

Being There: The Subjective Experience of Presence

I Introduction

What do you feel when you enter a virtual world? What creates the experience of presence? What factors contribute to making you feel like you are there¹?

This paper offers a subjective explanation of presence in which the yardstick to measure presence is applied not to assessing how closely a virtual world mimics real world sensations, but instead to analyzing the kinds of evidence a virtual experience provides to participants that help convince them they are there. Sensory realism is subsumed within this broader perspective, as one of the means that contributes to the experience of presence. The effectiveness of the illusion of presence created by a virtual world can be partially assessed by studying visitors to virtual worlds' subjective experience of how much they feel like they are there and what makes them feel that way. This goes beyond traditional objective concerns such as comparing output device characteristics to data on what the average human eye can perceive.

2 Three Dimensions of Presence

The basic premise is that experiencing your own presence in virtual reality (VR) is like the process of discerning and validating the existence of self in the natural world (which humans have engaged in since birth). A sense of presence in a virtual world derives from feeling like you exist within but as a separate entity from a virtual world that also exists. The differentiation and experience of self may be enhanced if other beings exist in the virtual world and if they appear to recognize that you

exist. It may be enhanced if the virtual environment itself seems to acknowledge your existence. As a framework to focus discussion, three dimensions of the subjective experience of presence (of existing), personal, social, and environmental presence, will be defined.

Subjective personal presence is a measure of the extent to which and the reasons why you feel like you are in a virtual world. Possible reasons are myriad, for example,

- 1 I see my own hand in the world.
- 2 The virtual world gives me a sense of *déjà vu*, as if I've been here before.
- 3 Although the rules of this world are different than the laws of physics in the real world, there seems to be a consistent pattern that I can learn to recognize.

Researchers trying to analyze subjective presence in virtual worlds can begin by trying to identify as many features of that world as possible that might contribute to convincing someone that they are there. Virtual world designers, when designing a new experience, can seek to consciously add in features that enhance the sense of presence. Perhaps small, inexpensive features that cost little in terms of memory or processing speed can significantly enhance the experience of presence.

Social presence refers to the extent to which other beings (living or synthetic) also exist in the world and appear to react to you. This is in some respects a subset of personal presence, discussed separately to draw attention to the power it may have in enhancing presence. Social presence may derive from conversing with other human beings, or from interacting with animated characters. Someone or something else that seems to believe that you are there may help convince you that you are there.

¹Throughout this and my other papers on virtual reality, I violate the academic convention of formal third person language, writing about what "I" or "you" experience rather than what "one" experiences. I do this to emphasize the unusual and very direct nature of entering a virtual world.

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Environmental presence refers to the extent to which the environment itself appears to know that you are there and to react to you. Perhaps lights turn on when you enter a room, or portals to other worlds flash into existence when you draw near. The argument is the same as for social presence. If the environment knows you are there, that may contribute to you believing that you are there.

These dimensions of presence will be discussed in relation to developments in VR research and development. Subsequently, two quite different virtual experiences for which data have been collected specifically for this purpose will be analyzed in terms of elements that contribute to personal, social, and environmental presence.

2.1 Personal Presence

Virtual reality research has focused extensively on creating a sense of personal presence by simulating as closely as possible the range and intensity of stimuli human senses detect and interpret in perceiving the natural world. The desire to create vivid artificial sensory stimuli leads to a quest for three-dimensional (3-D) images and sounds, photorealism, tactile and force feedback, and so forth. For example, a central NASA objective in VR research has been “to develop a new kind of interface that would be very closely matched to human sensory and cognitive capabilities” (Fisher, 1990). John Walker at Autodesk, Inc. (1990) describes part of their vision for VR: “The richness and fidelity of a cyberspace system can be extended by providing better three-dimensional imagery, sensing the user’s pupil direction, providing motion cues and force feedback, generating sound from simulated sources, and further approximating reality almost without bounds.” Zeltzer (1992) proposes that presence should be measured by the number and fidelity of sensory input and output channels. In some ways it is already possible to provide stimuli that are totally different from or exceed those a human experiences without the benefit of an artificial interface. Would this enhance or detract from the sense of presence?

Faced with technological limitations that prevent being able to simultaneously simulate all aspects of human perception, the alchemy of presence in VR is in part a

science of tradeoffs. Which elements are most critical to the experience of presence? When forced to choose between responsiveness to motion and resolution of images, developers are choosing responsiveness as the more important factor, based on their own experiences and observations of others. Because he considers motion responsiveness more critical than resolution, Carl Tollerander, Chief Scientist for Autodesk’s CyberSpace project, envisions a cyberspace that can run on a broad spectrum of platforms, such that “the space adapts the display itself to the resources available,” holding as constant as possible speed of motion and moving closer to visual realism as computer resources permit (Folz, 1991). Howard Rheingold reached a similar conclusion, describing his experience using a telepresence VR system that let him move his head to control a robot 20 feet away from himself in a Japanese laboratory. Moving his head turned the robot’s video camera, the output of which he saw through goggles. “The fact that the goniometer and the control computer made for very close coupling between my movements and the robot’s movements was more important than high-resolution video or 3-D audio” (Rheingold, 1991).

Immersion VR frequently uses head mounted display and position trackers to place the participant inside a virtual environment. The sense of inclusion within a virtual world that this technique creates has a powerful personal impact. Three hundred participants in Autodesk’s cyberspace rated “being inside” the virtual world as the most compelling aspect of the experience (Bricken, 1991). The virtual world appears to respond to head movement in a familiar way (the way the natural world does: not at all) and in a way that differentiates self from world. You move and the world stays still.

Frequently, being inside a virtual world is accompanied by a dynamic, artificial representation of some part of yourself—most often, a computer-generated hand. Meredith Bricken (1991) describes the experience of watching her dynamic self-representation hand within a virtual world as “convincing evidence that you’re There.” Perhaps it would feel even more like being there if you saw your real hand in the virtual world. Held and Durlach (1992) suggest that similarity of visual appearance of the operator and robot or virtual body are im-

portant to the experience of presence. On the other hand, Jaron Lanier (Ted/2 videodisc, 1990) expressed surprise at the ease with which people adapted to inhabiting nonhuman shapes, such as lobsters, in virtual worlds. These are interesting research issues related to personal presence.

In immersion VR, a sense of personal presence is based in part on simulating real world perceptions. You know you are "there" because sounds and images in the virtual world respond like the real world to your head movements. Seeing your virtual hand move when your real hand moves adds to the illusion. An alternative approach to personal presence that does not strive to precisely simulate reality is what Michael Miller calls "second person VR," exemplified by some of the work of Myron Krueger, Mandala, and ENTER Corporation. In second person VR, you know you are there because you see yourself as part of the scene. On one side of the room, you stand in front of a blue background. You face a monitor and TV camera. On the monitor you see yourself, but instead of being in front of the blue background, the self you see is inside of a graphic or combined video/graphic virtual world. Edge detection software keeps track of your location and movement and allows you to interact with graphic objects on the screen.

Experiencing second person VR is a curious, compelling transformation that places you into a world on the computer screen. William Bricken describes it as an out of body experience (Osgood, 1991). Your body moves much like it always does, except that while you move you are also watching your "real self" (that being on the screen) appearing in and interacting with a virtual world. Rather than mimicking real world sensations, second person VR changes the rules, and relies strongly on a "seeing is believing" argument to induce a sense of personal presence. According to Krueger (1991), a sufficient sense of presence was achieved that some people "reported a sensation in their finger when they touched the image of another person on the point. . . . It is enough that individuals have a very proprietary sense about their image. What happens to them, what touches it, they feel."

What you see and what you don't see matters. Held and Durlach (1992) point out that "artificial stimuli that signal the presence of a display" should be minimized,

and that measurement devices in the virtual or teleworld should be well disguised or hidden. Not showing the microphone and not shooting off the edge of the artificial set are two trivial tenants of movie production. There is much to be learned from movie making about invoking suspension of disbelief and creating the sense of being there in virtual worlds. Sheridan (1992) and Zeltzer (1992) both suggest that different kinds of virtual tasks may have different optimal minimal fidelity requirements. Do the tasks of learning or playing or being excited or amused require more or less fidelity to achieve a sense of presence than the task of flying through a molecule to determine its structure?

In telepresence, seeing your physical self from across the room has the opposite effect but the same result. (You see yourself, therefore you know you are NOT there.) According to Rheingold (1991), "what you don't realize until you do it is that telepresence is a form of out-of-the-body experience." Rheingold describes turning his head, which caused the robot he was looking through and controlling to turn its cameras toward Rheingold's physical body. "He looked like me and abstractly I could understand that he *was* me, but I know who me is, and me is *here*. He, on the other hand, was *there*. It doesn't take a high degree of verisimilitude to create a sense of remote presence." Thus, seeing yourself in telepresence is evidence for the proposition that the "real you" is not currently inhabiting your body.

Familiarity with a virtual world may also contribute to personal presence. Having "been there before" helps you believe you are there again. Held and Durlach (1992) and Loomis (1992) suggest that the sense of presence may increase with experience and practice. Participants' expectations, based on prior experiences with virtual worlds, may also be a factor. As the art of designing virtual worlds that induce a strong sense of presence improves, your expectations will rise, and experiences that may initially have seemed adequate may suffer by comparison.

2.2 Social Presence

The premise of social presence is simply that if other people are in the virtual world, that is more evidence that the world exists. If they ignore you, you be-

gin to question your own existence. The Hollywood fantasy theme of a human who becomes invisible to the rest of the world and is able to move freely around (and through) people exemplifies the experience of reduced presence in that kind of hypothetical virtual world. However, if the others recognize you as being in the virtual world with them and interact with you, that offers further evidence that you exist. Philosophers discuss the “social construction of reality,” wherein societies play a role in what is perceived as real, through interpersonal communication and through mass media such as television (Hawkins & Pingree, 1982). Here we acknowledge the social construction of *virtual* reality. If you were the only human living in the natural world, you would likely have considerably more doubt about your own existence than you do now. A one person virtual world is like that. (Except that the “gods” who created the virtual world and an audience of other humans waiting for their turn are probably watching you, perhaps contributing to the perceived reality in a perverse way.)

Multiperson virtual worlds have received some attention. VPL’s “RB2” (reality built for 2) allows 2 people to share the same virtual environment. Lanier speaks of hope for VR to become a medium for “post-symbolic communication” among people, in which they could jointly create or modify virtual worlds from within those worlds (Ted/2 Videodisc, 1990). VPL’s proposed “Reality Net” would link VR participants at remote locations. The HIT Lab in Washington is also working with phone companies to explore Televirtuality systems that connect remote participants (Jacobson, 1991).

Vincent John Vincent regularly combines two proximate Mandala (second person VR) installations, using a video switcher to put participants from the two different spaces into the same virtual screen and allowing them to interact with each other’s screen self. Krueger’s artificial reality experiments have also often allowed two or more individuals to interact in VideoPlace (Krueger, 1991). Participants saw themselves and each other in a virtual world. According to Krueger, “the sense of being together was very strong.”

Social presence can also be created through computer generated beings. Delaney (1992) describes a creature created for a VPL world that is programmed to travel to

wherever you are currently located and then begin repeating the phrase “pick me up” until you pick it up. As soon as the creature has been picked up, it starts repeatedly saying “throw me.” As soon as you throw it, it rushes back and resumes begging to be picked up. Although this gets annoying quite quickly, it does contribute to your sense that other beings notice and react to their movement in the virtual world. The characteristics of the agent and the interaction probably affect the strength of a sense of social presence that is created.

2.3 Environmental Presence

Many virtual world prototypes are, from the perspective of presence, unresponsive environments designed to “let you explore.” Many real world environments are not very responsive to human presence. There are solid objects in the room and you probably can move them or paint them. Sheridan (1992) proposes that the ability to modify a virtual environment is a key component of presence. Three-dimensional modeled virtual environments tend to be so totally unaware of observers’ presence that you can get lost inside of a couch or a mountain if you are not careful to avoid crossing illogical boundaries. Many virtual worlds cannot be modified. These factors likely detract from a sense of presence. Some responsive virtual environments are being developed. Warren Robinett at University of North Carolina has created virtual vehicles and tools—e.g., an elevator, which takes you up when you enter it. The HIT Lab has a rideable ferry in Virtual Seattle. A VPL demonstration kitchen includes a switch to turn on and off a fan. Some UNC environments give feedback, e.g., about the appropriateness of the position of a molecule or laser beam (SIGGRAPH Proceedings, 1990; Media Magic Video, 1991). Virtual worlds can also be designed to be more responsive than real worlds. When you walk into a room in the real world, it does not verbally or musically greet you or start raining. Virtual rooms might. It is quite possible that a virtual world that is more responsive than the real world could evoke a greater sense of presence than a virtual world where the environment responds exactly like the real world.

3 Descriptions of Two Virtualities

Having proposed a rationale to explain the experience of presence, let us move from theory to data, presenting studies conducted by the author of two virtualities: the BattleTech Center in Chicago and ENTER 3D Second Person VR demos at CyberArts '91. Following descriptions of the scenarios, issues of presence will be highlighted.

3.1 BattleTech

Since August, 1990, the BattleTech Center in Chicago has been transporting visitors to the year 3025, placing them in control of BattleMech robots at war in a computer-generated terrain amidst computer-generated weather conditions. For \$7.00 per person, uniformed crewmembers guide six players through a training and strategy session and then escort them to individual cockpits with multiple viewscreens and feedback mechanisms and more than 100 controls to navigate the terrain and fight each other's Mechs for 10 min. Somebody wins, others lose, and detailed statistics on the battle are provided after (and during) the game.

For four weekdays and one Saturday in September 1991, players were given questionnaires developed at Michigan State University when they purchased playing times, to be turned in after the game. Demographics about the "inhabitants" of this 1-year-old virtual world, their reactions to it, and their reasons for playing were studied. A total of 312 completed questionnaires were collected, for a completion rate of 34%. (One questionnaire was collected per person; at least 45% of the 1644 games sold during the sample days represented repeat plays within the sample period.) Different questionnaires were administered for each of 3 classes of players: novices, who had played 1 to 10 BattleTech games ($n = 223$), veterans, who had played 11 to 50 games ($n = 42$), and masters, who had played more than 50 games ($n = 47$). Novices had played an average of 3 games, veterans averaged 23 games, and masters had played an average of 228 games.

Ninety-three percent of the BattleTech players surveyed were male. Less than 5% of players surveyed were

under 12. One fourth were between the ages of 13 and 17. One fifth were between 18 and 20. Half of the players were over 20. Sixteen percent were over 30.

3.2 ENTER 3-D Second Person VR

At CyberArts '91 in Pasadena for 4 days in November, ENTER Corporation and the Michigan State University Comm Tech Lab exhibited 3-D interactive second person VR demos and conducted research on participant reactions. Participants wore 3-D glasses and stood in front of a blue curtain. The camera that was pointing at them was chromakeyed² over 3-D motion video scenes, so that they saw themselves inside of the video worlds instead of in front of a blue curtain on the monitor across the room. People were able to interact with graphic objects that appeared with them on the screen as part of the motion video backgrounds. This was the first time that 3-D motion video has been integrated into second person virtual experiences. (Most often, second person virtual worlds let participants see themselves inside of a 16- or 32-color graphic world.) We were hoping to enhance the sense of presence through photorealism (achieved by using a motion video background) and by having that video be 3-D rather than the usual 2-D television, using ENTER's 3-D technology.

Participants could choose to swim undersea and befriend unusual sea creatures, dance or wander peacefully through a Japanese garden, or transform into Godzilla to terrorize downtown Tokyo while aliens from outer space tried to stop them. A loose "narrative" story unfolded, with opportunities for the participant to interact. For example, in the undersea adventure, small animated octopuses swam out into the 3-D undersea video scene and grabbed onto you. They could be shaken off and would swim away, or the octopuses could be carried around. A little later, a much larger animated octopus

²Chromakeying one video signal over another involves use of a chromakey-capable video switcher that strips a predefined or user-defined subset of the overall picture chrominance of one of the two signals, and replaces all parts of the image that were comprised of that chrominance setting with the other video signal. Typically the color used is blue.

swam out and grabbed you. A shark swam by, and you were swallowed by a graphic whale, becoming stuck inside the whale until you discovered a way to get out.

For the first 2 days of demos, what the participants saw on the screen as a representation of their “self” was a one-color silhouette, or shadow that obviously looked like them and moved as they did. The second 2 days they saw their real, full color self. These two conditions represent two options available in second person VR hardware configurations. The silhouette version is much less expensive than the real self version. A question for this study was how much of a difference it made in participants’ sense of presence to see their shadow or their real self.

Approximately 160 individuals entered one or more of these ± 3 min virtual experiences. One hundred and ten were given questionnaires to fill out (in particularly busy moments, questionnaires could not be distributed). Eighty-seven completed questionnaires, for a response rate of 79%. Three-fourths of CyberArts respondents were male. Average age was 34, ranging from 17 to 55.

4 Personal Presence

4.1 Mixing Physical and Virtual Realities

The BattleTech Center in Chicago mixes physical and virtual reality. The Center itself is consistent with the theme of the virtual BattleTech experience. Uniformed crew take you to a training center to view a video of a nervous trainee being initiated by a tough commander. The crew member then escorts you to your ‘Mech cockpit. Inside the cockpit you find more than 100 buttons, a primary and secondary screen with 6 selectable inputs, foot pedals, and a joystick, all of which are physical, not virtual. But they control your virtual ‘Mech. You navigate, turning, stopping, starting, and it appears through your viewscreen that these events are occurring.

ENTER’s Second Person VR contrasts sharply with the BattleTech Center. If you look anywhere other than at the monitor in front of you, you are overwhelmingly reminded that you are standing in front of a blue curtain waving your hands in the air. When you look back at the

screen, you see yourself underwater grabbing an octopus. Of those who tried the demos, 71% considered the “being on the screen” to be their real self, rating their screen self either more real than the “being the camera pointed at” (29%) or as real as the “being the camera pointed at” (42%). Only 26% felt the being the camera pointed at was their only real self. These data suggest that a sense of presence in the world on the screen has been created by the experience.

Immersion VR replaces physical world sensations with virtual ones. Second person VR ignores real world sensations, suggesting an alternative scenario. BattleTech mixes them. Within a virtual world, mixing physical reality may add to the illusion up to a point, but it also may hold back the full effect of leaving the physical world, and impose other limitations. You are obviously not really inside of a robot, sitting in a physical cockpit in the middle of a room. The cockpit is always there, always the same, it cannot change during a game. What difference would it make to enter a virtual cockpit? Second person VR is an almost outrageous leap of faith, to transfer your self into a world on the screen. But perhaps that leap is a powerful first step to entering a virtual world. Like Peter Pan thinking a happy thought, once you make that initial leap, reality becomes plastic and you can fly.

4.2 Sensory Channels in VR

The “original” five senses no longer comprise an exhaustive list, nor are they necessarily the most relevant way to assess virtual experiences. Other new senses can be added in VR. In BattleTech there are auditory, visual, and tactile stimuli. The tactile sensations come from touching buttons and joysticks in the physical cockpit. Thus, they are like the physical world, except that they are not quite like what driving a real cockpit would feel like. Visually, we are accustomed to one set of stereoscopic eyes. In BattleTech, there is a primary monaural eye (the main screen) that is always visible, and selectable secondary “eyes” that show views looking down at yourself from 20 ft above your head, or 50 ft above your head, showing your own internal damage report or showing your weapon status. Returning to the idea of

personal presence, senses like the physical world help convince you you are there. Perhaps being able to examine your virtual self from new and different perspectives provides additional evidence.

In the ENTER second person VR demos, there was only sight (on a single screen) and sound. Yet touch occurred. The senses were transferred. Instead of feeling touch, you saw and heard touch. (The beings on the screen reacted visibly and auditorily when your screen self touched them. In the case of octopuses, the swimming creature stopped swimming, grabbed the part of your body that touched them, made gurgling sounds, and hung on for the ride unless you shook them off.) Respondents who completed surveys reported feeling both physical and emotional responses when they touched animated graphic objects in these worlds. The emotional responses were somewhat stronger than the physical responses. Only 14% reported feeling no emotional response when they interacted; 24% felt no physical response. Feeling something when you see an object on the screen touch yourself helps convince you you are there.

4.3 Movement/Navigation

In BattleTech, you drive the 'Mech, moving forward, back, left, right and rotating your "head." Your movement is unconstrained on the ground plane. Freedom to navigate without running out of world may enhance the sense of presence. The world must exist if you can go anywhere you want in it.

In the second person VR demos, you could move anywhere on the screen that you wanted, forward and back, left and right, watching yourself assume different positions within the motion video scenes. But if you walked any further than the edge of the screen, you disappeared from the scene. Within the stage, movement was potentially very free. One former dancer danced in the Japanese Garden. Some people got very involved, moving a lot. But contrary to our expectations of participants enthusiastically exploring 3-D video space by walking around in it, about half stood in one place, barely moving at all until encouraged to do so. Either the virtuality itself, the novelty of the experience, or self consciousness

from being watched by 5 to 30 people inhibited movement in the world, and probably reduced the sense of presence.

4.4 Feedback

In BattleTech, feedback occurs whenever you are fired at and whenever you aim or fire at someone else. Firing weapons also results in noises and visual effects. In fact, there is far more feedback than new players can attend to. Novices were asked about the three most basic forms of feedback: where they were in relation to other players, when they hit another player, and when another player hit them. Of novices 60% said they could tell where other players were, 35% said they sometimes could tell, and 5% could not tell at all. When you hit another player, there is a textual message indicating what happened to whom. Of novices 63% could tell when they hit someone, 30% sometimes could, and 7% could not. Feedback can contribute to environmental and social presence, particularly if it is understood. The BattleTech world is apparently keeping track of you and the others and knows you by name. The others seem to be aware of you, because they fire at you whenever they get into range.

In the second person VR demos, many participants expressed a desire in the open ended questions for more and more tightly coupled feedback. During part of the Godzilla experience, waving your arms triggered screams and roars. In the Japanese Garden, movements triggered music and scene changes. People wanted to know exactly what action triggered what response. Direct, overt coupling of action and reaction would have made them feel more like they were there.

4.5 Perceptual Richness

Ratings of how real the BattleTech world felt were stronger (2.8 out of 7, where 1 is *very much*) than ratings of the extent the BattleTech world responded like the real world (3.7). And there was not much desire expressed to enhance the perceptual realism of BattleTech. When I tried it, driving the 'Mech felt a little "laggy," not letting me turn as fast as it seemed I should be able

to. One of the master players explained that this was intentional, because it takes time to turn a big 'Mech around. Perhaps a good story can cover for a lack of perceptual richness.

Veterans and masters were asked how much they thought 11 possible changes to BattleTech would enhance the experience. The most desired changes were more variety, less cost, more players at a time, and playing time of longer than 10 min (ranging from 9.4 to 7.9 out of 10). Images in 3-D, motion simulators, and totally new games were the next tier (6.3 to 7.1). Being able to play from home was not rated particularly high (4.9). But least desired changes were to wear 3-D goggles, to wear a data glove, and to have less complex cockpits (3.4 to 2.2). Similarly, on a masters-only write-in question asking what they would change about BattleTech, the suggestions tended not to address fundamental alterations in the game or how it is played. Only two masters asked that BattleTech management work on "improving the reality." The overall lack of desire expressed by BattleTech regulars for radically improved realities may be somewhat disheartening to virtual reality developers working hard to generate ever greater realism. These findings suggest that there is more to presence than reality.

Unlike the BattleTech players, CyberArts participants wanted goggles and more realism. They already were experiencing themselves in 3-D photorealistic motion video space for the first time, and they wanted more. Respondents were asked whether they would prefer to experience themselves in the 3-D world by wearing glasses and looking at the screen as they did at CyberArts, or by wearing goggles that fill their vision with what's on the screen, no matter which direction they look. This question is complicated. It was intended to begin to address the constraint of having to look straight ahead to see a screen all the time. The vast majority of respondents (84%) indicated they would prefer to wear goggles and be able to turn their head in any direction, even though the video world they were seeing would stay still, and they would watch themselves turning in a world that did not move. None of them has actually tried this—it creates its own complications because you cannot see the real world you are moving around in

when your entire field of vision is taken up by a virtual world. You enhance presence by removing competing real world perceptions, but complicate presence by making the experience even less like reality. Goggles versus single screen would be an interesting second person VR experiment.

For whichever of the three experiences a participant tried (Undersea Adventure, Japanese Garden, or Tokyo Godzilla), they were asked to rate their enjoyment, on a scale from 0 to 10, with 10 being very enjoyable. Those who experienced only their shadow on average rated the experience 5.8, compared to average ratings of 8.0 for those who saw their real self. Otherwise identical experiences were considerably more enjoyable when you got to see your real self in the world. In a seeing is believing world, seeing your real self gives more evidence that you're really there.

Second person VR write-in suggestions were numerous, with more interactivity mentioned by more than 70%, and more realism expressed by about half, including 3-D graphics, real photos instead of graphic objects, making the 3-D sound, tactile feedback, etc. Greater perceptual richness was definitely desired. (These people were attending a virtual reality trade show.)

5 Social Presence

If participants have their way, VR will be a very social technology. Both the BattleTech and CyberArts data identify consistently strong desires for interacting with real humans in addition to virtual beings and environments in VR.

In BattleTech, playing against and with other people was very important. Just 2% of respondents would prefer to play against computers only; 58% wanted to play against humans only, and 40% wanted to play against a combination of computers and humans. In general, respondents preferred playing on teams (71%) rather than everyone against everyone (29%).

The BattleTech study results are corroborated by the CyberArts findings. Respondents were given a list of different kinds of experiences which could be created using this technology, and asked to rate their likely en-

joyment of each genre, where 10 is *highly enjoyable* and 0 is *not enjoyable at all*. The desire to have other, real people in second person VR worlds with you is extremely strong. Sixty-nine percent of respondents rated having multiple players in the virtual world as highly enjoyable (9 or 10). The average rating was 8.5. The second highest desired experience was to participate in live events interactively, rated highly enjoyable by 61%, for an average anticipated enjoyment level of 8.3. Although the popular fiction and media images of virtual reality tend to portray people moving away from the real world into imaginary worlds, these data suggest that virtual worlds and virtual reality interfaces can serve to connect people to other people and to world events in new ways. In fact, people want that connection more than any other experience. Placing more than one person in a virtual world may be an easy way to induce a sense of presence regardless of the other perceptual features of the world.

6 Environmental Presence

In BattleTech, the terrain is not particularly responsive, but the system is aware of you at all times. It keeps score. After the game, it generates a complete printout summarizing every shot fired by any of the six concurrent players and what happened as a result of the shot. The score comes as a surprise to players—they eagerly await the display that tells them how they and others did. And the printouts are the most revealing of all. They actually provide an external validation of the experience, making it more real. When asked whether the printout matched what a novice player thought happened, he answered “I have no idea what happened, but this will tell me.”

As mentioned under feedback, 3-D second person VR participants overwhelmingly wished for *more interactivity*. They wanted the environments to be more responsive. They wanted to become more a part of the video image than they already were. They wanted real, 3-D photorealistic fish to swim in front of them that they could play with. They wanted complex interactions. Pre-

sumably, this would enhance their enjoyment and their sense of presence. They wanted the holodeck.

7 Conclusions

William Bricken says that “psychology is the physics of virtual reality” (SIGGRAPH Proceedings, 1990). This paper focuses that psychology beyond perception, spotlighting a messy array of elements tied together by the concept of validation of virtual existence. A question to guide designers of virtual worlds is *how do I convince participants that they and the world exist?* Research can address issues of which elements matter more—personal, social, environmental. Two example studies are reported here. More specific questions can now be framed to assess and compare the experience of presence in its different forms.

Different personality types may be more or less receptive to alternative types of virtual experiences and to various forms of evidence of existence. Children and adults may apply very unrelated criteria. Females and males may approach VR with different criteria for “being there.” No significant differences were found between males’ and females’ responses to second person VR at CyberArts. Many significant gender differences were found in reactions to BattleTech. They may have been reactions to the competitive, warlike nature of the game, or to the type of VR. Educators and psychologists identify different learning styles, such as preference for visual, auditory, or touch communication channels. An individual’s preferred channel is presumably the most convincing to them for creating a sense of presence. Perhaps an imagination IQ test should be developed. Is one person’s experience of presence in a virtual world the same as another’s?

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