Field Observations of Therapists Conducting Virtual Reality Exposure Treatment for the Fear of Flying

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ABSTRACT

Recent research suggests Virtual Reality Exposure Therapy (VRET) for the treatment of fear of flying as an important reliable technique for this phobia. This paper focuses on the role of the therapist during an exposure session. Six therapists were observed in 14 sessions with 11 different patients. Results show that in 93% of the observed sessions, therapists started with a similar flight pattern. Furthermore, a total of 20 errors were observed where therapists initiated inappropriate sound recordings such as pilot or purser announcements. Findings suggest that the system might be improved by providing the therapist with automatic flying scenarios.

Keywords

virtual reality, exposure treatment, task analysis, field observations, user interface.

ACM Classification Keywords

H.5.2. [**Information Interfaces and Presentation (e.g. HCI)**] Multimedia Information Systems – *artificial, augmented and virtual realities – Evaluations/methodology*. User Interfaces – *Ergonomics, Graphical user interfaces (GUI).*

1. INTRODUCTION

In the industrial world flying has become an accepted mode of transportation. People fly to meet business partners, to attend conferences, to have holidays, and to meet friends and family. For some people however, flying comes with an undesirable amount of anxiety. Even so much that they avoid flying altogether or endure it with intense anxiety or distress. The fear of flying is categorised as a situational type of specific phobias in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) [1]. In its diagnostic criteria the manual also states that sufferers recognise that their fear is excessive or unreasonable, and it interferes significantly with their professional or social life. Reports on the fear of flight affecting the general US population vary, with estimations of 13.2% [4] and 3% [17], and only 0.4% in a survey among young woman in Dresden, Germany [3]. This survey also found that on average their responders developed this fear at an age of 15 years old, which lasted around 6 years.

Exposure in vivo, i.e. exposure to the real life situation, is regarded as the golden standard in the treatments of phobia and an extensive amount of research has been conducted in this area [6]. During this treatment, therapist and patient first develop a hierarchy of feared situations, and the goals a patient wants to achieve. The exposure starts with a situation less feared and is gradually increased to more anxiety arousing situations with prolonged periods of exposure until anxiety becomes extinct and habituation takes place. Besides its effectiveness, the treatment also has a number of drawbacks. First of all, therapists are not always in full control of the real situation. Also, arranging the exposure, e.g. flying as a passenger on a plane, can be time demanding, logistically difficult to set up and expensive especially as multiple exposure sessions are needed. Furthermore, the thought of being exposed to the situation they fear and normally avoid is so uncomfortable for some patients that they are unwilling to undergo treatment. Exposure in Virtual Reality (VR) is therefore seen as an alternative that might overcome these drawbacks, especially as recent meta-studies [8; 13; 14] indicate that exposure in VR is as effective as exposure in vivo. VR exposure in the treatment of fear of flying is now seen as an important, reliable technique to be used in the treatment of this phobia [5]. Besides it effectiveness, patients are more willing to be exposed in VR than in vivo. In a survey [7] among patients 76% preferred in VR exposure over in vivo exposure and refusal rate dropped from 27% to 3%.

Instead of focussing on the effectiveness of the treatment, this paper reports on how therapists conduct the Virtual Reality Exposure Therapy (VRET) in the treatment of fear of flying. A field observation is presented, analysing the interaction between therapists and VRET system, but also with the patient during an exposure session in VR. Before the field study is presented, the next section will give a brief introduction into the set up of the VRET system and the task of the therapist and the patient. The paper concludes with a number of design implications that are drawn from the observations.

2. BACKGROUND

The Dutch clinic where the therapists were observed used a VRET system that was developed by Delft University of Technology in collaboration with the department of Clinical Psychology at the University of Amsterdam. Besides the flight simulation, the system also includes worlds for the treatment of acrophobia (fear of heights), and claustrophobia. Figure 1 shows the communication between the patient, the therapist and the VRET system. The functional architecture of the Delft VRET system [18] was based on a task analysis of the therapist and the patient established by interviews and observations in an university setting [15]. As therapist and patient have different task goals, the system also needs to support them differently. The patients' main goal is to get rid of their fear. To achieve this they follow the instructions of the therapist, however, they might occasionally try to avoid the feared situation to get rid of their fear only for the short term. Furthermore, they have to understand the treatment by asking questions about it. For exposure in VR to work, the patients need to have a feeling of being there (in the VR world), i.e. a feeling of presence. The type of display technology and locomotion techniques used in VRET systems can affect this feeling and patients' anxiety level [10; 16]. Still, increase in presence does not automatically also lead to treatment improvement [10]. Presence is not a key factor for therapists' task goal, which is to cure the patient. During the exposure session they monitor the patient's fear level, which is often done by asking patients to rate their anxiety on Subjective Unit of Discomfort (SUD) scale [20]. Based on this information therapists need to control the exposure and answer questions about the treatment patients might have.

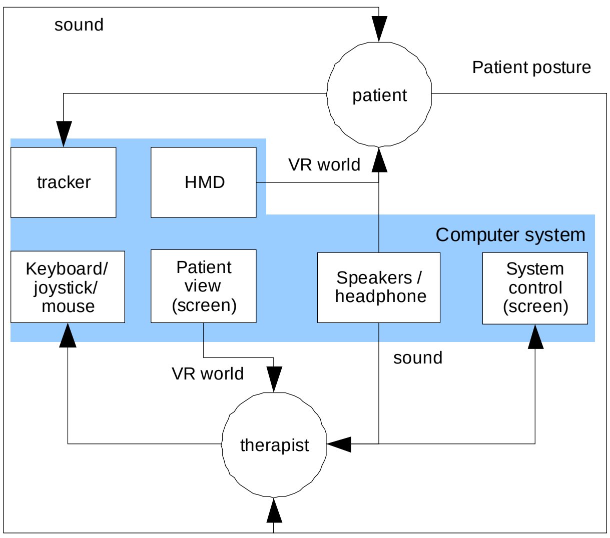

Figure 1: Communication between therapist, patient, and parts of the VRET system, adapted from Schuemie [15].

Therapists interact with the system using keyboard, joystick and mouse. Furthermore, they look at two screens: one displaying what the patient is seeing, the other screen (Figure 3) showing functions to control the system, such as patient information, flight plan, but also sound control and patient VR view. During the session patients wear a Head Mounted Display (HMD) with a six degrees of freedom tracking system. Furthermore, the patient sits in an actual airplane chair, which vibrates during the session to simulate the movement and trembling of the airplane. The vibration will increase especially during take-off, turbulence and landing. The chair is positioned next to a part of the airplane cabin. The therapists are positioned behind a table facing the patient, with in front of them a monitor that shows what the patient is seeing and another monitor that shows the therapist console to control the VR simulation (Figure 2).

Figure 2: Set-up of VRET system in the treatment of fear of flying.

The design of the therapist user interface (Figure 3) was the result of a number of design iterations including usability evaluations [9]. Its main widgets are: Session information control (A) to enter session and patient information; Flight plan control (B) to set destination, time of day etc of the flight; Simulation control (C) to start or stop the simulation; Flight control (D) to set the stage of flight; Map control (E) to select the patient's seat; Patient view (M) to monitor what the patient is seeing in the VR world; Free view (N) to monitor the patient projected in the VR world; Cabin control (F) to set cabin light, seat belt light, and open and close window shutters; Roll control (G) to tilt the airplane; Flight view (L) to see the current stage of the flight; Note/SUD score (K) to enter comments and to record SUD scores; Time (J) to set the timer of the SUD alarm; System status (I) to monitor network connection; and Sound control (H) to play sound recordings such as purser or pilot announcements, or bad weather recordings. The therapists interact with these widgets by using a mouse and a keyboard.

3. METHOD

In 2006 the VRET system was installed at a Dutch clinic. Two years later, however, news arrived that some therapists were uncomfortable using the system as it had malfunctioned on some occasions. The system was repaired, and to build therapists' confidence again a researcher would be present in a number of sessions as technical assistant repairing the system on the spot if needed. It was soon realised that the researcher was in a unique position to make field observations of the interaction between on one side the therapist and on the other side the VRET system and the patient.

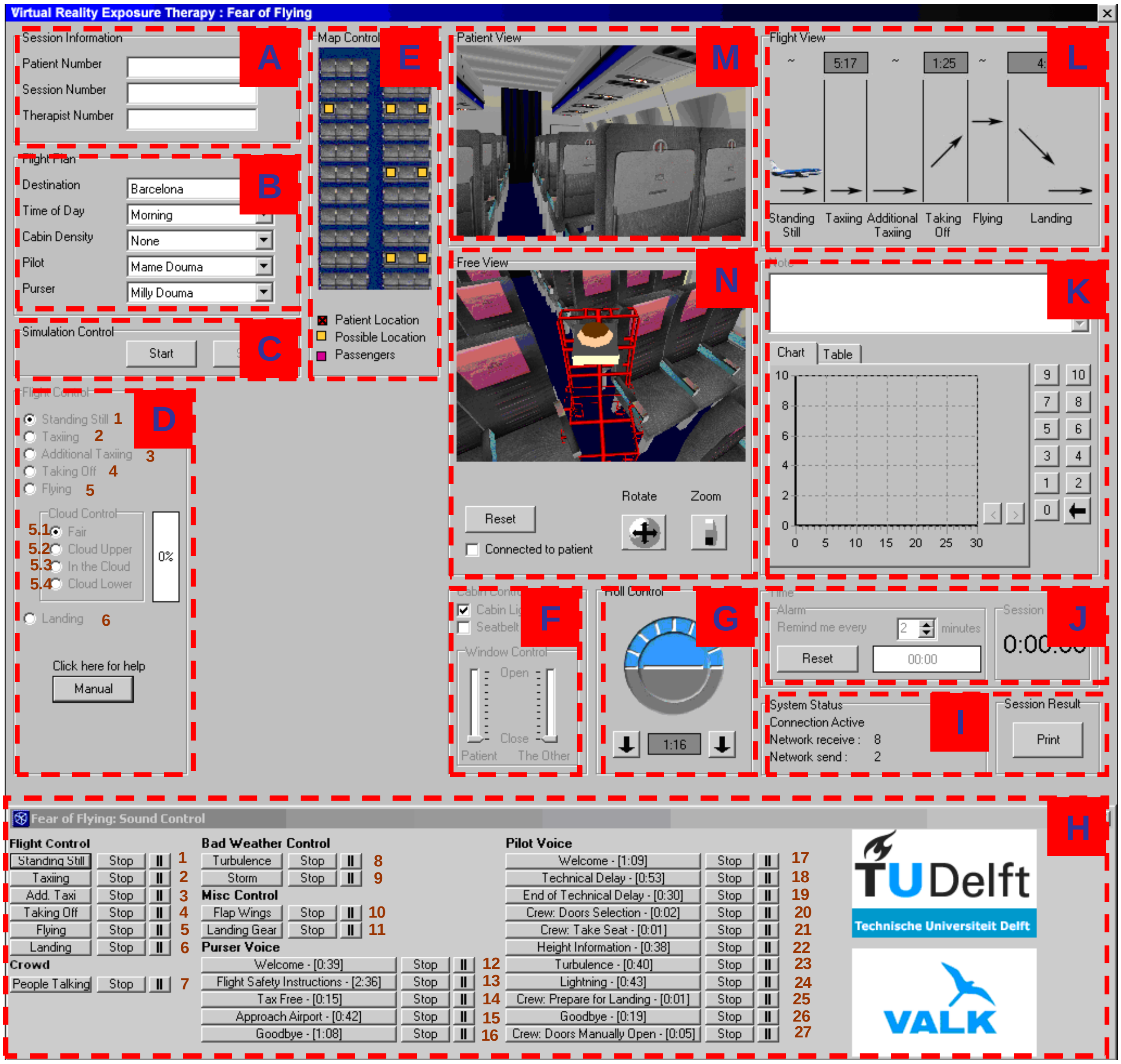

Figure 3: Screen coding scheme of the therapist console.

3.1 Participants

Six therapists working in the clinic participated in the field observations. One of the therapists was also a pilot. The clinic is specialised in the treatment of aviation related anxiety. The clinic not only treats fear of flying in passengers, but it also helps cockpit and cabin crew for all types of mental health problems. Both patients new to a VR exposure and patients with prior VR exposure experience were included in the observations.

3.2 Procedure

During the session the observer sat beside the therapist at the table with the two screens of the therapist console (Figure 2). During the session the observer made recordings of his observations, and when needed asked the therapist for clarifications after the session once the patient had left.

3.3 Material

All recordings were made with pen and paper and to ensure patient's privacy even further, no identifiable references to patient identity were recorded. To facilitate the event sampling, a coding scheme (Figure 3) was created which uniquely identified the interaction elements of the user interface. Each interaction element received a letter, extended with a number in some cases to identify specific buttons. The coding scheme allowed the observer to quickly make a record of any observed interaction in his log. Besides the interaction events, the phase of the flight was recorded, the length of the phase, and the comments made by the patient or the therapist, include requests for a SUD score.

4. RESULTS

Prior to the exposure, patients had an intake interview. Here the therapist also trained patients in a number of relaxation exercises which they could use during the exposure session.

Similar to other reports [15; 19] in which the VRET system was used, at the start of the exposure session, the therapist introduced the patient to the VRET system, explained the use of the HMD and how to adjust the helmet for their head size, eye strength and position of their eyes. After this the VR world was started and calibrated with a joystick. A flight plan was then selected e.g. destination: Paris, time day: morning, Cabin density: moderate, pilot: Mame Douma, and purser: Milly Douma. Patients were often located at a seat next to a window where they could see the airplane wing. The window shutters were opened, after this the flight simulator was started with the plane in the standing still stage of the flight. During the simulation the therapists initiated the different stages of the flight (taxiing, taking off, flying, landing) and played various sound recordings such as announcements from the purser or the pilot, but also sound from the airplane (flapping wings, retracting landing gear), or caused by the weather condition (turbulence or storm). During the session therapists monitored the patients and their anxiety (e.g. tense muscles, crying), thereby with intervals asking for SUD scores. In some sessions patients were also asked to do their relaxation exercises during the exposure.

4.1 Data preparation

In total 23 VR sessions were observed. However, only 14 sessions were included in the analyses as four VR sessions were with acrophobia worlds, two VR sessions involved a VR simulation of an airport and not an airplane, and in three sessions the recording was incomplete. The 14 sessions included 11 different patients and six therapists. On average each session took 25 minutes. Some patients had two sessions immediately after each other. However, they always had at least a small break in between the sessions to avoid simulation sickness.

Figure 4 shows a part of the log recording. At 11:39 two buttons were pressed, H8 (turbulence) and H23 (pilot announcement of turbulence). One minute later at 11:40, the therapist asked a SUD score, which the patient replied with a score of eight. The patient also commented that he/she was very curious, and was looking around because he/she liked to know what was going on. At the same time the therapist moved the plane above the clouds (D5.4). Two minutes later, at 11:42, the therapist changed to a more or less cloud free weather condition (D5.1, flying fair) stage and gave the patient an exercise to relax the muscles and asked the patient to pay attention to his/her breathing. This and all the other written logs were coded and entered into spreadsheets for further analysis.

….	….	…..
11:39	H8, H23	
11:40		SUD: 8, P: very curious, looks a lot around, wants to know what is going on
11:40	D5.4	
11:42	D5.1	T: 'muscles are a bit tense; contract them a bit more and then let go to relax. Notice your breathing'
….	….	…..

Figure 4: Short part of the field-recording log (P: patient, T: Therapist)

4.2 Event sampling results

Table 1 gives an overview of the mean number of events observed per therapist. Notable is the relative high level of interaction with the VRET system. On average therapists made 45 (SD = 8.7) mouse clicks. Looking at the interaction therapists directly had with a patient either by asking a SUD score (M = 7.6, SD = 2.4) or making a comment (M = 1.1, SD = 1.2), this was significantly ($t(5)$ = 13.8, p. < 0.001) lower than their interaction frequency with the VRET system. Although a high interaction frequency with the patient during an exposure might be undesirable as it might affect their feeling of presence, a high interaction frequency with the VRET system seems undesirable as well. This was also confirmed in the discussions with the therapists after the exposure sessions. They indicated that the system was at times demanding too much of their attention, and blame this on the design of the user interface, with its 'extensive number of buttons' as they put it. Asking for a SUD score with an average interval of 3.6 minutes was significantly below the often reported [2; 19] five minutes. However, the use of a two minutes interval [11], or a three minutes interval [15] have also been reported. As Figure 3 shows, the alarm is set to go off every two minutes, and none of the therapists seems to have changed this setting as the mean interaction frequency with the time control (J) was zero (Table 2). When the alarm was triggered the background of the screen flashed a number of seconds. However, the therapists were not aware of this. Most of them thought that this was simply a hardware malfunction of the screen. Furthermore, in a usability evaluation [9] conducted in 2002, participants also mention not to like the SUD reminder.

Table 1: Frequency of events and session time (average session results)

	Therapist						
	A	B	C	D	E	F	Mean
Session(s) observed	1	1	2	3	3	4	
SUD asked	7	5	6	8.3	7	12	7.6
Patient's comments	8	3	2.5	1.3	0.7	3	3.1
Therapist's comments	0	3	0	1	0.7	2	1.1
Perform exercises	0	2	0	1	0.3	1.3	0.8
Repeated phases	1	2	0.5	1.3	3.3	3.3	1.9
Mouse click	42	37	42.5	42.3	42.3	62	44.7
Voice announcements	10	8	10	9.3	9.3	12.5	9.9
Session length (min)	30	24	27.5	21.7	22.3	25.8	25.2
SUD interval (min)	4.3	4.8	4.6	2.6	3.2	2.1	3.6

Most of the interaction with the system involved playing sound recordings (Table 2). Followed by the interaction with the flight control, which is used to set the phase of the flight and allow the plane to fly below, in or above the clouds. Some elements were rarely used or only by a few therapists. For example, only one therapist used the roll control. This therapist was also a pilot, and probably had more experience in using more advanced options of the simulator, or had a more in-depth understanding of the aircraft's behaviour. Furthermore, this therapist, with his 62 mouse clicks, had an interaction frequency far above the average of 45 mouse clicks.

None of the therapists use the print option (I) as also no printer was attached to the system. This seems unfortunately as this function was previous rated as very useful [9]. None of the therapists used the note taking facility. The therapists avoided using a keyboard during the exposure as the typing sound might distract the patient. Furthermore, as the system was stand-alone without a printer, therapist had also no access to the computer notes afterwards in their office. Instead therapists wrote their comments on the patient's paper form. No interaction with the Free View panel was recorded. Although Schuemie's guidelines [15] recommend that therapists should be offered this view, it might be more useful in VR settings were the patient actually moves through a virtual world for example in the treatment of acrophobia where patients walk up to an edge of a roof terrace [15].

Table 2: Frequency of therapist interaction with VRET system

Screen element	Mean	*SD*
A - session info	1.0	0.1
B- flight plan	1.0	0.1
C- simulation control	1.0	0.1
D- flight control	9.2	1.1
E- map control	1.0	0.1
F- cabin control	1.2	0.4
G- roll control	0.3	0.6
H- sound control	22.7	5.6
H- flight control	5.1	0.9
H- crowd	1.1	1.2
H- bad weather	2.0	0.7
H- misc control	4.7	2.6
H- purser voice	4.1	0.7
H- pilot voice	5.8	1.0
I- system status	0.0	0.0
J- time	0.0	0.0
K (SUD)	7.6	2.4
K (notes)	0.0	0.0
N- free view	0.0	0.0
Total	44.7	8.7

4.3 State sampling results

During the observation a record was kept of the stages (phase) of the flight: standing still (S), taxiing (T), additional taxiing (A), taking off (O), flying (F), flying fair (F1), flying below clouds (F2), flying in clouds (F3), flying above clouds (F4), and landing (L). Examining Table 3 quickly shows a consistent starting pattern of standing still, taxiing, taking off, flying, and landing. If no distinction is made between taxiing and additional taxiing and in the different flying phases, 93% of the observations had a similar begin pattern of STOFL (Table 4). For longer patterns less similarity was found, with two observations that were extended with an additional standing still (STOFLS) phase or with a taxiing and taking off phase (STOFLTO). Interesting is that only in two observations the therapist went from a landing phase to a stand still phase. Apparently, the landing was often regarded as the last phase, ignoring the fact the plane has to come to a complete standstill before, for example, the doors could be opened. However, this idea might not have been reinforced by the design of the system as in the flight control panel (D) the landing phase was at the bottom of the list (Figure 3).

Table 3: Sequence of flight phases.

Therapist	Sequence of phases
A	S T A O F1 F2 F3 F4 F1 L
B	S T O F1 F2 F3 F4 F1 F4 L
C	S T A O F1 F4 F3 F2 F1 L
	S T A O F1 F2 F3 F1 L
D	S T O F1 F2 F3 F1 L S
	S T O F1 F2 F3 F4 F1 L
	S T O F1 F2 F3 F1 L
E	S T O F1 F2 F3 F4 L
	S T O F1 F2 F3 F4 F1 L
	S T O F1 F2 F3 O F1 F2 F3 T O F1 F2 F3 L
F	S T A O F1 F2 F3 L T O O
	S T O F1 F2 F3 F4 F1 L T O F1 F2 F3 F4 F1 L
	S T O F1 F2 F3 F4 L
	S T O F1 F2 F3 F4 F1 L S

Table 4: Similarity in flight phase patterns.

Start pattern	Match
STOF	100%
STOFL	93%
STOFLS	14%
STOFLTO	14%

Figure 5 shows a transition diagram of the phases in a flight. Again pattern STOFL can be seen as the dominate path therapists followed in the sessions. The diagram also shows only a small number of variations in the phase transitions, for example, after flying (F) taking off (O) again, or going back to taxiing (T) and to taking off (O) again. This was observed in the last session of therapist E. In the previous session, the patient had shown a high level of anxiety during take offs. By exposing the patient multple times to this stage of the flight the therapist aimed at habituation of the fear situation resulting in a lower level of anxiety.

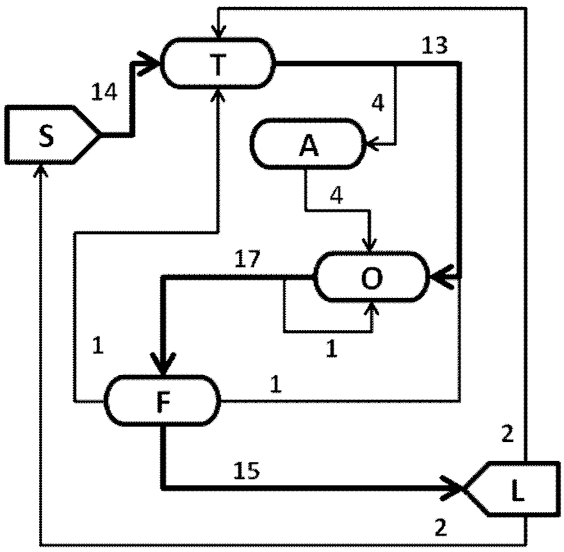

Figure 5: Transition diagram of phases and the frequency of the phase transition observed (S - standing still, T - taxiing, A - additional taxiing, O - taking off, F - flying, and L - landing).

The patterns of various flying phases were also analysed. As Figure 6 shows exposure often included the transitions from flying fair, to flying below the clouds, to flying in the clouds, to flying above the clouds, and finally to going back to flying fair. This was often followed by a landing phase.

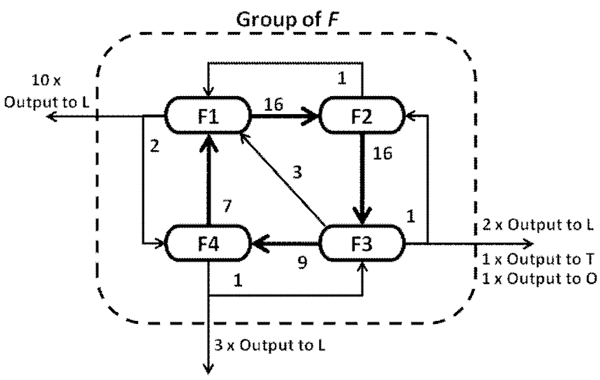

Figure 6: Transition diagram of flying phases and the frequency of the phase transition observed (F1 - flying fair, F2 - flying below clouds, F3 - flying in clouds, and F4 - flying above clouds).

Examining the therapists' interaction with the VRET system per phase (Table 5), the flying phase had the highest level of interaction (M = 15.7) and made up the largest part of the exposure with an average of 9.2 minutes. Still, looking at the average interaction frequency per minute across the phases, this was below two per minute (M = 1.7, SD = 0.4).

Table 5: Frequency of interaction events with VRET system, phase time, and interaction per minute averaged over sessions.

Phase	Freq. Interaction	Time (min)	Interaction per min
Standing still	4.5	2.2	2.0
Taxiing	7.1	4.1	1.7
Add. Taxiing	0.8	0.8	1.0
Taking Off	5.6	2.7	2.1
Flying	15.7	9.2	1.7
Flying fair	6.8	3.4	2.0
Flying below clouds	2.5	1.3	1.9
Flying in clouds	5.2	3.2	1.6
Flying above clouds	1.2	1.3	0.9
Landing	10.1	5.3	1.9

4.4 Errors

In one of the updates of the system, a sound control panel had been added to the therapist user interface as a patch to extend the simulation with more sound recordings (e.g. flight safety instructions, and people talking at the background). To reduce redundancy the sound panel in the original user interface was hidden with a grey panel (Figure 3, right side of element D). However, the original user interface was designed with error prevention in mind. The system only allowed therapists to select sound recording that were appropriate for the current stage of the flight. With the new sound panel therapists could play sound recordings at any moment. Table 6 shows that during the 14 sessions, therapist played 20 inappropriate sound recordings. For example, on six occasions, they played the pilot announcement asking the crew to open the doors while the plane has not come to a complete standstill yet, or on two another occasions the pilot welcome announcement was played while the plane was taxiing. In reality, however, pilots are often occupied during taxiing for example communicating with the tower, and therefore will make such announcements before taxiing. Furthermore, in his welcome announcement the pilot also mentioned that the luggage was being loaded on board. This example clearly illustrates that there might be several reasons why therapist make these errors. First, they might not be aware of the content of the announcement. Second, they might not have an accurate mental model of a flight. Third, they might have an accurate mental model, however, they might have thought the flight to be in another phase, in other words a mode error [12]. Fourth, therapists might have problems with fitting a sound recording into the timeslot of the phase thereby overshooting the phase or by anticipating on this, playing the sound recording too early. Interesting in this context are the observations of the therapist who was also a pilot. Four errors were also observed in his sessions, for example giving height information (H22) while taking off. This makes it less likely that an inaccurate mental model of a flight can simply explain all errors. Still in all of this, it is important to consider that there were no indications that any of these errors had a negative effect on the treatment.

Table 6: Errors made by playing sound recordings.

Phase	Voice Announcement / Aircraft sound	Freq
Standing still	▪ Purser- Flight safety instruction (H13) too early; is normally issued during taxiing.	1
Taxiing	▪ Pilot- Welcome (H17) too late; pilot too busy during taxiing to make announcements, also the pilot mentioned in his welcome that the luggage is being loaded.	2
Taking off	▪ Purser- Welcome (H12) too late; during take off purser is sitting down and will not make announcements.	1
	▪ Pilot- Crew: door selection (H20) too late as doors should have been closed before take off	1
	▪ Pilot- Crew: take seat (H21) too late as the crew should already been sitting	2
	▪ Pilot- height information (H22) too early; plane is still climbing	1
Flying	▪ Landing gear sound (H11) too early/late; should be retracted while climbing after take off, or extended just before landing	1
	▪ Pilot- Crew: take seat (H21) too early; should be issued just before starting the landing	2
	▪ Pilot- Crew: prepare for landing (H25) too early; should be issued just before the landing	1
	▪ Landing gear sound (H11) too early; should only be extended just before landing	1
Landing	▪ Purser – tax free (H14) too late; should be announced while flying	1
	▪ Pilot- Crew: door manually open (H27) too early; should be announced after complete stand still	6
	total	20

5. DISCUSSION AND FINAL REMARKS

Two main conclusions can be drawn from these observations. First, therapists perform dual tasks, interacting with the patient and with the VRET system. Reducing their task load might be possible by reducing the need for frequent interaction with the VRET system, as this is currently relatively high compared to the interaction frequency with the patient. Secondly, the current set up allows therapists to make unnecessary errors. For the exposure, therapists now need knowledge about the treatment and the patient, but also about flying and about running the VR simulation. Especially the need for the last two should be minimized allowing the therapists to focus on their main task and that is to cure the patient.

The observations also have a number of design implications. (1) Because of the consistency in the sessions it might be possible to develop a treatment oriented instead of the simulation oriented user interface for the therapist, taking the sequence of flight phases as a starting point. For example, in each phase, inappropriate simulation elements could be hidden to avoid errors. (2) To reduce system interaction frequency, to extent the variation in the flights, and to improve the realism of the experience, it might also be possible to provide therapists with several automated flight simulations scenarios (for example good or bad weather flight, short or long taxiing). In these scenarios the simulation runs automatically, applying the appropriate flying routines, but still allows therapists to control when to move to the next phase, or change to another scenario altogether if required because of the patient's response. Furthermore, the system should also support therapists if they like to deviate from the standard flight sequence. For example, expose patients to multiple take offs if needed.

Based on the reported field observations, the therapist user interface is now being redesigned. Besides the automatic flight scenarios the redesigned user interface now also includes better support for notes taking, whereby therapist can select predefined comment flags that are placed on a single timeline overview of the flight. The automation might reduce part of therapist's task load. Therefore, preliminary work has also started whether a therapist can simultaneously give multiple patients an exposure in VR. Still, with all these new research directions it will be important to keep in mind the lessons learned from these field observations about the dual task therapists are performing and that the system should be designed to avoid errors.

6. ACKNOWLEDGMENTS

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