A Preliminary Study of Shy Males Interacting with a Virtual Female

Xueni Pan[1] and Mel Slater[1,2]
[1]Department of Computer Science, University College London, London, UK
[2] ICREA - Universitat Politècnica de Catalunya, Virtual Reality Centre of Barcelona, Barcelona, Spain

Abstract

This paper describes a preliminary experiment that studied the reactions of male participants to an approach by an attractive and friendly virtual woman in a Cave-like system. The experiment is a 2×2 between groups factorial design. The first factor is whether the participant experiences social anxiety in everyday life or is socially confident. The second factor is whether the other virtual characters in the bar sometimes glance at the participant or never do. 24 male participants took part in the experiments. There were 4 categories of data collected based on: questionnaires, physiological recordings of ECG and electro-dermal activity, post experimental interviews, and observations of behaviour during the experiment. Our results show that the participants tended to respond to the situation at the subjective, behavioural and physiological level as if it were real. Moreover, for the anxious group, their anxiety response to the virtual woman was positively associated with their normal level of social anxiety, and independent of whether or not other virtual characters were looking at them; however, for the confident group, there is some evidence to suggest that there was some impact of being observed. This preliminary study has been used in order to generate hypotheses for the next level of experimentation.

1. Introduction

This paper describes an experiment that studied the reactions of male volunteers to an approach by an attractive and friendly virtual woman, who initiates a conversation with them in a bar. This is part of an ongoing study of whether people with social phobia react with appropriate anxiety to virtual reality depictions of social encounters. Social phobia involves a strong fear of one or more social performance situations. People with this condition fear that they will act in a way that is humiliating or embarrassing and that others will judge them negatively. Although they recognize that this fear is irrational, they experience extreme discomfort and anxiety when in the feared situation and will seek to avoid the social encounter whenever possible [1]. Our question is the extent to which people will respond with appropriate affect to virtual social encounters: for example, will males who are normally shy or who usually avoid encounters with women react with anxiety, and will males who are socially confident enjoy the encounter? Moreover, a particular trait of social phobia is that individuals become particularly anxious when they feel that they are being observed by others in a social situation [2]. We therefore also include in our study a factor where the social encounter between the real male and virtual female may be the subject of attention, or not, by other virtual humans who populate the bar scenario.

2. Related work

Psychotherapy has been one of the major applications of virtual reality technology [3]. As part of a treatment programme, a client might be placed in a Virtual Environment (VE) depicting a situation that triggers their anxiety, which is then overcome by series of gradual exposures in the context of Cognitive Behavioural Therapy (CBT). This has been applied, for example, to fear of heights [4] fear of flying [5], arachnophobia [6], post traumatic stress disorder [7], attention deficit disorders in the classroom [8], and pain distraction [9]. The use of virtual reality in the successful treatment of anxiety conditions and phobias relies heavily on the extent to which patients will respond to the virtual reality events and situations as if they are real. This is the concept generally referred to as 'presence', and forms the background to our research [10].

A particular area of social anxiety that has been studied is fear of public speaking [11] where participants were exposed to positive or negative virtual audiences and their reactions recorded. Such studies provide increasing evidence that people respond to such virtual social encounters as if they are real [12], and that virtual reality can be successfully used together with CBT for treatment [13].

The experiment that we describe in this paper is unique in the type of social encounter that is depicted – which should normally be experienced as a pleasant one were it to occur in everyday reality. Here an attractive woman initiates contact with the male participant – with the conversation becoming increasingly personal, and increasingly pleasant – for example, the woman even complements the man on his dress and appearance. For males who experience strong social anxiety in encounters with the opposite sex this approach by a woman should be anxiety provoking, but not so in the case of socially confident males.

(a) (b) (c)

Figure 1 – The (a) virtual character first looks at the participant and then (b) approaches him and (c) a conversation ensues while the other characters continue their conversations.

3. Experimental Design

3.1 Materials

The experiment was conducted in a Cave-like projection based system [14] – the specific system being a Trimension ReaCTor. This has three back-projected vertical screens (front, left and right) (3m×2.8m) and a floor screen (from a ceiling mounted projector) (3m×3m) controlled by a Silicon Graphics Onyx 2. Head tracking is through an Intersense IS 900. The participants were fitted with a ProComp Infiniti (Thought Technology) physiological recording device that records ECG (256Hz), skin conductance (32Hz) and respiration (32Hz). Electrodes were placed on the palmar areas of the index and middle fingers of the left hand in order to record electrodermal activity. Electrodes were placed on the left and right collar bones and the lowest left rib in order to record ECG. The Procomp chest strap was used for recording respiration.

3.2 Scenario

The scenario was a virtual bar which is populated by 5 virtual characters 4 of whom are talking to one another, except for one lone female, 'Christina'. Once the participant enters the scenario Christina begins to stare at him for a few seconds (Figure 1a), then makes her way towards him (Figure 1b), and then initiates a conversation (Figure 1c). It is important to note (as shown in Figure 1c) that from the point of view of the participant Christina is life-sized and that the projection is active stereo. The participant stood approximately in the centre of the room and head tracking was used so that Christina could look at him in the eyes, and also the other characters in the room would occasionally look towards him.

Christina is modelled to be an attractive female, speaking English with a slight Portuguese accent (the accent of the real actress who recorded the script). She started the conversation with the participant by introducing herself and asking the participant questions. When he spoke, she appeared to listen carefully and showed her interest by nodding and smiling. She also showed her interest by leaning forward to him, smiling, looking at him, and also by breaking typical UK norms of social distance by approaching within 0.5m. If the participant asked where she was from, she told him that she is an air hostess and had just arrived in London. Finally she suggested they should meet up again. The whole conversation lasted about 10 minutes. The detailed interaction is shown in Table 1.

Christina's behaviour consisted of a number of multi-modal utterances containing recorded speech, and body and facial animation, which were triggered from a control panel by an experimenter, who was listening to the experiment out of view of the participant. There were around 60 utterances prepared and pre-recorded; half of these are the core of the conversation and the rest of them are backups for unexpected situations. Each utterance is a synchronised combination of speech (audio file) and movements (animation). Our animation engine distinguishes between foreground behaviour, the multi-modal utterances, and background behaviour. Background behaviours are behaviour patterns that happen continuously, and in parallel with any utterances, either for the whole scenario or parts of it. They are vital providing a sense of life and believability to the character. We use two background behaviours: gaze and proxemics. We simulate character gaze behaviour using a model of gaze for conversation [15]. We use a model of proxemics that ensures that Christina mostly orients towards the participant and maintains an appropriate conversational distance, but breaking this as time goes on as she gets closer. The following is an extract from a typical conversation: (Christina – C; Participant – P)

C: This shirt looks great on you, how much was it?

P: Thank you! It is a gift.

C: Ah, I really want to find a pair of trousers something like those for my brother [glancing down at the man's trousers]. Where did you get those?

P: Haha, I cannot remember, but there are a lot of nice shops along Oxford Street if you are interested.

C: [Turns her face to the other virtual characters around] So, Do you know anyone here?

P: Well, not really anyone else, no.

C: I feel a bit shy about talking with the other people, do you mind if I talk with you for a bit longer?

P: Sure, no problem.

3.3 Factorial Design

The experiment is a 2×2 between groups factorial design. The first factor is whether the participant experiences social anxiety in everyday life or whether he is socially confident. This is determined by a the SPAI (Social Phobia and Anxiety Inventory) questionnaire [16]. In SPAI, there are 21 questions explicitly related with anxiety towards interacting with the opposite sex, and each question has an 'anxiety' scale ranging from 1 to 7. We selected 9 questions out of 21 which are related to our scenario, and one additional question which of special relevance ("I feel anxious when being approached by opposite sex"). We also include another 27 questions from the SPAI to avoid the participant realizing what we were trying to test. We chose the lowest scoring 30% percent of volunteers as socially confident and the highest 30% as shy participants, discarding the remaining people who had volunteered.

The second factor is the extent to which the other virtual characters in the bar stare towards the participant. In one condition once the conversation had started the other characters did not look towards the participant, and in another condition they did look frequently. Our interest was to discover whether social anxiety would be increased for those participants who become aware that they were being observed by others.

4. Procedures

Participants were recruited by posters and email on the campus at University College London to all levels of staff and students, with finally 6 participants in each of the 4 cells of the factorial design (in all 24 participants). The experiment was approved by the UCL Research Ethics Committee.

The SPAI questionnaire was put on line and the web page was advertised through emails and posters on the campus at UCL. 63 people filled in the online pre-questionnaire, and the top and bottom scoring 30% were invited, and eventually 28 participants were recruited and attended our studies. However, 4 were eliminated: 2 of them being over 50, the system failed in the experiment for one participant, and another participant reported himself as gay during the subsequent interview so that the scenario had been too disturbing for him. Thus eventually we had 24 valid participants, 6 for each group. The mean age was 25 (from 18 to 36) years with no significant difference in age within the 4 conditions. There were 6 undergraduates, 6 Master students and 8 PhD students. The rest were 1 faculty, 1 university staff, 1 lawyer and 1 office worker. They were all fluent in English.

Events / Questions	Event
1	Baseline starts
2	Baseline ends
3	Experiment starts
4	Avatar stares at the participant
5	Avatar approaches to within normal social distance
6	"Hi, It looks like we are the only people alone here, right?"
7	"My name is Christina."
8	"It's very nice to meet you."
9	"So, what are you doing for a living?"
10	"Very interesting, tell me more."
11	"I'm an air hostess; I just arrived in London yesterday. Where do you live?"
12	"I don't know London very well, but actually, I am thinking about moving here, what do you think?"
13	" But I heard it rains all the time here, is that true?"
14	"Well, the weather is not that important to me. Have you lived here long?"
15	"Do you like it here?"
16	"I've noticed that people dressed very well around here. By the way, that shirt looks great on you. How much was it?"
17	"Ah, I really want to find a pair of trousers, something like these (Looking down) for my brother. Where did you get these?"
18	"So, do you know anyone here?"
19	"I feel a bit shy about talking with other people, do you mind if I talk with you for a bit longer?"
20	The avatar approaches to an intimate distance
21	"If you don't mind me saying, I think you look very nice."
22	"I was wondering actually, are you single, or involved with someone at this time?"
23	"Maybe we should meet up."

Table 1 - Sequence of Events and Avatar Questions in the Virtual Encounter

Participants attended the experiment at pre-arranged times. Each participant was provided with an information sheet, and given a consent sheet to sign if they agreed to do the experiment. Each was also asked to fill in a pre-questionnaire giving basic information such as age, occupation, etc.. Then he was introduced into the experimental room and fitted with shutter glasses, a head tracker and the ProComp Infiniti (Thought Technology) physiological recording device, and a microphone in order for the experimenter to hear the conversation. A 2.5 minute baseline recorded participant's physiological responses while they were standing still in a relaxed state, and the background music was playing. This was then followed by the actual experiment, which took about ten minutes. Then participant was required to fill in a post-questionnaire (an adjusted SPAI questionnaire, post-SPAI, that related specifically to the

experience that they had just had, rather than life in general) and a version of the so-called SUS presence questionnaire (e.g., [17]). Finally a short interview was held. The whole procedure took between 45 and 60 minutes. The experimental operator and an assistant were there throughout the whole experiment; both of them were females.

5. Results

There were 4 categories of data collected: questionnaires, physiological recordings of ECG and electro-dermal activity, post experimental interviews, and observations of behaviour during the experiment. A significant part of the EDA and ECG data was lost due to equipment failure, the main reason why we are treating this study as a preliminary experiment, in order to generate hypotheses for an entirely new study.

5.1 Questionnaire Results

Overall the presence scores from the SUS questionnaire were high (Figure 2), and there were no differences between the various groups.

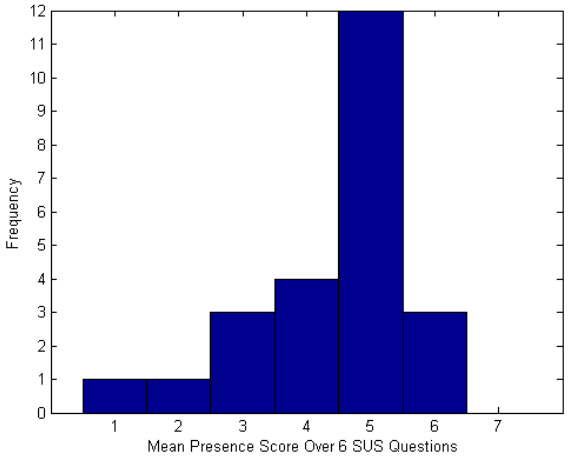

Figure 2 - Histogram of presence scores for the 24 participants. Each entry x is the number of scores greater than or equal to x-0.5 but less than x+0.5. (There are no scores <1).

Table 2 shows the mean post-SPAI scores for each cell of the design table. The results suggest that those in the Anxious group tended to have a greater anxiety response than those in the Confident group, and for the Confident group there was greater anxiety as a result of being observed.

	Not Observed	Observed
Confident	1.68 ± 0.28	2.76 ± 1.42
Anxious	3.49 ± 0.90	3.20 ± 1.41

Table 2 - Mean and Standard Deviations of post-SPAI scores (n = 6 observations per cell)

However, Figure 3 shows a possible reason for this, which is the differential response to being looked at between the Anxious and Confident groups. For the Anxious group it seemed to make no difference – perhaps because their anxiety was already high, and being watched was of marginal importance. However, for the Confident group there is some evidence that those who were being observed had a higher tendency to anxiety than those who were not being observed, though this may be due to one outlier. This is the second reason why this study is being treated as preliminary: clearly more data is needed to resolve this issue.

Retaining the possible outlier a two-way analysis of variance rejects the hypothesis that the mean post-SPAI is equal between the Confident and Anxious group (P=0.0211) but does not reject the hypothesis of equal means between those who were observed and those who were not, and there is no interaction effect. A Jarque-Bera test does not reject the hypothesis of normality of the residuals (P=0.10). If we exclude the extreme point, then a two-way analysis of variance similarly rejects the hypothesis of equal mean post-SPAI between the Confident and Anxious groups (P = 0.0016) and there are no other significant effects. Again the hypothesis of normality of the residuals is not rejected (P = 0.35).

If we treat preSPAI as a covariate and retain the extreme value, then the Analysis of Covariance result (treating the main effects as binary variables) is shown in Table 3, which corresponds well to the result seen in Figure 3.

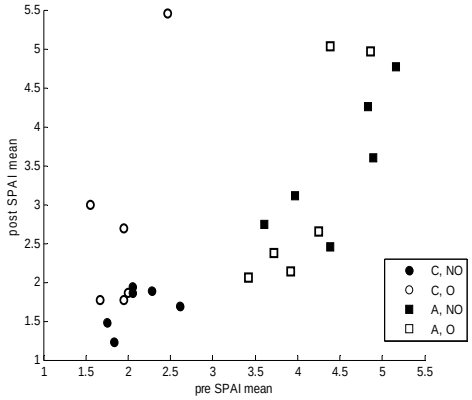

Figure 3 - Post SPAI mean against pre SPAI mean by anxiety and observation factors. C = confident, A = anxious. NO = not observed, O = observed.

The analysis of the questionnaire data therefore suggests that for the Anxious group their anxiety response to the virtual woman was positively associated with their normal level of social anxiety in everyday life, and independent of whether or not other virtual characters were looking at them. However, there is some evidence to suggest that for the

Confident group there was some impact of being observed, although more data would be needed in order to verify this. This will be examined in more detail in the new experiment.

Variable	Estimate	P
Constant	-0.4938	0.3766
Group × Observed	-3.4542	0.0009
preSPAI	0.9181	0.0000
Observed × preSPAI	0.8296	0.0007

Table 3 - Analysis of Covariance: Group (Confident = 0, Anxious = 1), Observed (no = 0, yes = 1), R^2 = 0.67, F=13.24, P = 5.47×10^{-5}, d.f. = 20. The hypothesis of normality of the residual errors is not rejected (P = 0.86).

5.2 Physiological Data Analysis

Electrodermal activity [18, 19] was recorded during a 2.5 minute baseline period and subsequently throughout the experimental session. Participants were asked to stand still during the baseline period during which time the bar scene was displayed, without virtual people, though there was background music. Data was available for only 14 of the 24 participants: 7 in each of the Anxious and Confident groups, and 7 in each of the Non-Observed and Observed groups. Although this loss of data compromises the power of any statistical analysis there is still a good spread of available data across the groups.

Skin conductance level (SCL) reflects the overall level of sympathetic arousal and skin conductance responses (SCR) reflect transient sympathetic arousal, either spontaneous or in response to events.

5.2.1 Skin Conductance Level We first consider mean event-related SCL for the combined group of 14 participants. Figure 4 shows plots of the means over all n=14 of 10s segments around each of the events. It can be seen that the one that reaches the highest peak is for the event when the avatar violates the norms of social distance approaching the participant very closely (curve 20).

Figure 5 shows another way of looking at the same data with boxplots for each of the 10s sequences for each event. It is clear that the highest median is for event 22 ("I was wondering actually, are you single, or involved with someone at this time?"). Note the generally lower values of the SCL for the ordinary topics of conversation (questions 12-16) and then the general increase as the conversation becomes more intimate.

For the sake of obtaining some insight into the statistical significance of these results we use a Kruskal Wallis non-parametric one-way analysis of variance, to test the hypothesis that the medians of all the events are equal. Of course this hypothesis is rejected with P=0 (effectively). Then a multiple comparisons test with simultaneous significance level of 5% shows that the questions fall into clusters as follows:

- Questions 7, 20, 21, 22, 23 have median significantly greater than all of the others;
- Questions 6, 8, 9, 10, 11, 18, 19 have medians significantly greater than the remainder.
- Question 17 has median significantly greater than the remainder
- Questions 5, 12, 13, 14, 15 have median significantly greater than 1-4.
- Question 15 is not significantly different from 4,5 and 16
- Question 2 (end of baseline) is significantly lower than 3-22.

Note again that 22 (the most intimate question) stands out as having the highest median score.

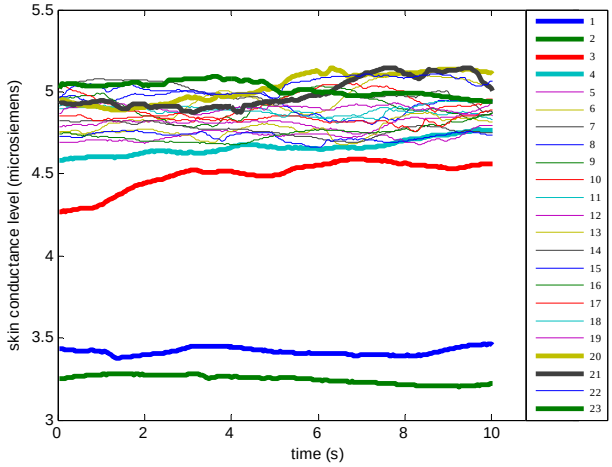

Figure 4 - Event Related Mean SCL. The mean SCL over n=14 participants is taken in a 10s window after each event, except that for the end of the baseline the sequence starts 10s before the end. The highlighted curves are (2) the last 10s of the baseline, and the remainder are 10s from the start of: (1) the baseline, (3) the start of the experiment, (4) when the avatar first initiates contact by gazing at the participant, (23) the avatar says "Maybe we can meet up afterwards", (21) "If you don't mind me saying, I think you look very nice" (22) "I was wondering actually, are you single, or involved with someone at this time?" (20) when the avatar violates normal social distance and approaches the participant closely.

It should be noted that the KW test requires independent observations for each factor being compared, which is not the case here, since the data for each variable is a segment of a time series, so that this analysis should be taken only in a descriptive sense. It can be seen in any case simply from the box plots in Figure 5 that 20-23 together with 6-10 have greater SCL values than the remainder.

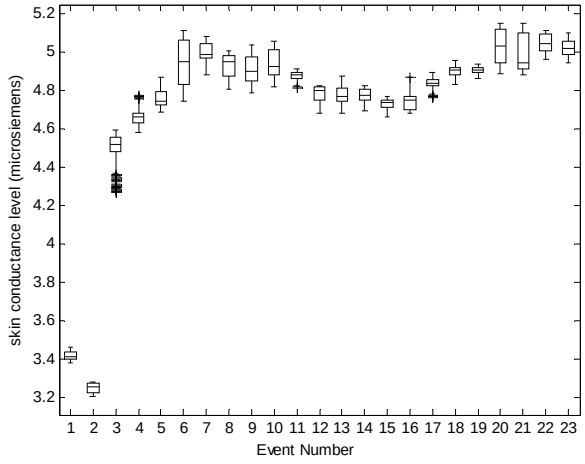

Figure 5 - Box plots of mean SCL for 10s after an event for each event. These are standard boxplots, showing the median and range of values for each event for 10s after the event except for event 2 which is the 10s leading up to the end of the baseline recording.

5.2.2 Skin Conductance Responses Now we turn to the number and amplitudes of the SCRs. In particular we focus on these variables around the time of the most intimate questions towards the end of the experience (the period between events 19 and 25) and examine the number and amplitude of SCRs in that period. As a control we also consider these variables during the time of the less intimate questions (events 11 through 15). This control is important because during both periods the participant was asked questions and also talked, and simply these acts would have caused SCRs. However, we wish to see whether the content of the conversation had an influence on the SCRs, since it is the *content* that is the only difference between the two conditions.

We would expect to find associations between the number and amplitude of SCRs for the 19 to 25 period and the main effects variables (confident/anxious, not observed/observed) in the first case, but not in the second case. Also we can eliminate the effect of the number of SCRs and their amplitude in the baseline period.

Skin conductance responses (SCR) were defined to be local maxima that had amplitude of at least 0.1 μS and in a period not exceeding 5s to the maximum in the individual skin conductance time series. Over the time periods in question both the number and mean amplitude of each SCR were computed.

The number of SCRs per unit time should follow a Poisson distribution. Hence a log-linear Poisson regression was carried out with the number of SCRs per unit time in the period 19 to 25 (*NumSCR19to25*) as the response variable, the mean number of SCRs per unit time in the baseline as an explanatory variables (*baselineRate*), together with the experimental main effects.

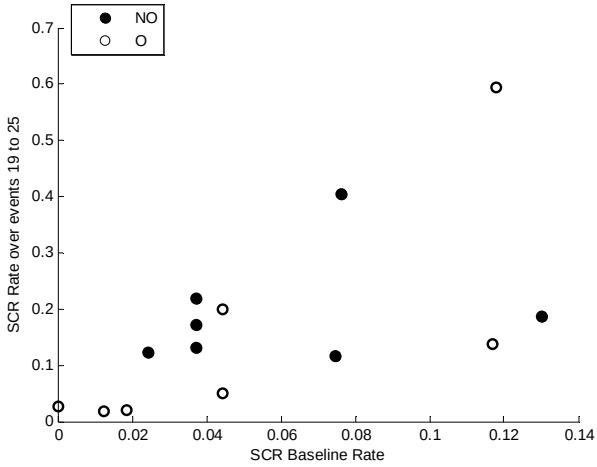

Figure 6 -The SCR Rate over events 19 to 25 by SCR Baseline Rate classified by whether participants were observed. The SCR Rate is the number of SCRs per unit time. NO refers to those in the Not Observed group, and O to the Observed group. It can be seen that for the former there is no trend, but there is a positive relationship amongst the Observed group.

There is no significant relationship between *NumSCR19to25* and the Group Anxiety main effect when *baselineRate* is taken into account. However, there is a significant relationship with respect to the Observed main effect.

Variable	Estimate	Standard Error
Constant	-1.6483	
Observed	-1.7959	0.3942
Observed× baselineRate	20.8161	3.639

Table 4 - Log-Linear Regression (Confident = 0, Anxious = 1) Observed (no = 0, yes = 1) Response Variable: *NumSCR19to25*, n = 14, d.f. = 11. All P values for the coefficients are 0.0000 (Observed = 0, for the non-observed group, and 1 for the observed group)

This can be seen in Figure 6 and the results of the log-linear regression analysis in Table 4. For *NumSCR10to15* there is no significant relationship with either of the main effect variables.

Now we consider the amplitudes of the SCRs. Figure 7 shows a plot of mean SCR amplitude during the questions 19 to 25 against the baseline amplitude. It can be seen that there is a possible positive linear trend for those in the anxious group, but not for those in the confident group. A linear regression was carried out, and the results are shown in Table 5. A Jarque-Bera test does not reject the hypothesis of normality of the residuals. The scatter plot in Figure 7 suggests some possible outliers. In order to check this, a robust regression analysis was carried out, but with no

change in the results. Regression analysis was carried out for the mean amplitude over the questions 10 to 15, with both main effects and possible interactions considered, but there were no significant results at all.

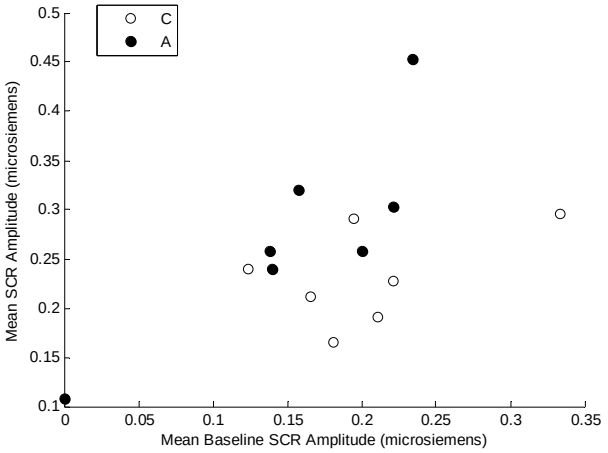

Figure 7 - SCR amplitude during the period of events 19 to 25 by mean baseline SCR amplitude, categorised by group (C = confident, A = anxious).

Variable	Estimate	P
Constant	0.0652	0.2352
Anxious (Group=1)	0.0850	0.0252
Baseline Mean SCR Amplitude	0.8130	0.0047

Table 5 - Analysis of Covariance. Response variable: Mean Amplitude of SCRs during events 19 to 25. R^2 = 0.57, F = 7.3212 , P = 0.0095, d.f. = 11.

Analysis of the skin conductance responses and their amplitudes suggests that the number of discrete SCRs (i.e., arousal events) was influenced by the statements and questions addressed to the participants during the time of the most intimate questions (but not during other questions). However, the intensity of those SCRs differed depending on whether the participants were confident or anxious, their amplitude tending to be higher for the anxious ones.

5.2.3 ECG Analysis The ECG data from only 12 participants could be used, and these were not balanced across the experimental design. The ECG signal from these 12 were analysed in the time domain with respect to their heart rate and heart rate variability. The results strongly suggested that people in the Anxious group were significantly more stressed (higher heart rate increase, lower heart rate variability) than those in the Confident group around the time that the woman first approached them. However, this anxiety diminished over time, and that by the end of the experiment the levels of anxiety were not significantly different. However, with the small sample size this result is not particularly reliable, but if valid, would point the way to the use of this type of environment as a training tool, through which high anxiety individuals could learn to adapt and reduce their anxiety over time.

5.3 Interviews

Immediately after the experiment the participants were interviewed about their responses. This is always useful to shed more light on what has happened than is possible through fixed questionnaires, behavioural or physiological data. We report here a selection of unedited comments that gives some insight into the responses of the participants. The first three responses highlight the strong realism in the responses of the participants:

"The background music, whether dimmed deliberately or not, sounded like the sort of music you would experience at the party, and so added to the realism. Something that has disturbed me about the experience were the physical and emotional changes I felt when speaking to the 'woman'. As she got closer to me and more suggestive in her comments, I found myself responding in a sexual manner, I'm hoping that this doesn't make me a freak!"

"I was amazed most of all when the virtual woman started coming on to me - I felt guilty as I am involved with someone and felt tempted to do something illicit. The idea of cheating on my partner with this virtual woman caused a real physical and emotional response - this was the strongest and most surprising aspect of the experience."

"The initiation of a conversation by the woman and the sheer life-like quality of the conversation at most times made me unaware that I was surrounded by others in a party. This was particularly the case as she moved much closer to talk to me. I am impressed and a little surprised at just how close to real life this virtual reality study is!"

The final quote also shows how, in virtual reality, things can go wrong:

"The feeling of immersion was considerably lessened when the woman I was talking to appeared to lose an arm. I was surprised by how much the experience benefited from being able to see depth in the people moving around. This particularly noticeable when things catch your attention in your peripheral vision."

6. Conclusions

This is a preliminary study in the sense that there is only complete data for the subjective results (questionnaire and interview), and incomplete data for the physiological results. In any case although the results are statistically strong, more participants would be needed to resolve some of the ambiguities. Nevertheless some interesting hypotheses were generated that will form the basis of our next study. First, socially anxious males have levels of reported anxiety (questionnaire based) in response to a virtual woman correlated with their reported levels of anxiety in real life. Contrary to the expectation that shy males would be made more anxious by other (virtual) characters watching them, this did not show up in the results. However, and surprisingly, confident males may show more anxiety on being observed by others. This difference may be for two

reasons: the anxious males are already so anxious that the fact of others watching them makes no difference. On the other hand, confident males may have become more anxious due to not being able to perform as they might have in reality, given the constrained situation in virtual reality. Third, there was a clear arousal effect produced by the intimate statements and questions by the woman, as evidenced by the EDA analysis (and also comments by participants in the interviews). In other words people are responding appropriately in comparison with how they would be expected to behave in a similar real-life situation. Finally, a more tenuous result is that socially anxious males are significantly more anxious than confident males on the initial approach of the woman, but that this anxiety gap decreases as events proceed. One of the major problems for males who are shy in relation to women is that they do not have experience of social interaction with them. Therefore initial heightened anxiety would be expected. However, as time progresses there should be an adaptation effect, as suggested by our ECG analysis. This last result is an excellent pointer for the potential utility of this simulation in training and therapy.

Acknowledgements

We thank Celine Loscos, Marco Gillies and David Swapp. The research is funded through the EPSRC Empathic Avatars project EP/D505542/1. MS's contribution was also through the EU PRESENCCIA Contract Number 27731.

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