social situations. Generalized SAD causes a great burden on everyday life, including impairments in education, work and relationships <sup>2,3</sup>.

Individual cognitive behavioral therapy (CBT) is the most effective psychological treatment for SAD <sup>4</sup>. CBT targets dysfunctional behaviors and cognitions by challenging harm expectancies and learning new strategies <sup>5</sup>. Regular CBT has several limitations for which virtual reality (VR) may be a helpful tool. First, as generalized SAD is often characterized by severe avoidance, the threshold to engage in *in vivo* exposure can be too high. Second, it can be challenging and time consuming for therapists to find appropriate situations for exposure with the right amount of personalized triggers. Finally, exposures are often performed as homework exercises, on which feedback is given retrospectively and highly dependent on a patient's subjective reports.

VR based therapy may offer a solution to these limitations <sup>6,7</sup>. VR environments can be personally tailored to fit the specific triggers of a patient, and enables practicing social behavior in relevant environments <sup>8</sup>. Behavior can be practiced repeatedly within VR, and therapists provide direct feedback. Furthermore, VR therapy is performed within the treatment room, lowering the threshold to engage in exposure.

VR interventions for mental health are rapidly expanding. Similar effectiveness of conventional (exposure therapies as well as CBT) and VR based therapies have been reported for specific phobias such as spider phobia and fear of flying <sup>9,10</sup>. Comparable effectiveness was also found for public speaking anxiety <sup>11,12</sup>. Interestingly, Wallach et al. (2009) reported a 50% decrease in dropout rate during VR based CBT (VR-CBT) in comparison to *in vivo* CBT for public speaking anxiety <sup>11</sup>.

Only two randomized controlled trials (RCT) have been performed in patients with (generalized) SAD using immersive VR exposures for multiple social situations with semi-structured scenarios <sup>13,14</sup>. Kampmann and colleagues (2016) tested VR exposure therapy in 60 patients with generalized SAD <sup>14</sup>. The therapy consisted solely of behavioral elements and no cognitive elements. VR exposure therapy was effective in reducing social anxiety and stress. However, *in vivo* exposure therapy was superior to VR exposure therapy in improving social anxiety, general anxiety, depression and quality of life. Bouchard et al. (2017) conducted an RCT in patients with SAD ( $n = 59$ ), using both cognitive and behavioral elements <sup>13</sup>. In contrast to Kampmann and colleagues, they found VR-CBT to be more effective than CBT with *in vivo* exposure <sup>14</sup>. Additionally, therapists reported VR-CBT to be more practical than conventional CBT, and therapeutic alliance, a known factor related to treatment outcome, was reported to be similar for both therapies.

Recently a VR-CBT intervention was developed and tested in patients with a psychotic disorder who experienced social anxiety and paranoid ideation, and avoided social engagement <sup>15</sup>.

Results indicated that VR-CBT was successful in reducing anxiety in the company of others as well as paranoia. As paranoia and social anxiety were shown to be strongly associated<sup>16–18</sup>, and seem to share underlying processes<sup>17</sup> we aimed to test the same VR intervention in patients with generalized SAD<sup>15</sup>.

In this pilot study, we tested VR-CBT in patients with severe generalized SAD. The goal of the present study was to assess the feasibility (by assessing attrition rates, treatment duration, and the suitability of measures) and the preliminary efficacy of VR-CBT. It was hypothesized that VR-CBT would reduce social anxiety, depression, and paranoid ideation, and would improve quality of life. Moreover, it was expected that VR-CBT would reduce anxiety in the company of others, perceived social threat, and paranoia, and would increase social activities in daily life.

## 2. Method

### 2.1. Participants

Patients with generalized SAD referred to a tertiary outpatient clinic in the Netherlands were enrolled. Participants were informed about the study by their treating specialist. Inclusion criteria were a primary diagnosis of generalized SAD as established with the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)<sup>19</sup>, a Social Interaction Anxiety Scale<sup>20</sup> score > 25, and age 18–65 years. Exclusion criteria were IQ < 70, neurological conditions, severe psychiatric comorbidities that could prevent therapy adherence (e.g. addictions), and insufficient mastery of the Dutch language. Participants provided written informed consent. The study was approved by the VU Medical Center review board, protocol nr. 2014.015. The trial was conducted between January 2015 and February 2017. Participants received no compensation for participating.

### 2.2. Design and procedure

This was a pilot study with a single group. Assessments were completed at baseline, post-treatment (three months after baseline), and follow-up (six months after baseline). After the baseline assessment patients started VR-CBT. VR-CBT entailed maximally 16 one-hour individual sessions, delivered once or twice a week by regularly employed psychologists. The treatment manual was constructed by adapting existing CBT protocols<sup>21</sup>. The most important adaptation to existing protocols was that all *in vivo* exposures and behavioral experiments were done within virtual environments<sup>22</sup>.

During therapy sessions 1 and 2 the VR system was introduced, a personal case conceptualization was developed, and treatment goals were defined. From session 3 onwards participants practiced with exposure exercises for 40 minutes each session. During these exercises patients tested their beliefs, approach behaviors were elicited, and feedback was given on cognition and behavior. Further therapy strategies included psycho-education and cognitive restructuring of dysfunctional beliefs. If learning goals were achieved and no distress could be triggered in VR any longer, the therapy was considered successful and could be stopped before the 16th session. No homework assignments were given.

### 2.3. VR program

Four virtual environments were available: a street, bus, café and supermarket. These environments enabled exposure to observation fears and interactions, such as short interactions with the cashier in the supermarket. VR environments were constructed by CleVR with Vizard software. The hardware consisted of two computers, a joystick, and a head-mounted display with headphones and a tracking system (Sony HMZ-T1). With accompanying software the environments could be adapted. The software enabled manipulation of the crowdedness (0-40 virtual humans called "avatars", could be present), ethnicity (% of avatars with a Caucasian or North-African appearance), gender, hostility (intensity and frequency of hostile looks of avatars), interpersonal distance, and watching behavior. Pre-recorded sentences could be uttered by avatars. The number of sentences was limited, therefore therapists also spoke short sentences when the situation required it to initiate interaction. Background noises and sounds such as sirens and laughing were also available. Before each exposure exercise, the therapist and patient agreed upon the type of environment, crowdedness, and characteristics of avatars.

### 2.4. Outcome measures

The following outcome measures were administered at baseline, post-treatment and six-months follow-up: the Social Interaction Anxiety Scale (SIAS) <sup>20</sup>, the Green et al. Paranoid Thought Scales (GPTS) <sup>23</sup>, the Beck Depression-II Inventory (BDI) <sup>24</sup> and the Manchester Short Assessment of Quality of Life (MANSA) <sup>25</sup>. After session 4 the Igroup Presence Questionnaire (IPQ) <sup>26</sup> was completed.

Mental states and experiences in daily life were measured with the experience sampling method (ESM), a diary technique. Participants carried an iPod with the PsyMate app for six days during each assessment period (baseline, post-treatment and follow-up). The app signaled at ten random moments between 7.30 a.m. and 10.30 p.m. After the signal, a self-assessment had to be completed on the app. Participants had to complete a minimum of 1/3 of the assessments on four consecutive days to be included in analyses. Items on mental states were rated on 7-point Likert scales ranging from 1 (not at all) to 7 (very). The following subscales were assessed: *Social activity* was measured by calculating the proportion that participants were in company with others when the app signaled (excluding time spent with healthcare workers) (binary scale). *Momentary anxiety in company* was assessed with the score on the item "I feel anxious", but only when someone was in the company of others when the app signaled. *Perceived social threat* was defined as the average of the following items which were only completed if someone was in the presence of others: "I like this company" (reversed score), "In this company, I feel accepted" (reversed score), "I would rather be alone", and "In this company, I feel threatened" <sup>27</sup>. *Momentary paranoia* was defined as the mean score of the following items: "I feel that others might hurt me", "I feel that others dislike me" and "I feel suspicious" <sup>15,28</sup>. *Acceptability* of the ESM method was assessed at the end of each ESM assessment with the score on the item "this beep disturbed me".

## 2.5. Analyses

Data were analyzed with IBM SPSS Statistics 22 and Stata 11. Paired samples t-tests (two-sided) were performed on questionnaire data, comparing post-treatment and follow-up to baseline. Multilevel analyses (SPSS MIXED) were performed on ESM data as these have a hierarchical structure; multiple repeated measures (level 1) in each assessment period are nested within individuals (level 2). Binary ESM social activity data were analyzed with logistic multilevel analyses (Stata XTLOGIT function). Separate multilevel models were estimated for post-treatment and follow-up, comparing both to baseline. All multilevel models included time (baseline and post-treatment; or baseline and follow-up) as a fixed effect and a random intercept for participant. Models were estimated with restricted maximum likelihood and an identity covariance structure. Significance was accepted at  $\alpha = 0.025$  (Bonferroni corrected for two tests). Effect sizes were calculated with an adapted version of Cohen's *d* for repeated measures designs<sup>29</sup>. For binary data odds ratios (OR) were calculated. Analyses of the normal distributions (visual inspections and Shapiro-Wilk tests) revealed that the GPTS persecutory ideation subscale was right-skewed. Therefore this scale was analyzed with the non-parametric Related-Samples Wilcoxon Signed Rank Tests.

## 3. Results

Seventeen participants signed informed consent; two declined to participate during the baseline measurement, resulting in a total of 15 participants. Demographic and clinical characteristics are presented in Table 1. Of the participants, 67% was referred to secondary outpatient services because of treatment resistance or frequent relapse.

**Table 1.** Participant characteristics.

	VR-CBT n = 15
Age in years	34.9 (12.4)
Male	7 46.7%
Level of education	
Vocational or lower	4 26.6%
Higher tertiary	10 66.7%
Unknown	1 6.7%
Duration of illness in years	9.4 (7.8)
Previous SAD treatment	12 80%
Previous CBT treatment	6 40%
SCID-I comorbidity	
None	7 46.7%
Generalized anxiety disorder	2 13.3%
Depressive disorder	1 6.6%
Bipolar disorder	1 6.6%
Dysthymic disorder	3 20.0%
Body dysmorphic disorder	1 6.6%
Medication	
None	9 60%
SSRI	1 6.6%
SNRI	4 26.6%
Benzodiazepine	1 6.6%

*Note:* Categorical variables are given in *n* and percentage, interval data are presented with *M* (*SD*).

Two participants stopped after session 7. Reasons for stopping were: 1) too high anxiety during exposure and 2) incongruence with the method as the avatars were experienced to be too unrealistic, and the VR equipment was too distracting. The number of sessions of participants who completed VR-CBT ( $n = 13$ ) ranged from 13-16 ( $M = 15.0$ ,  $SD = 1.2$ ). Sense of presence in VR was sufficient with a mean score of 46.2 ( $SD = 9.3$ ). Two participants refrained from post-treatment measurements (but did complete the follow-up); four refrained from follow-up measurements.

Results are shown in Table 2. Significant time effects were observed for social interaction anxiety, depressive symptoms and quality of life. Social anxiety was significantly reduced after VR-CBT, with a mean decrease of 12.1 ( $d = 0.9$ ). This improvement was maintained at six-month follow-up resulting in a total decrease of 16.8 points on the SIAS compared to baseline ( $d = 1.3$ ). Depression scores were significantly lower at follow-up ( $d = 1.1$ ). Quality of life increased significantly between baseline and post-treatment ( $d = -0.5$ ), at follow-up the difference was only marginally significant, due to a small  $n$  ( $d = -0.8$ ). No significant time effect was found for persecutory ideation and ideas of social reference. However, by follow-up the mean score on ideas of social references had decreased by 25% compared to baseline ( $d = 0.8$ ).

Eleven participants had both baseline ESM data and post-treatment and/or follow-up data and were included in analyses. The reason for missing baseline ESM data was technical problems with the app ( $n = 2$ ). Additional missing post-treatment and follow-up data resulted of technical problems (post-treatment  $n = 1$ ; follow-up  $n = 1$ ), and unwillingness to complete the assessment (post-treatment  $n = 2$ ; follow-up  $n = 5$ ). The ESM seemed acceptable for the participants: participants rated the disturbance of the diary measurements on average with 2.3 ( $SD = 1.7$ ;  $n = 1011$ ). Yet we did not collect data on the overall experience of this method.

Momentary anxiety in company and momentary paranoia reduced from baseline to post-treatment. These improvements were maintained at follow-up with high effect sizes (momentary anxiety in company  $d = 3.4$ ; momentary paranoia  $d = 1.7$ ). There was no time effect for perceived social threat. There was a time effect of the amount of time spent in social activity. Compared to baseline, participants were significantly less in company of others at post-treatment ( $d = 0.2$ ,  $OR = 0.7$ ) and follow-up ( $d = 0.3$ ,  $OR = 0.8$ ).

## 4. Discussion

We investigated the feasibility and effects of a novel VR-CBT intervention for generalized SAD. Therapy dropout rates were low; two patients (13%) did not complete VR-CBT, and on average VR-CBT took 15 sessions. This suggests that the therapy was well tolerated. After VR-CBT, patients experienced social encounters more positively; less anxiety at social encounters and less paranoia was reported in everyday life. Furthermore, patients reported less social interaction anxiety, less depressive symptoms and improved quality of life. No improvements were observed in perceived social threat in daily life or social activity.

**Table 2.** (Weighted) means, standard deviations and test results of outcomes over time.

	Baseline		Post-treatment		Follow-up		Baseline - post-treatment		Baseline - follow-up		
	M (SD)	n	M (SD)	n	M (SD)	n	p	d	p	d	
<b>Clinical &amp; functional outcomes</b>		n=15		n=13		n=11					
Social interaction anxiety	59.9 (8.1)		47.8 (10.1)		43.1 (13.9)		$t(12) = 3.2$	0.9	$t(10) = 3.9$	0.003	1.3
Depressive symptoms	27.7 (9.3)		21.4 (12.8)		17.0 (12.4)		$t(12) = 2.1$	0.5	$t(10) = 3.2$	.01	1.1
Ideas of social Reference	37.3 (14.8)		33.1 (12.5)		27.9 (12.2)		$t(12) = 1.6$	0.4	$t(10) = 1.3$	.24	0.8
Persecutory Ideation	24.3 (11.2)		25.5 (15.8)		19.9 (9.3)		$z = 0.25$	-0.2	$z = -0.52$	.60	0.4
Quality of life	47.5 (9.9)		50.5 (10.8)		54.4 (11.1)		$t(12) = -2.7$	-0.5	$t(10) = -2.1$	.06	-0.8
<b>ESM</b>		n=11		n=10		n=7					
Social activity (binary)	0.53 (0.20)*		0.48 (0.31)		0.47 (0.22)		$z = -2.3$	0.2	$z = -3.2$	.002	0.3
Momentary anxiety in company	2.81 (1.24)		2.32 (0.99)		1.31 (0.19)		$F(1,352)=35.9$	0.4	$F(1,328)=74.0$	.000	3.4
Perceived social threat	2.52 (0.46)		2.46 (0.78)		2.34 (0.23)		$F(1,409)=2.2$	0.1	$F(1,349)=3.3$	.07	0.4
Momentary paranoia	2.03 (1.35)		1.78 (1.27)		1.11 (0.11)		$F(1,769)=36.0$	0.3	$F(1,658)=16.0$	.000	1.7

Note: The GPTS persecutory ideation subscale was right skewed and analyzed with the non-parametric Related Sampled Wilcoxon Signed Rank test.

\*For ESM social activity,  $n=10$ .

Results suggest that VR-CBT can be of added value for patients with complex and enduring SAD. Although patients had high levels of social anxiety and co-morbid diagnoses, VR-CBT was acceptable for most. One participant indicated that VR exposures caused such anxiety that he was not willing to continue therapy. Getting people engaged in exposures is challenging in SAD. The present VR program enabled gradual exposure. It was possible to start exposure in e.g. an almost empty street, and gradually increase the difficulty level. *In vivo* exposure does not allow for this amount of control, as therapists nor patients can control everyday environments. Here VR can be a useful tool as a first step in therapy.

Social encounters were experienced more positively after VR-CBT. Participants experienced less paranoia and anxiety during social interactions and reported reductions in social anxiety and paranoid ideations. One of the most important techniques that may have caused these reductions is challenging of negative expectations. By putting feared situations in scene in VR with the relevant triggers, patients experienced through exposure that the consequence they feared did not happen (expectation violation). This in turn can diminish anxiety and related symptoms <sup>5</sup>.

The lack of increase in time spent with others (i.e. social activity) was unexpected, and even a decrease was observed, though with small effect size. A similar lack of improvement in social activity was observed using the same design in patients with a psychotic disorder <sup>15</sup>. Possibly more time is needed before positive social encounters translate into more social contacts. Alternatively, the measure may be insensitive to measure time spent with others. Social activity was measured only at the moment of the signal, and intervals between signals could last several hours, therefore information on social encounters was limited. Furthermore, some participants may have felt uncomfortable completing the diary in company, and may have ignored assessments at such occasions leading to underreporting. Because of these limitations, future research should add an extra ESM item that asks whether the person has spent time in the company of others *since* the previous signal (yes/no), and when yes, who this company consisted of.

Perceived social threat during social interactions did not change. This finding seems to contrast our findings of reduced anxiety during social interactions. Although we do not have an adequate explanation for this, a similar result was found in the VR-CBT study of Pot-Kolder and colleagues <sup>15</sup>. Pot-Kolder et al. suggest that this subscale may reflect a preference of being alone instead of threat feelings, and needs more validation.

Many participants reported paranoid ideations. Although social anxiety and paranoid ideations are strongly associated, they are separable entities <sup>30,31</sup>. Our findings indicate that awareness of and attention for paranoia is needed in the assessment and therapy of SAD.

#### **4.1. Strengths and limitations**

This study has several strengths. This was the first VR-CBT study specifically for generalized SAD, using an intervention with both behavioral and cognitive elements. In addition, adjustable complex social environments were used which resembled common real-life situations. This contrasts with the two previous VR studies in generalized SAD that used more structured VR scenarios <sup>13,14</sup>. A final strength was the choice of outcome measures: both questionnaires and

ESM assessment. As both measures converged to the same outcomes, this strengthens the credibility of our findings.

Important limitations were the uncontrolled nature and small sample size. Therefore, the statistical analyses were exploratory and provide only preliminary evidence. Second, the number of verbal interactions was limited. Sentences had to be pre-recorded, and therefore role-playing was restricted. Therapists reported this to be the most restrictive limitation of the VR software. To compensate, therapists also spoke short sentences when the situation required interaction. Third, no homework assignments were given. Larger effects and stronger generalization are to be expected if patients are encouraged to practice in the real world. Fourth, technical problems with the app resulted in missing data, these issues need to be overcome.

#### **4.2. Conclusions**

This pilot study indicates that VR-CBT may form a feasible and promising addition to treatment for patients with severe generalized SAD. VR-CBT seems effective in improving anxiety and paranoia in daily life, as well as interaction anxiety and depressive symptoms. These findings contribute to the scarce literature of VR based interventions for generalized SAD and show that VR could form an important tool for therapy.

Whereas large improvements had been made following VR-CBT, there remained room for improvement. Therefore future studies should combine VR-CBT with *in vivo* (homework) exercises, this may increase the efficacy of the therapy. Moreover, options allowing more complex verbal interactions with virtual characters need to be incorporated in the VR software. Concerning outcomes, ESM seems a good addition to classical measures though some technical issues need to be overcome. Finally, many participants reported paranoid ideations, indicating that future treatment studies may benefit from paying attention to paranoia in SAD.

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