PRESENCE AS THE DEFINING FACTOR IN A VR APPLICATION

Virtual Reality Graded Exposure in the Treatment of Acrophobia

Larry F. Hodges[α], **Barbara O. Rothbaum**[β], **Rob Kooper**[α], **Dan Opdyke**[γ], **Thomas Meyer**[α], **Johannes J. de Graaff**[δ], **James S. Williford**[ε], **Max M. North**[ϕ]

[α] Graphics, Visualization & Usability Center
Georgia Institute of Technology

[β] Department of Psychiatry & Behavioral Sciences
Emory University School of Medicine

[γ] Department of Psychology
Georgia State University

[δ] Delft University of Technology,
Delft, the Netherlands.

[ε] Division Psychiatrist
101st Airborn Division (Air Assault)
Fort Campbell, Kentucky

[ϕ] Human-Computer Interaction Group
Clark Atlanta University

ABSTRACT

The sense of presence that a user experiences in a virtual environment is perhaps the best-known attribute of virtual reality. It is an appeal to this sense of presence that is used to distinguish virtual reality as something different from merely a multimedia system or an interactive computer graphics display. Our basic understanding of presence, however, is still primarily anecdotal in nature. We have yet to rigorously explore basic questions about the nature of presence.

We describe an application of virtual reality, virtual reality graded exposure (VRGE), in which a sense of presence is the salient factor determining the success of the application. Subjective and objective data from a clinical study on the usefulness of VRGE for treating persons with acrophobia is analyzed as experimental evidence for formulating several assertions about the characteristics and nature of presence. We then discuss the implications of our assertions on several open questions concerning the definition, quantification, and usefulness of presence.

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Virtual Reality Graded Exposure in the Treatment of Acrophobia

In this paper we discuss our experiences in using virtual reality graded exposure therapy for persons with acrophobia--the fear of heights. One of the goals of this project was to test if a particular form of therapy, *in vivo* graded exposure (a process of exposure and adjustment to height situations), could be adapted to use virtual height situations in place of physical ones. With respect to research in the creation and understanding of virtual environments, however, we also undertook this experiment as a way to identify and explore issues related to the concept usually referred to as a *sense of presence*.

There have been a number of recent articles published on the experience of *presence* in a virtual or remote environment. Sheridan (1992) proposed three measurable physical variables that determine presence: extent of sensory information, control of relation of sensors to environment, and ability to modify physical environment. Both Naiman (1992) and Loomis (1992) have argued that the normal human experience is not of the physical world but of our perceptions of the physical world, i.e, reality is what we perceive it to be. In his taxonomy of graphics simulation systems, Zeltzer (1992), identifies presence with the number and fidelity of available sensory input and output channels. Heeter (1992) discusses three dimensions: personal, social and environmental, of the subjective experience of presence. Fontaine (1992), based on analysis of international and inter cultural encounters, identifies a sense of presence with a state of consciousness in which one experiences "realness, vividness, and feeling very much alive", "attending the immediate situation", "a perception of thinking and acting in new and innovative ways", and "a broad awareness of everything around." Held and Durlach (1992) discuss the need to define sensorimotor and cognitive factors that determine a sense of presence. Mowafy, Russo, and Miller (1993) are investigating the role of presence in training tasks involving construction of mental models of spatial relationships. Pausch, Shackelford and Proffitt (1993) have demonstrated a generic search task in which users perform better in an immersive environment than a stationary display window.

In most of these papers, the authors make substantial use of speculation, intuition, anecdotes from individual experience, and extrapolation from results in other areas to explore the notion of presence. As pointed out by several authors (Held and Durlach, 1992; Sheridan, 1992; Kalawsky, 1993), we have not yet developed a scientific body of knowledge or theory delineating the factors underlying the phenomenon of presence. There is, however, an emerging general consensus within the virtual environments and teleoperations community on several issues that are important to the development of scientific use of the concept of presence. Based on the literature and our own experiences we suggest the following as five open questions concerning presence.

(1) Is there a definition of presence that is sufficiently operational and quantitative to be useful?

(2) What are the factors that create a sense of presence?

(3) Are there subjective and objective measures that can quantify presence?

(4) What does presence do for us? Are there applications for which a sense of presence actually improves operator performance?

(5) Are there applications for which presence is a necessary ingredient? If so, how are these applications different from applications for which a more traditional display system is just as effective?

We report here on the implications of our pilot study of the use of virtual reality graded exposure to the answers of these questions. First we provide background on the study and on the issues that arose as we created virtual environments for use in therapy sessions. Then, based on our observations of subjects' behavior and on the data collected, we will make several assertions concerning the sense of presence. Finally, we will relate those assertions to our list of open questions.

Background: The Acrophobia Project

Acrophobia and Graded Exposure

Acrophobia, the fear of heights, is classified as a simple phobia in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1987). A phobia is an irrational fear resulting in a conscious avoidance of the specific feared object, activity, or situation. Somewhere between 5 to 12 percent of the population are affected by simple phobias. The most common feared objects and situations in simple phobias, listed from most common to less common, are animals, storms, heights, illness, injury, and death (Kaplan and Sadock, 1991).

Behavioral therapy of acrophobia has included exposing the subject to anxiety producing stimuli. These stimuli are generated through a variety of modalities including imaginal (subject generates stimulus via imagination) and *in vivo* (subject is exposed to natural height situations). Systematic desensitization, a form of imaginal exposure in which relaxation is combined with exposure, has long been found to be effective with simple phobics (Marks & Gelder, 1965). Graded exposure is similar to systematic desensitization except that relaxation training is not involved and treatment is carried out in a real-life context (Kaplan and Sadock, 1991). *In vivo* graded exposure is a common and effective treatment for acrophobia and has been shown to be superior to systematic desensitization. (Crowe, et al., 1972).

Based on an initial subjective evaluation of what types of height situations cause anxiety in a patient, a therapist using an *in vivo* graded exposure approach would arrange therapy sessions in which the patient goes through a process of exposure and adjustment to those situations. Patients begin with less threatening situations first and gradually work their way up a hierarchy of more anxiety producing situations. For example, if the patient is afraid to look out the window of a high building, sessions might begin by looking through a third floor window with the therapist present. In subsequent sessions the patient might move up to a window on the tenth floor. Other common locations for *in vivo* therapy could be outside stairways, balconies, bridges, and elevators.

Creating Virtual Height Situations

Based on the types of height situations used for *in vivo* stimulus, we designed a number of virtual height situations. Ideally we would have liked to create virtual environments containing objects that were realistically rendered, stereoscopic, and which reacted in real-time to head motion of the user. The reality is that we could not do all of these things and had to prioritize based on available hardware and computing power.

Available graphics workstations for this project were a number of Silicon Graphics machines including a reality engine, an Indigo Elan, several regular Indigos, and several GTX class machines. We defined real-time response as at least ten frames per second. With the ten/frame/second rule as our bottom line we then experimented with the amount of detail we could put into the image. It soon became apparent that we would have to choose between stereoscopic images with a relatively low degree of detail and monoscopic images with more realistic details provided by texture mapping. Our SGI Reality Engine provided real-time texture mapping but did not support stereo for head-mounted displays. We could provide stereo by running two machines in parallel but none of our other machines were as fast as the Reality Engine nor did they support hardware texture mapping. Additional considerations were the horizontal resolution of our head-mounted display and the nature of the environments we wished to generate. The nature of the scenes that we generated was such that most of the important details that implied that the user was in a height situation were located at least several meters away. The relative depth levels defined by discrete pixel widths in horizontal parallax for our HMD (a Virtual Research Flight Helmet with through the optics pixel width of 0.5 cm.) only allowed five displayable depth locations between three meters and infinity. Based on these considerations we decided to render textured monoscopic images for the acrophobia treatment sessions.

Environments Used for Therapy

Three environments were created for use in the therapy sessions: an elevator, a series of balconies, and a series of bridges. The three environments are shown in figures 1-4. Modeling was done using Wavefront software (Wavefront, 1989). The Simple Virtual Environment (SVE) software library (Verlinden, et al., 1993) was used to create virtual environments from the models.

The elevator is modeled as an open elevator (no walls or ceiling) located on the inside of a 49 story hotel (figure 1). A guard rail was located about waist high to the occupant. To provide a greater sense of actually being in the elevator we built a wooden platform with guard rail that the subjects stood in to ride the virtual elevator (figure 5). The rail and elevator platform in the real world corresponded in size and position to the rail and platform the occupant saw in the virtual world. Located on the rail were icons to indicate that the occupant wanted to go up, down or stop. We also provided the rider with a tracker for their right hand. A virtual right hand followed the movements of the users' right hand so that it could be used to operate the controls of the elevator. The occupant had tactile feedback in that everything that appeared within reach from the elevator (the rail and floor) could actually be felt or grasped.

The second model consists of outside balconies attached to a tall building (figure 2). Four balconies were created at different heights: ground level, second floor (six meters), tenth floor (thirty meters), and twentieth floor (sixty meters). As with the elevator we used a wooden platform with guard rails that corresponded in position to the virtual rails on the balcony.

The third model is a canyon with bridges of different heights spanning the canyon from one side to the other. A river ran through the bottom of the canyon. The bridges varied not only in height but also in apparent steadiness. The lowest two bridges (seven and fifty meters) appeared safe and solid (figure 3). The highest bridge (eighty meters, dubbed the Indiana Jones Bridge by one of the subjects), was a rope bridge with widely spaced wooden slats as the flooring (figure 4).

Subjects and Assessment

Subjects for our study were recruited through questionnaires distributed to students taking introductory psychology and computer science classes at Georgia Tech, Emory University, and Georgia State University. The questionnaires screened students for a circumscribed fear of heights consistent with the diagnosis of simple phobia (America Psychiatric Association, 1987). Subjects were randomly assigned to either a treatment group or a waiting list control group. Waiting list subjects were assessed at pre-treatment and then again after seven weeks. Treatment group subjects were assessed at pre-treatment, received seven weeks of therapy, and then were assessed again after treatment. Twenty subjects participated in the study, ten in the treatment group and ten in the waiting list group.

Data relevant to the subjects' sense of presence were collected in several different ways. During therapy sessions, subjects were asked every five minutes to evaluate their current anxiety on a 0 to 100 subjective units of discomfort (SUDS) scale. Records were kept on the relation of the subjects' SUDS level to the virtual height situation they were experiencing. We also video taped every therapy session. The videos were used to collect data on subjects' actions in virtual height situations and subjects' verbal comments describing what they were experiencing. Pre and post testing was done using questionnaires designed to measure anxiety, avoidance and fear of heights. The Acrophobia Questionnaire (Cohen, 1977) described twenty height situations with rating scales for anxiety (0-6) and avoidance (0-3). Adequate consistency and test-retest reliability have been previously demonstrated for this test, and it has been shown to discriminate between phobic and nonphobic subjects (Cohen, 1977). It has also been responsive to treatment and group effects in several studies (Cohen, 1977; Menzies & Clark, 1993; Pendelton & Higgins, 1983). The Fear Questionnaire was constructed for use in this study and consisted of relevant items adapted from other scales (Marks & Mathews, 1979; Abelson & Curtis, 1989).

Assertions Concerning Presence

Based on the data collected we make the following assertions concerning the sense of presence.

• *A person's experience of a situation in a virtual environment may evoke the same reactions and emotions as the experience of a similar real-world situation. This may be true even when the virtual environment does not accurately or completely represent the real-world situation.*

In a sense the most important result of this project was the one whose existence we assumed to be true when we were first developing the idea. People who are acrophobic in the real world are also acrophobic in a virtual world. When subjected to virtual height situations, our subjects exhibited the same types of responses as would be exhibited in a real-world situation. These responses included anxiety, avoidance, and physical symptoms.

As a measure of anxiety subjects were repeatedly asked to rate their current level of anxiety on a SUDS scale of 0 to 100, where 0 represented "completely calm and comfortable with the situation" and 100 represented "complete panic". Subjects ratings of anxiety were consistent with the "scariness" of the virtual height situation. Subjects rated their anxiety with a low number when at ground level, their anxiety increased with apparent height, and then decreased as they stayed in the situation. For example, one subject rated his anxiety at 40 when he first moved up to our middle level bridge. After staying on the bridge for five minutes, his anxiety level had dropped to a 20. At this point we moved him to the highest bridge. After only a few seconds on the highest bridge, his anxiety rating rose to 70. Twenty minutes later, at the end of the session, his anxiety rating on the highest bridge was down to fifteen.

A second measure of anxiety was actual subject behavior and verbal reports. Examples of common subject behavior in our study included subjects tightly gripping the guard rails that surrounded them, and reluctance to let go of the rails or dangle their foot over an edge when suggested by the therapist. Verbal expressions recorded included "the higher I get, the more worried I get,", "I was terrified," or "I've got to get off of this bridge." In addition to magnitude of height, subject anxiety was also affected by the apparent safety or steadiness as portrayed by the visual representation of the space they occupied. Bridges with gaps between the flooring were much more anxiety producing than bridges that looked as if they had solid floors.

Typical avoidance behavior was to stare straight ahead and avoid looking down. Physical symptoms reported by subjects included shakiness in the knees or ankles, heart palpitations, feeling "off balance", tenseness, tightness in the chest or throat, sweaty palms, and faintness.

Remarkably, subject reactions consistent with relative height were experienced in spite of the fact that their virtual experience misrepresented a corresponding real-world experience in several ways. For example, subjects were "teleported" from bridge to bridge, or balcony to balcony instantly, with no intervening experience of walking or riding to the next level. Also, no matter what the visual representation of the flooring and guard rail of the virtual space, subjects were always standing physically in the same enclosure on a solid, carpeted platform four inches off the floor. All environments were visually simpler than a real scene, contained only simple haptic cues (i.e., subject could grasp the rail around them) and did not include auditory cues.

• *Each person brings their own Gestalt into a virtual reality experience.*

Gestalt, a German word often translated as form or configuration, refers to an understanding of behavior in which emphasis is put on the whole person or the whole situation in which they adjust (Munn, et al., 1972). We use the term here to indicate that a person's reaction to a particular virtual environment depends on the whole of who they are and on their previous experiences. We have observed two distinct effects which we refer to as individual Gestalt and communal Gestalt. The implication for VEs is that the sense of presence is dependent not only on the analytic qualities (resolution, realism, interactivity, lag time) of the experience provided by the VE, but also on what the participant psychologically brings to the environment.

First, consider individual Gestalt. Just as two different individuals may react differently to a real-world experience, they may also have extremely different reactions to the same virtual world experience. This point was repeatedly demonstrated by the variety of reactions among subjects to the height situations that we created. First, there was variation over subjects. Two of the subjects went through all phases of all three height situations in their first session with almost no anxiety. One subject, however, was so anxious over any virtual height situation that she experienced extreme anxiety on the lowest bridge. Most of the subjects fell somewhere in-between, able to work their way through 1-2 levels of one situation in their first session and going through all levels of the three height situations by their last session. There was also individual subject variation over time for each situation. As a person spent time at a particular level of a particular situation, they usually began to get used to the situation and their anxiety level decreased.

Communal Gestalt refers to the cultural and physical experiences that we all have in common and expect to encounter in our environment. In one of our early prototypes of our virtual elevator, before we added a real rail around the subjects, it was possible for a passenger in the elevator to walk through the virtual guard rail and out into space. Since our virtual environment had no gravity, the passenger could walk safely through the air without falling. Almost without exception, no one tried to step off the "floor" of the elevator into empty space. This was true not only of guests to our lab, but also of the programmers who designed the environment and who knew that empty space was no less solid than the floor of the elevator.

Our balcony scenes included a street with a yellow line running down the middle of the street (figure 2). At the lower balcony levels the street looked like an empty street with a line down the middle. From the highest balcony, however, the size of the line and the coarse resolution of the head-mounted display screen combined to create a very noticeable temporal aliasing effect so that the line crawled considerably with head motion. Several of the subjects noticed the aliasing and commented on the "cars" moving along the street. Presence consists not only of what we put into a virtual experience, but also of what the user expects to happen.

The best known model for understanding and explaining the concepts of virtual environments is the three-axis characterization (autonomy, interaction, and presence) of virtual environment systems proposed by Zeltzer (1992). Presence is identified primarily with fidelity of sensory input and output channels. Our experience is that the Gestalt of the user is as important as sensor fidelity in creating a sense of presence.

• *A primary difference between the experience of an event in a virtual environment and the experience of the same event in a real environment is in the intensity or vigor of the experience.*

This assertion is based on the fact that although our subjects' reactions in virtual height situations corresponded closely with the reactions that we would expect to get in real height situations, we can not say that they were as intense. For example, the highest bridge (see figure 4) was a rope bridge, with widely spaced wooden slats as flooring, suspended eighty meters high over water. Most of our subjects were eventually able to get on this bridge and stay there until their anxiety levels decreased. We suspect that they would be much more anxious had we asked them to cross a real rope bridge of this height. Several subjects also verbally stated during a group discussion that was part of the post testing session that the virtual height situations gave them the same type of feelings as physical height situations but that the feelings were not as intense.

We draw an analogy here from the world of computer games. Many games provide a player with a series of difficulty levels. Each level represents the same game played at a higher level of skill. In this light a VE might be considered to be the easy level of experience, as compared with the same experience in a physical environment. They both provide the same types of responses, but they present at different levels of intensity for the participant.

• Familiarity with a virtual environment does not necessarily increase the participant's sense of presence.

The idea that a sense of presence may increase with experience has been suggested by several researchers (Naiman, 1992; Held and Durlach, 1992; Loomis, 1992). In this application we could not document this notion to be true except in the trivial sense that it took each subject a few minutes to adjust to the resolution and experience of wearing the head-mounted display. Each of our subjects was given an initial training period where they looked around a (ground level) virtual environment and performed a simple manipulation task of turning a light on and off. After a few minutes (typically 5 to 10), they began to recognize objects in the environment, could manipulate their virtual hand, find the lightswitch, and were generally acclimated.

In discussing what might happen during the course of the study we anticipated four possible scenarios: (1) subjects would not feel present in a height situation at all, (2) subjects would initially react as if they were present in a height situation but would gradually begin to feel less present, (3) subjects would initially feel some level of presence in a height situation and that sense of presence would increase over time, (4) subjects would feel some sense of presence throughout the study with little change based on experience.

Based on subject reactions and on their comments at the end of the study, scenarios (2) and (4) seemed to come closest to describing what was actually happening. Subjects' reactions during their first therapy session as to the "realness" of their virtual height experience were, in general, consistent with their behavior throughout the study. Just as would happen in a real situation, subjects became more familiar with each virtual environment as they spent more time within it. For example, subjects became more adept at pushing the elevator buttons as they spent more time operating the elevator. A few of our subjects stated that any particular virtual height situation actually felt less real to them as they gained more experience in it and that moving to a different height situation with which they were not familiar increased their sense of presence compared to a well-known situation.

•A person's perceptions of real-world situations and behavior in the real-world may be modified based on his experiences within a virtual world.

Most applications of virtual reality (games excluded) have had the primary goal of increasing or modifying a person's *intellectual understanding* of the structure or nature of an object. Examples include use of VR for architectural walkthoughs (Brooks, 1986), molecular modeling (Bergman, et al., 1993), and medical visualization (Bajura, et al., 1992). Each of these applications may be viewed as applying a new tool (VR) in an old way (increasing intellectual understanding). A virtual environment, however, can also provide users with experiences that affect the way they think about and react to the real world.

We base this conclusion both on results from the subject test results and on subject reports of their behavior in real height situations. The results of the pre and post-treatment assessments on the Acrophobia and Fear Questionnaires indicated that there was a statistically significant decrease in anxiety and avoidance of heights for the treatment group but not for the Wait-List group in our study. A complete analysis and report on this data is available in Rothbaum, et al. (1994).

We did not test subjects with actual exposure to physical height situations but some of our subjects indicated self-exposure to heights. For example, one subject reported that, at the beginning of her VRGE therapy, she would drive around on the ground level of the parking deck until a parking space was vacated to avoid parking on a higher level. If she could not find a parking place after several trips around the first level and was forced to park on a higher level, she would always choose an inner parking place well away from the edge of the deck. At the end of seven weeks of therapy she reported that, not only had she purposely parked on the fourth level of the deck, but that she had also walked over to the edge of the deck and looked over the rail. Another subject reported going to a downtown hotel with an outside elevator with glass walls and riding it up to the seventy-second floor. He reported being anxious but much less so than he used to be because of his exposure to virtual heights.

Discussion of Open Questions

We now return to our list of open questions concerning *presence.* Our purpose is not to completely resolve these questions but to contribute to their answers.

There are a number of definitions of presence that have been offered in the literature. The definition that we propose is a variation of the definition offered by Sheridan (1992).

Presence is the sense of being physically present in a computer generated or remote environment.

Our basic assertion in this definition is an agreement with Loomis (1993) that "the phenomenology of synthetic experience is continuous with that of ordinary experience." To understand what factors contribute to a sense of presence in a virtual environment we must first understand what it is that creates a sense of physical presence. In the spirit of previous models by Zeltzer (1992) and Sheridan (1992) we present our own three-axis taxonomy of a *sense of presence.* A participant's sense of presence (virtual, tele, or physical) in an environment may be represented by three primary determinates:

1. *Fidelity and extent of sensory information.* This axis corresponds closely to the "sensory information" axis proposed by Sheridan (1992) or the "presence" axis proposed by Zeltzer (1992) and can be measured with respect to the quality and quantity of information that is available to a person experiencing an environment.

2. *Consequences of participant's actions.* This axis corresponds to the interaction between a participant and the environment. On a basic level it would include the ability of a participant to modify his point of view through head movement, or to interact with objects (or other participants) in the environment. On a higher level it would also include physical laws. If the user steps off of a platform, gravity pulls the user down. If the user collides with a solid surface, the user experiences pain. We conjecture that the shortage of consequences is an important difference between the experience of a real environment and a virtual environment.

3. *Gestalt of the participant.* This axis represents what the participant brings to the environment in the sense that a person's reaction to their environment depends on the whole of who they are and on their previous experiences.

Figure 6 illustrates these three determinants of presence as orthogonal axes of a Sensory, Consequences and Gestalt (SCG) cube. Our understanding of presence differs from previous models in several respects. Previous taxonomies have ignored the notion of Gestalt as a primary determinate of the nature and intensity of a user's sense of presence for a given situation or task. Our work with acrophobic subjects has clearly illustrated that what the user psychologically brings to the environment is important to their experience of the environment and can not be ignored.

We also propose that it is not reasonable to identify any one point of the model as representative of virtual reality or presence. As has been convincingly argued by Fontaine (1992), we are often much less than 100% present psychologically even in a physical environment. The sense of presence is a continuum that may vary in its intensity and quality. We postulate that a sense of presence may be associated with every point inside the cube. The intensity or vigor of the sense of presence would, in general, increase as we move along each axis.

Finally we do not differentiate between virtual (or tele) presence and physical presence. The SCG presence cube is equally valid for describing the characteristics of either real or virtual experience. Just as virtual environment systems differ in their ability to provide sensory information, individuals differ in their ability to process sensory input. Gestalt or what the individual brings to the situation is consistent between environments as was shown by the reactions of our subjects. They were not only acrophobic in physical situations but also in virtual ones. The greatest variation between physical and virtual environments possibly comes in the experience of consequences. In the physical world consequences are predictable and generally known. Because of limitations in current technology, consequences in virtual environments are both selective and limited.

A further contribution of our work with acrophobic subjects has been the accumulation of a list of assertions for what presence does for us that are based on experimental evidence and that can be experimentally validated by other researchers.

With respect to applications, we have illustrated the existence of an application, virtual reality graded exposure, for which a sense of presence is clearly a necessary ingredient. Our subjects in this study reacted to virtual height situations in the same way as they would to similar physical situations. Subjects who were shown the same scenes on a crt did not react as if they were in the situation. In addition to our work with acrophobia subjects, which we hope to extend to other types of phobias, there has been preliminary work in Japan using virtual environments for treatment of autistic patients (Kijima and Hirose, 1993). We postulate that there exists a large category of applications in clinical psychology, for which virtual environments that convey a sense of presence may be substituted for physical environments.

Summary

We have applied virtual reality to the treatment of acrophobia--the fear of heights in a methodologically controlled study. Our study represents the first published report of an application of virtual reality in which the user's sense of presence in a virtual environment is the defining factor in the success of the application.

We discuss issues concerning a user's sense of presence in a virtual environment that were examined during the study. Based on evidence taken from pre- and post-testing of subjects using the Acrophobia Questionnaire and Fear Questionnaire, on SUDS (subjective units of discomfort scale) ratings taken during subject therapy sessions, and on video taped patient behavior and verbal reports, we have supported the following five assertions concerning the experience of a sense of presence.

(1) A person's experience of a situation in a virtual environment may evoke the same reactions and emotions as the experience of a similar real-world situation. This may be true even when the virtual environment does not accurately or completely represent the real-world situation.

(2) Each person brings their own Gestalt into a virtual reality experience.

(3) A primary difference between the experience of an event in a virtual environment and the experience of the same event in a real environment is in the intensity or vigor of the experience.

(4) Familiarity with a virtual environment does not necessarily increase the participant's sense of presence.

(5) A person's perceptions of real-world situations and behavior in the real-world may be modified based on his experiences within a virtual world.

We have also proposed an understanding of the sense of presence based on three primary determinates: fidelity and extent of sensory information, consequences of a participant's actions, and the Gestalt of the participant. This approach to understanding presence differs from earlier taxonomies in that we include the user's Gestalt (what the user psychologically brings to the environment) as an important determinant of a sense of presence and we do not distinguish between virtual (or tele) presence and physical presence.

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FIGURE CAPTIONS

Figure 1. View from the elevator.

Figure 2. View from a third floor balcony.

Figure 3. Bridges suspended 7 and 50 meters above a river flowing through a canyon.

Figure 4. Rope bridge suspended 80 meters above a river flowing through a canyon.

Figure 5. Participant riding in the virtual elevator.

Figure 6. The SCG Presence Cube. The gray arrow represents the approximate location of the acrophobia project within the cube.

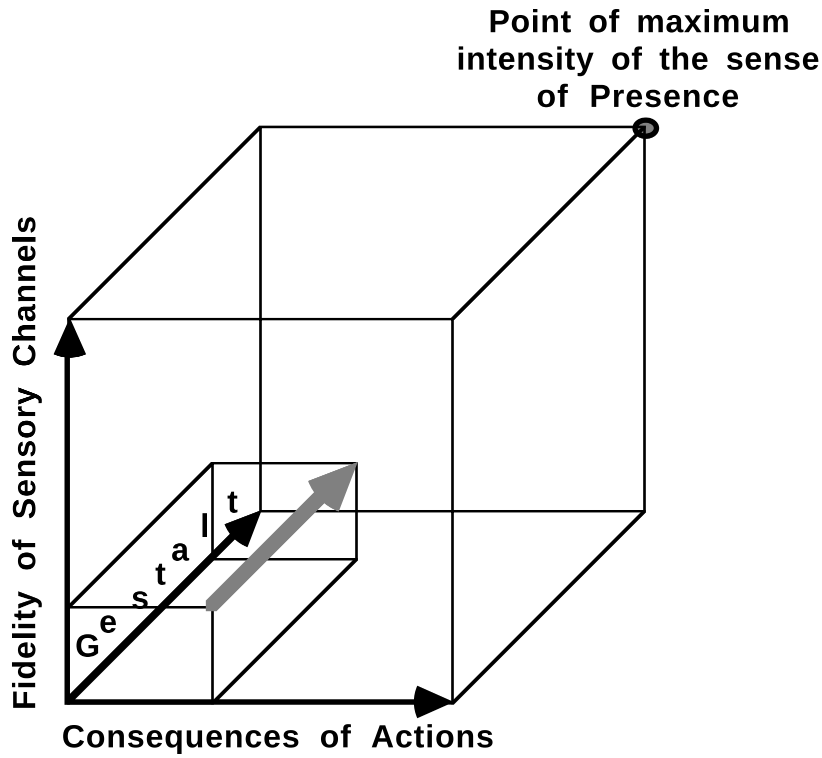

Figure 6. The SCG Presence Cube. The gray arrow represents the approximate location of the acrophobia project within the cube.