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Use of virtual reality as therapeutic tool for behavioural exposure in the ambit of social anxiety disorder treatment

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ABSTRACT

We hereby present a study whose aim is to evaluate the efficiency and flexibility of virtual reality as a therapeutic tool in the confines of a social phobia behavioural therapeutic program. Our research protocol, accepted by the ethical commission of the cantonal hospices' psychiatry service, is identical in content and structure for each patient. This study's second goal is to use the confines of virtual exposure to objectively evaluate a specific parameter present in social phobia, namely eye contact avoidance, by using an eye-tracking system. Analysis of our results shows that there is a tendency to improvement in both the questionnaires and eye contact avoidance.

1. INTRODUCTION

The goal of our study is to define a therapeutic program for social anxiety disorders using virtual reality (VR) and to assess its efficiency in order to confirm that VR is a promising tool for psychotherapists in the ambit of social phobia treatment. We equally introduce our eye-tracking device as a new tool for the assessment of social phobia and present our preliminary results obtained with it.

Nowadays, exposure to VR presents itself as an alternative to standard in vivo exposures in the context of cognitive and behavioural therapy (CBT). As of today, several studies have been conducted regarding the use of VR in the treatment of social phobia (North et al., 1998; Pertaub et al., 2001; Pertaub et al., 2002; Harris et al., 2002), all leading to the conclusion that VR immersion seems adequate for such treatments but evaluated on a limited sized cohort. Anderson's study (Anderson et al., 2003) equally evaluates the treatment on a small cohort (2 people). James (James et al., 2003) concludes that a socially demanding VR environment is more anxiety provoking for a phobic than a non-socially demanding one. Slater (Slater et al., 2004) demonstrates that the difference in impact between an empty room and a room with avatars is more important in the case of phobics than in that of non phobics. In her study, Klinger (Klinger et al., 2005) concludes that both VRT (Virtual Reality Treatment) and CBT treatments are clinically valid and that the difference between the two is trivial.

Regarding eye contact, Horley (Horley et al. 2001) conducted a study on visual scanpath over 15 social phobic subjects and 15 non phobic subjects. Her results suggest that the avoidance of salient facial features is an important marker of social phobia.

As preliminary work, we have conducted a study during which we exposed subjects to a VR situation representing a 3-dimensional audience composed of emergent gazes in the dark and surrounding the subject (Herbelin et al., 2002; Riquier et al., 2002). We experimentally confirmed that the audience was able to provoke more anxiety to social phobics than to non phobics and emitted the hypothesis that eye contact is an important factor of social phobia. We therefore developed and experimented with an eye-tracking setup integrated in the VRE system (Herbelin 2005) and concluded that eye-tracking technology could "provide

therapists with an objective evaluation of gaze avoidance and can give tangible feedback to the patients to estimate their progress during gaze behaviour exercises”(p.62).

In the second section of this paper, we describe our research protocol; we then present our results in the third section and conclude in section 4.

2. RESEARCH PROTOCOL

VR offers anxiety provoking scenarios which are difficult to access and are not easily available in real life. As an example, it would be extremely difficult for a therapist to fill his/her office with spiders in order to treat a patient. Equally, it would be extremely expensive and time consuming to repeatedly take a patient on an airplane in order to treat him/her against fear of flights. VR also allows repeating exposures without limitations. For example, a job interview is an accessible but exceptional situation. It would be difficult to have to do a job interview every week, as a habituation exercise.

In order to evaluate the efficiency and the potential of VRE, we use one of the social situations which are most characteristic of social phobia: the fear of public speaking according to Hofmann’s model (1997). To this end, we have conceived a framework based that model. We replace the group exposure situations proposed in this therapy by individual exposure sessions to different virtual public speaking situations (Figures 1, 2, 3, 4). Phobic subjects usually recourse to avoidance strategies concerning fearful situations. The aim of these exposures is to confront the subject to his/her fear and by habituation, make him/her cope with anxiety instead of avoiding it.



Figure 1. *Job interview simulation.*



Figure 2. *Meeting in a bar.*

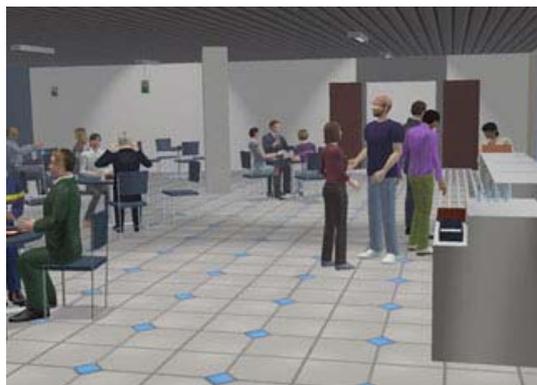


Figure 3. *Meeting in a cafeteria.*



Figure 4. *Speech in front of an auditory.*

In order to evaluate the efficiency of our program, we use various scales specific to social anxiety disorders at different phases of the treatment, namely the Fear Questionnaire (Marks and Matthews, 1979), the Liebowitz social anxiety questionnaire (Yao et al., 1999), the Social Interaction Self-Statement Test (Yao et al., 1998), and the Beck Depression Inventory (Beck et al., 1961). Our aim is to obtain a normalization of the score values for each subject after treatment as well as to uphold the improvement during the follow-up evaluations.

Regarding evaluation of visual contact avoidance, we use an eye-tracking system, coupled with exposure to two virtual scenes with a 3 minute verbal expression exercise in each case. We evaluate eye contact

avoidance from the recording of the pupil by an eye-tracking system during exposure to the virtual scene. We seat the subject in front of a large back projection screen and equip him/her with the eye-tracking device. We then record the pupil movement at the rate of 60Hz (60 measures per second). Finally, we analyze this recording and materialize the data as a map showing the zones swept by the gaze as well as the lapse of time contact lasted.

Our eye-tracking system allows us to put into evidence and analyze in the virtual environment's zones which are looked at by the subject in real time (Figure 5). We evaluate the eye contact in a pre-therapeutic phase and at the end of the treatment. We can therefore estimate the possible effect of the treatment on this parameter.



Figure 5. Eye-tracking system visual demonstration [Herbelin, 2005].

This project is a clinical experiment following an A-B protocol. During the A phase – the non-intervention phase – we establish and analyse the target symptoms evolution curve through 3 evaluation sessions. During the B phase – the intervention phase – we expose the subjects to anxiety provoking situations through an HMD (Head Mounted Display) on a weekly basis, during 8 weeks; each session lasting approximately 30 minutes of which 10 in the HMD.

The study is conducted over 8 subjects recruited via a mailing sent to students in 2nd and 3rd years of college and via ambulatory consultations specialized in anxiety disorders. We admitted these subjects to participate to the study after a structured interview regarding socio-demographical variables as well as psychiatric and medical antecedents. We led a diagnostic according to the *DSM-IV*'s 5 axis for each subject and presented them with the M.I.N.I. (Mini-International Neuropsychiatric Interview) (Sheehan et al., 1998) in order to verify the prevalence of social phobia and the absence of comorbidity. Originally, they were 10 but two dropped out during the A phase of the treatment.

During the A phase, at weeks -2, -1 and 0, we asked the subjects to fill in the above mentioned questionnaires (Fear Questionnaire, Liebowitz scale, SISST and BDI). We then analysed them and averaged the results we obtained over the three weeks in order to obtain a before-treatment value for each subject and each scale.

Between phase A and phase B, subjects participated in a group session without VR. We instructed them on social phobia and asked them, one after the other, to give a speech on what they had learned about this anxiety disorder.

For the B phase, we asked the subjects to mention 8 social situations and to classify them from least to most anxiety provoking. We then exposed them to various virtual situations throughout the 8 HMD sessions, each more anxiety provoking than the previous one. The proposed virtual scenes were:

- In an office, facing one man or one woman (fig. 1)
- In an office, facing 5 people
- In an auditory, facing one man or one woman
- In an auditory, facing approximately 20 people or sitting at the back of the room (fig. 4)
- In a cafeteria, facing one person but with many people around (fig. 3)
- In a bar, facing one person but with many people around (fig. 2)

It is known that to deal with a person of the opposite sex is a typical trait of social phobia. We therefore consider the office with one person (man or woman) and the auditory with one person (man or woman) as four different situations.

We set the virtual characters in each of these scenes with a number of pre-recorded sentences which can be triggered by the psychotherapist to respectively begin, continue and end the speech session. We equally set up the virtual characters with facial animation corresponding to each of the pre-recorded sentences. We have noticed that vocal interruptions from the therapist during HMD exposure created breaks in presence. We therefore avoided these by making our virtual characters talk instead. Finally, we set up our characters with a “look at” function which allows them to make eye contact at all time and more specifically when talking to the exposed subject.

For the first HMD session, we asked each subject to present social phobia once again, as they did for the group session. Then, each week, we asked them to prepare the following week’s session. As homework, they had to prepare the following week’s speech in front of a mirror in order to auto-evaluate their body language. Sessions 2 to 8 consisted in the following themes:

- Session 2: talk about hobbies
- Session 3: talk about professional or educational activity
- Session 4: talk about a memorable event
- Session 5: talk about a dramatic situation
- Session 6: talk about a conflict situation
- Session 7: talk about anxiety related to love
- Session 8: we gave them documents discussing “efficient communication” and asked them to talk about these documents as if giving a lecture

We gave them these situations in this specific order for each to be more personal than the previous, and therefore, more anxiety provoking. However, since each subject isn’t affected by each situation in the same way, we modulated these according to each subject. As an example, some subjects recited a poem or sang a song for session 7 because talking about their love life wasn’t sufficiently anxiety provoking.

As in Hofmann’s therapeutic program, we asked, as homework, for the subjects to prepare and repeat speaking exercises in front of a mirror. We also asked them to try to decrease their avoidance behaviours in real life. Finally, we also asked them to fill in a “fearful situation” document in which they exposed the anxiety provoking situations to which they have been confronted in the past week as well as the degree of avoidance, the degree of anxiety, and the satisfaction felt throughout this experience. We then used this document as base to each weekly discussion.

We asked the subjects to fill in the same 4 questionnaires as during the A phase of the treatment at week 5, half way through the treatment and once again at week 9, after the end of the HMD sessions.

We conducted the eye-tracking tests before and after the HMD sessions in order to analyze the progression in eye contact before and after treatment. Before starting with the first session, we exposed the subjects to a 5 minute habituation session. We asked them to write their name on the back projection screen with their eye. This was done in order to habituate them to the equipment and to relax before exposure by playing a game. During both sessions, we set the subjects in front of two different scenes, facing one man sitting in his office (fig. 1) and facing an auditory containing an audience of approximately 20 virtual actors (fig. 4). We did these two recordings in order to check whether the eye contact attitude is the same in different situations or not.

Our protocol equally plans another group session, which has not taken place yet. During this group session, we will ask them to present their lecture on efficient communication once again, in front of the others. This will equally allow us to see if there is a difference in attitude between HMD session and in vivo group session.

Finally, our protocol plans a follow-up session, at week 24 to verify the presence of continued evolution.

3. RESULTS

The results we present here only concern 7 people out of the 8 since the last subject has not yet been through all the HMD sessions; we therefore do not have his post-treatment results yet.

We note a general improvement for most subjects through the analysis of the various questionnaires. We can equally see that the tendencies for each subject are repeated throughout all questionnaires.

We also note that visual contact avoidance decreases. Our results show that the subjects present less avoidance behaviour after treatment than before treatment.

We equally note that one person out of the 8 does not follow the improvement pattern, on the contrary. We can see that the subject 'G's evolution is the opposite of all other subjects'. If we took out this subject from our study, we would have a much better mean evolution.

3.1 Questionnaire Analysis

In the mean, we can see that the social phobia score for the Fear Questionnaire has decreased from 22.3 to 16.4 for women and from 19.8 to 16.5 for men. The norms to this questionnaire for phobic subjects are of respectively 15.94(8.96) to 23.4(8.4) for women and 21.4(5.44) to 24.4(8.0) for men (Bouvard, Cottraux, 2002). Our results are therefore promising.

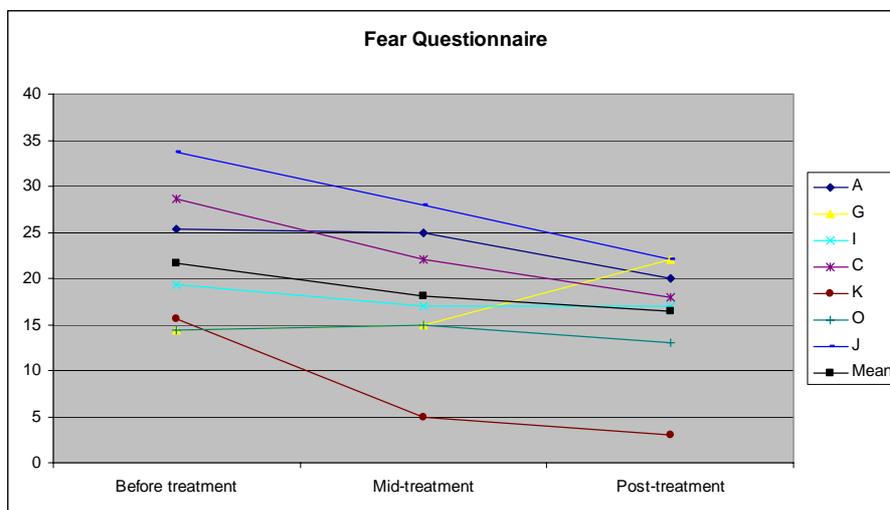


Figure 6. Graphical results to the Fear Questionnaire.

Regarding the Liebowitz questionnaire, the mean score decreased from 73.3 to 56.7 (Bouvard, Cottraux, 2002). Knowing that the norm for social phobic subjects is of 67.2(27.5), our results are equally promising.

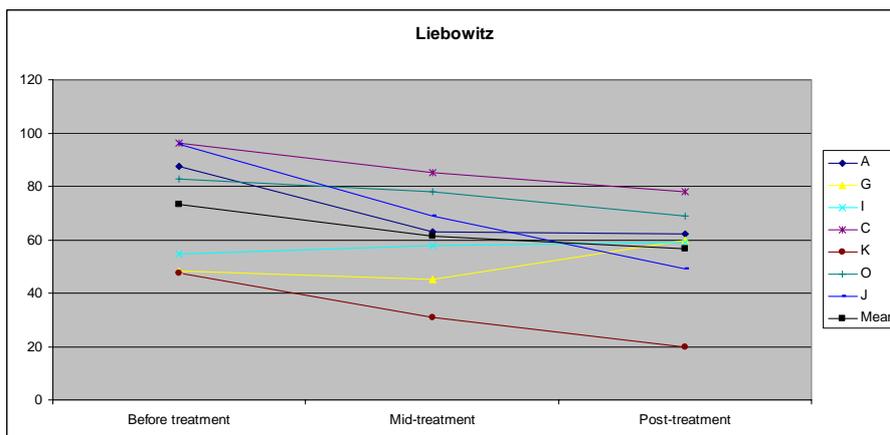


Figure 7. Graphical results to the Liebowitz Questionnaire.

In the mean, the score to the SISST positive thoughts has evolved from 37 to 42.6 and the score to the SISST negative thoughts, decreased from 46.9 to 38.6. For phobic subjects, the norms to this test are of 36.93(7.40)

and 53.46(9.11) for positive and negative thoughts respectively (Bouvard, Cottraux, 2002). Once again, these results confirm those to the previous tests.

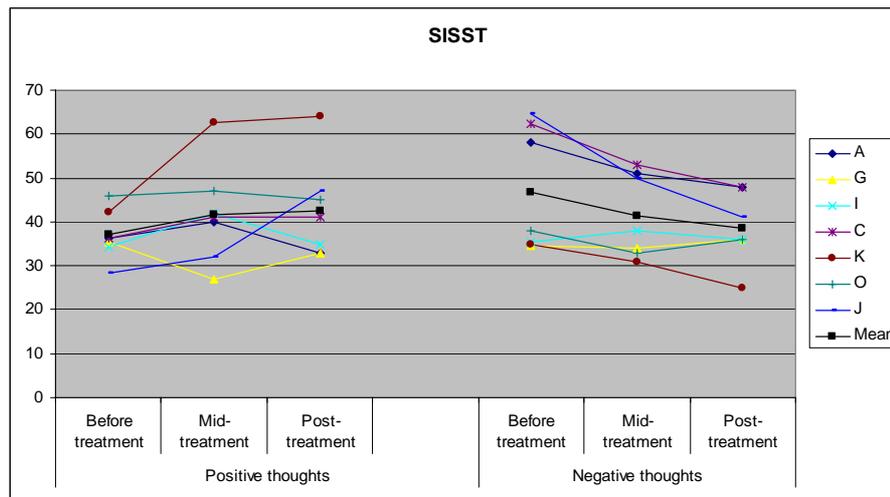


Figure 8. Graphical results to the SISST Questionnaire.

For the BDI questionnaire, the mean score has decreased from 9.7 to 5.3. Knowing that a score of 18.7(10.2) denotes a slight depression and that a score of 10.9(8.1) denotes no depression whatsoever (Bouvard, Cottraux, 2002), we can conclude that our subjects were not depressive should it be at the beginning of the treatment or after its end.

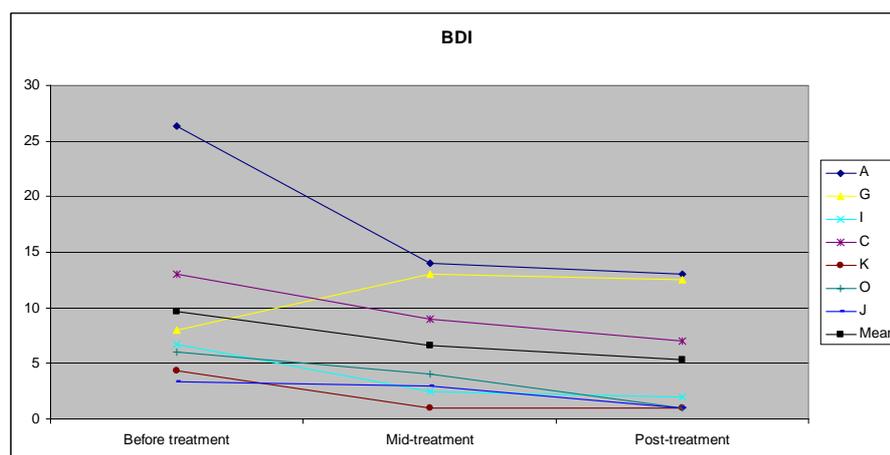


Figure 9. Graphical results to the BDI Questionnaire.



Figure 10. Eye-tracking results for the interview simulation, **Left:** before treatment, **Right:** after treatment.

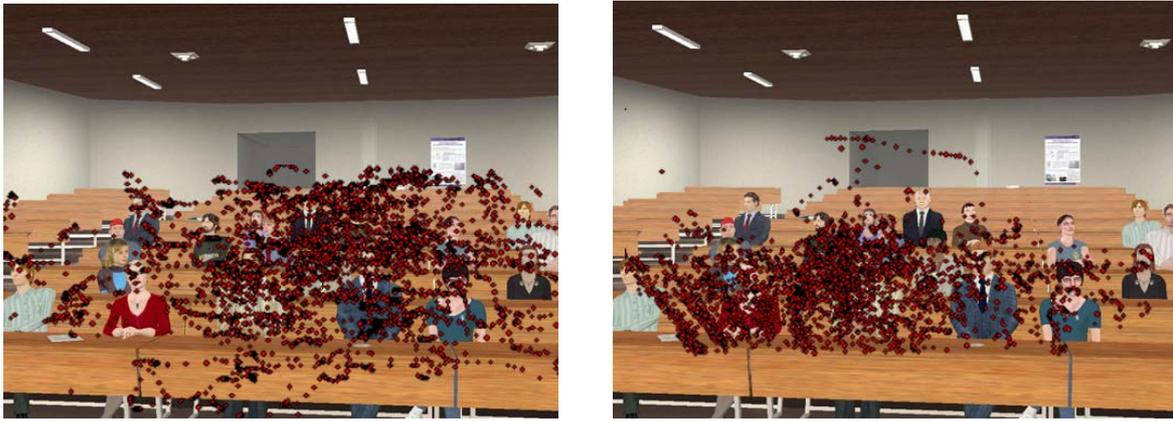


Figure 11. Eye-tracking results for the speech simulation, *Left: after treatment, Right: after treatment.*

3.2 Eye-tracking

We hereby present a case study of the outcome of eye-tracking recordings. The evolution in eye contact is different in each case but this is a representative tendency in visual contact improvement.

It is noticeable, from these recordings, that after treatment, eye contact behaviour has changed. We can notice that the virtual character's face is much more looked at after the end of the treatment than before treatment (fig. 10(a) and fig. 10(b)). We can see that the talking virtual characters (the lady in red and the man with the white sweatshirt respectively) are equally much more looked at after treatment than before treatment in the second situation (fig. 11(b) and fig. 11(b)). These results tend to show that eye contact avoidance has diminished after treatment and that looking at the talking person's face has become less difficult.

4. CONCLUSIONS AND DISCUSSION

In this paper, we have presented a study whose aim was to evaluate the efficiency of a therapeutic program using VR as a tool to treat social phobia. We have presented the VR-based protocol which we have used to conduct a study over 8 social phobic subjects. We have equally presented the results we have obtained through questionnaire analysis and eye-tracking recordings.

Firstly, we have noticed a general improvement for most subjects after having analysed all questionnaires. We have equally noticed that the tendencies for each subject were the same over the questionnaires. This leads us to think that certain people are more reactive to VRET than others. We have seen, in our results, that one of the subjects apparently wasn't affected by the treatment at all. However, due to the limited size of our sample, we cannot conclude to the validation of VR as a treatment for social phobia. Nevertheless, our results show that it could be a promising therapeutic tool and that VR demands more extensive experimentation. In order to validate this tool, another study should be conducted over a minimum of 30 subjects and with a control group. However, 50 subjects should be recruited since some of them will certainly drop out before the end of the study, as we have seen in ours.

Secondly, and according to our former experience in case studies (Herbelin 2005), we have observed a deviation of the gaze during VRE and have obtained a qualitative appreciation of the patients' gaze avoidance. After having analysed the eye-tracking recordings, we have equally noticed an improvement in eye contact avoidance. We intend to conduct more extensive research on eye contact avoidance and analyse our results in more detail, in order to correlate the results between scenes for a same subject as well as between subjects themselves. We also intend to investigate the eye scan and its speed.

By using subjective appreciation of social anxiety throughout the whole experiment (the 4 above mentioned questionnaires) as well as video recordings of the exposure sessions and the results provided by our eye-tracking system, we have noticed an improvement regarding avoidance behaviour and a decrease of anxiety with time and exposure. The follow-up with the subjects will give us the opportunity to validate our actual results regarding VR therapy on a long-term basis and its ability to continue providing results once the therapy is over.

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