Videogame play and the effectiveness of virtual environments for training

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ABSTRACT

The Sensory Environments Evaluation (SEE) project set out to examine the effects of emotional valence of a virtual training scenario on learning and memory. Emotional arousal is well-established as having enhancing effects on memory (McGaugh, 2000). A virtual scenario called DarkCon was created to resemble a night-time reconnaissance mission. Priming of subjects was the first experimental variable. Subjects were randomly assigned to receive their mission briefing in a serious style, suggesting a serious military mission, or in a lighter style, suggesting a fun role-playing game. The influence of videogame experience was included in analysis of subjects' recall of the environment and of their physiology. In the present study, 34 Army Rangers from Fort Benning, GA underwent the DarkCon mission. Significant effects of priming condition and videogame play were discovered in subjects' recollection of the mission, and in their physiological reactions to highly exciting material. This paper is primarily concerned with the effects of videogame play frequency on subjects' behavior, recall, and physiology. The effects of priming will be cursorily discussed here as they relate to videogame play habits, and explored in more detail on their own in future publications. Directions for future research into the effects of videogame play experience on training are discussed.

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INTRODUCTION

The goal of the Sensory Environments Evaluation Project, or SEE, has been to research the role of emotion in immersive training environments, delivered by traditional virtual reality techniques. It was hypothesized that increasing the emotional valence of a virtual scenario would add to its value as a training tool. The enhancing effect of emotional arousal on memory is well-established in psychology literature: for instance, it has been demonstrated that emotional and/or arousing stimuli play a role in preferentially engaging neural mechanisms that improve memory of events or facts (for a review, please see McGaugh, 2000). This seems due to the physiological arousal induced by heightened emotional states, and goes beyond the overt effects of simple rehearsal and repetition (Guy & Cahill, 1999). An emotionally evocative training environment would therefore, it was hypothesized, provide an advantage to learning.

To test this hypothesis, an environment had to be designed that was both realistic and provided a cognitively engaging task. For this a design approach termed “cognitive realism” was developed. The result was the virtual scenario named DarkCon, so named because it represented a nighttime military reconnaissance mission. The DarkCon environment represents a small area of an unnamed Eastern European country, the inhabitants of which might be either civilian refugees or militant rebels. The task is a reconnaissance mission, and takes place at night (hence, “DarkCon”). The user, portraying a military scout, is dropped off at the entrance to a culvert, and told to make his way through it to reach the mission target: a cluster of buildings, on the other side of a river into which the culvert empties. Various clues available in the environment will tell him whether the inhabitants of the buildings are fleeing villagers or dangerous paramilitary forces. The user is given a virtual GPS transmitter at the beginning of the mission. If he thinks the ‘enemy’ is using this area as a base of paramilitary operations, he is to place the transmitter near one of the buildings, as a tracking device that will allow the area to be bombed. If he finds no evidence of paramilitary activity, he is to keep the transmitter. The decision must be thoughtful and supported by evidence. In either case, he is to return to the rendezvous point through the culvert without being detected.

It was a challenge to create a plausible military exercise within a virtual scenario that sought to be emotionally compelling. The inability of the scenario to narrate directly to the user led to a heavy reliance on cues contained in the environment itself. Many of the ‘clues’ in the environment, mentioned above as evidence for the refugee/paramilitary determination, were objects deliberately placed in the culvert to elicit emotional reactions. A baby doll near the entrance squeaks “mama”, if stepped on. Family photo albums lie discarded in the mud. Near the culvert’s exit, the careful user would notice blood spattered on the wall and bullet casings on the ground. Taken together, these and other scenario elements describe a tragic story: people fleeing their homes, trying to save family treasures, and being attacked in the attempt to escape (see Figure 1). These and other stimuli were designed to provoke an emotional connection between the user and the environment. Such a connection, it was hypothesized, would improve the training value of the scenario, both by enhancing the sense of presence or “being there”, bringing the simulation closer to reality (in which soldiers have to cope with emotional distractions), and of heightening physiological arousal state, thus facilitating learning and memory (McGaugh, 2000).

Increasing the user’s sense of telepresence has been the traditional goal of virtual environment creation. Telepresence is achieved by successfully making a user feel as though he is actually in the simulated environment. With current levels of simulation technology, a user is always somewhat conscious of the surrounding real world, and so the goal of telepresence becomes to remove this consciousness as much as possible. This can be accomplished through realistic graphics, accurately spatialized sound, the ability to interact with tangible objects, or olfactory stimuli (such as those provided by the Scent Collar,

Figure 1: Objects in the culvert.

also developed by the SEE Project [Tortell et al., in press]). Emotional connection to a VE is still another way of heightening this feeling.

Telepresence is a concept that has existed in research literature for slightly more than a decade, being first defined by Held & Durlach (1992). The field still lacks an agreed-upon operational definition of telepresence. As such, there have been attempts to relate a user's presence to his performance on a virtual environment task (for instance, Darken et al.'s (1999) work on attention and spatial knowledge acquisition). In the case of this study, increasing the sense of telepresence was a high-level goal during environment creation. It was believed that this could be achieved through the cognitive realism design approach described below. In the context of the present study, achieving telepresence was less important than achievement of effective training provided by the environment, measured using recall of the environment and physiological state, and hopefully enhanced by an emotionally valent experience.

Another way of directing the user's connection to the scenario was through manipulating the context in which it was to be experienced. The state of mind with which a user approaches a scenario can influence his behavior in that situation. The Army's increasing usage of games as training tools, and the prevalence of videogame use in the population most likely to receive such training, led to the decision to explore the contrast between behaviors induced by the perception of an activity as an inconsequential game, and those induced by its perception as a serious, significant exercise. These differential perceptions in subjects were encouraged in several ways, primarily through manipulation of the characteristics of the speaker delivering instructions to the subject.

Instructions were given to participants by one of two specially targeted videos. In one video, the task was portrayed as a serious mission by a stern soldier, while in the other it was described as a fun role-playing game by a friendly civilian, according to the subject's group. The actual instructions given to both groups were identical, but presented very differently. It was hypothesized that the difference in authority of the speaker would affect the way the subject perceived consequences of performance in the scenario, and that the subject would be 'primed' to treat the experience as trivial or serious appropriate to the instructional video received. This was related to the goal, described above, of increasing the user's emotional connection to the scenario. Greater perceived consequences would result in the subject becoming more involved in and engaged by the scenario, and therefore provoke a greater physiological response.

Individual differences were also anticipated to impact subjects' behavior. Subjects were therefore administered a modified version of the Immersive Tendencies Questionnaire (Witmer & Singer, 1998).

Part of the modification was the inclusion of questions about video-game play habits: since the virtual environment was to be presented to half of the subjects as a videogame, it was decided to investigate the influence of videogame experience on their behavior as well. According to a recent study of children, time spent playing video or computer games currently exceeds time spent watching television (Christakis et al., 2004), and studies of the potential effects of video games, typically restricted to the study of violence and aggression, have demonstrated that behavior can be and is affected by frequency of videogame play (Anderson, 2004). It was therefore expected that this would have an effect on behavior in a virtual environment.

METHODS

A prior experiment in the DarkCon environment tested 63 civilian subjects and seemed to indicate that priming was an effective experimental manipulation. The present study examined the effects of priming and game play experience on 34 male Army Rangers at Fort Benning, GA, ranging in age from 18 to 40. The Rangers are a highly trained and highly selective special operations force of the Army. This study specifically examined soldiers because DarkCon was designed as a training environment for military reconnaissance.

Thirty-four Rangers participated in this experiment; sixteen received game-style instructions, and eighteen received serious instructions. Difficulties with the tracking system resulted in the mechanical loss of data from eight subjects. Heart-rate data from a further seven subjects had to be discarded due to the difficulties with the BioRadio equipment. For analyses including any examination of heart-rate data, total n=19. For all other analyses, total n=26.

Subjects were alternately assigned to either the game priming condition or serious priming condition in advance of their arrival at the testing facility. After giving informed consent, participants filled out the modified version of the Immersive Tendencies Questionnaire described above, as well as the standard Simulator Sickness Questionnaire (Kennedy et al., 1993). Game play habits were indicated roughly by a subscale of the ITQ representing the sum of five questions on a seven-point scale, from 1 (Never) through 4 (Occasionally) to 7 (Often). The first question asked, "Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen (respond Never if you do not play video games)?" The next four asked: "How often do you play [type] video games? (Often should be taken to mean every day or every two days, on average)", for first-person shooter, strategy/simulation, massively multiplayer online role-playing games, and puzzle games. This resulted in a range bounded by a minimum value of 5 and a maximum value of 35.

Subjects' arousal states were measured by heart rate and skin conductance, using the Cleveland Medical BioRadio 110 wireless acquisition system. A skin conductance sensor was built by the experimenters to be used with the BioRadio, having preset gain of 1 and 10 mV/μS. The wireless system was originally believed to be ideal for the scenario, in which the participant would be expected to turn his head to explore, crouch down to hide, and otherwise potentially tangle up his wires. However, unforeseen consequences far outweighed the perceived advantages of a wireless system: significant signal degradation, mechanical error in recording gain settings, and the difficulty of data reduction with unproven software. Though skin conductance was recorded for all subjects, the data ultimately proved unreliable, and it was reluctantly concluded that they could not be considered for analysis. Heart rate therefore became the sole metric of physiological arousal. Both EKG and SCR channels were recorded with 16 bit resolution and a sampling rate of 640Hz.

The DarkCon scenario was run on a mobile three-node PC cluster. Two nodes of this cluster were dedicated to left- and right-eye view in stereo mode, while the remaining node drove a 5.1 spatialized 3-D sound system (this evaluation was run in mono visual mode). Participants viewed the environment through a Kaiser Electro-Opticals ProView XL-50 head-mounted display (HMD). They moved through and interacted with the environment using a Polhemus magnetic 6DOF tracking system with navigation wand.

Preliminary training was necessary to help the subjects familiarize themselves with navigation and interaction within the 3D environment. Therefore, a simple orientation environment called the "tutorial room" was constructed. Subjects spent ten to fifteen minutes in the training room guided by an experimenter, performing simple tasks to increase their proficiency with the equipment. In addition to training the subject, this time provided an opportunity to record baseline physiological state for each participant. Baseline was recorded during the final exercise of the training room, a variable-length free-navigation task ("find your way back to the room where you started").

Once the subjects had completed the tutorial room exercises, they were shown the video instructions for the DarkCon task appropriate to their priming condition. In one instruction video, the speaker introduced himself as "Major O'Neill", addressed the participant as "soldier", projecting a stern look and grave tone. In the other, the speaker was a smiling and friendly civilian, who told participants about the fun role-playing game they were about to experience. They were told the nature of their task (described in the introduction, above), told that they would have thirty minutes to complete it and instructed to be both cautious and observant.

Subjects' physiology was recorded throughout the experience, which was divided into three epochs. The first epoch, "in culvert", was the period of time that the subject spent inside the culvert at the beginning of the experience. The subject's path was constrained by the narrow tunnel shape of the culvert, and there were occasional startling stimuli. The second epoch, "out of culvert", began at a specific action trigger marked in the recording (a truck passing overhead near the end of the culvert). This area was non-constrained, and subjects had free range of movement. It was designed to be calmer, and included hiding places. The third, "end of scenario", represented the thirty to forty seconds elapsed during the high-arousal scenario-ending sequence, beginning with the subjects' detection by one of the building inhabitants and ending with virtual death.

It is important to note that the DarkCon task was designed to be nearly impossible for even fully trained soldiers to complete without being caught. This was done to ensure that all subjects would be exposed to a situation of high arousal at least once during the scenario. Even getting near the designated mission target area puts the subject in the observational range of sentries and other inhabitants of the world, increasing chances of discovery to near certainty. Events surrounding discovery may also contribute to a heightened state. The user may hear building inhabitants speaking in alarmed tones, or see a guard on the roof of the building jump up and run off. In one of four possible end-of-scenario sequences, the user will hear shouting voices, followed by the appearance of snarling attack dogs. Finally, the screen fades to black, and the mission is over.

After the DarkCon experience was concluded, the HMD was removed and the subject was seated for a structured interview about their experience. The "after-action review" was an open-ended spoken interview of eleven questions, intended to elicit the subject's observations from throughout the experience (see Figure 2). The questions asking subjects to recall items in a category (for example, "How many vehicles did you see?") were 'scored' by counting the number of correct items the subject reported. 'Correct' in this instance means actually present in the scenario that the subject experienced. After this interview, subjects were asked to fill out a final set of questionnaires: Witmer and Singer's Presence Questionnaire ([1998]; companion to the ITQ that subjects completed before the experience), the identical Simulator Sickness Questionnaire (Kennedy et al., 1993), and the Virtual Environments Questionnaire (Usoh et al., 1999).

RESULTS AND DISCUSSION

The subscale of the ITQ dealing with game play habits, described above, was mean-deviated for clarity of interpretation (M=12.81, SD=6.741). Mean-deviated ITQ games score (henceforth referred to as "videogame play"), priming condition, and their

1. *What did you understand your goal to be as outlined in the video instruction?*
2. *Do you believe you were successful in achieving this goal?*
3. *Please explain why you feel this to be the case.*
4. *How many vehicles did you observe in the environment? Please describe.*
5. *How many people did you observe in the environment? Please describe.*
6. *How many weapons did you observe in the environment? Please describe.*
7. *Did you observe any remains within the environment? If so, please describe.*
8. *What things did you observe while within the culvert?*
9. *Were you able to determine whether or not the culvert was used by refugees or militant forces? If so please describe.*
10. *How much time do you feel you spent within the environment?*
11. *How much time were you given to complete your goal?*

Figure 2: Questions in the after-action interview.

interaction were included in ANOVA analysis. Using the method described in Judd & McClelland (1989), the ANOVA was implemented using multiple linear regression. Contrast codes were chosen to represent categorical predictors such that the parameters of the regression model corresponded to questions of a priori interest, listed below..

This paper is primarily concerned with the effects of videogame play frequency on subjects' behavior, recall, and physiology. The effects of priming will be cursorily discussed here as they relate to videogame play habits, and explored in more detail on their own in future publications.

The first question was of the effect of the above predictors on time spent by each participant in the in-culvert and out-of-culvert epochs, as well as total time spent in DarkCon. End-of-scenario epoch time was not determined by participant action, and was therefore not examined individually. Regression analysis revealed that no predictor had significant effect.

Table 1: Results of regression analysis on time spent outside the culvert.

Parameter	B	Std. Error	t	p
Intercept	149.940	15.720	---	---
Videogame play	4.600	2.459	1.871	.075
Serious priming	-12.831	15.720	-.816	.423
Interaction of game play and priming	2.784	2.459	1.132	.270

However, across both priming conditions, videogame play demonstrated a trend toward increasing time spent outside the culvert, $t[22]=1.871$, $p=0.075$ (see Table 1). This indicates that participants with higher games scores spent more time in the environment outside the culvert, though it did not appear as an effect on total DarkCon time. The relationship of this effect to performance is unclear.

The second question was of the effect of the above predictors on recall of items in the scenario as reported during the after-action structured interview. Again, no predictor had significant effect on any category of free recall. However, in recalling goals (question 1 in Figure 2), mean-deviated videogame play and priming condition trended towards an interaction, $t[22]=1.761$, p=0.092, with no main effects (see Table 2). This seems to indicate that the effect of videogame play on recall depended upon the priming condition of the subject. When subjects were game-primed, videogame play had a negative effect on their report of goals. When subjects were serious-primed, videogame play had a positive effect on their report of goals.

Table 2: Results of regression analysis on recall of goals.

Parameter	B	Std. Error	t	p
Intercept	3.445	.199	---	---
Videogame play	.020	.031	.642	.528
Serious priming	.205	.199	1.028	.315
Interaction of game play and priming	.055	.031	1.761	.092

It appears that game play experience had different effects on recall, depending on how subjects were primed; in other words, depending on the context from which the subject approached the virtual environment experience. It may be that, when the subject was primed to take the exercise seriously, previous familiarity with and skills gained from playing videogames augmented his performance. When the subject was primed to treat DarkCon as simply a videogame, there may have been no reason for him to pay special attention to what was, essentially, just another game. This further underscores the importance of taking individual differences into account, especially those, like game play, that are substantially related in technology or content to the training experience.

Some questions not having to do with item recall were isolated from the after-action report for being of particular interest as dependent variables. We examined whether participants believed they had been successful (question 2, Figure 2), and to what factors they attributed this determination (question 3, Figure 2), specifically: placing or not placing the transmitter, being killed or found out, and determining or not determining the nature of the area inhabitants. However, no effects of the above predictors were found.

Finally, physiological data were analyzed. As stated earlier, values of heart rate (mean, minimum, maximum, and standard deviation) were tracked during each epoch of the scenario. Each was divided by its counterpart value acquired during the free-walking baseline task in the tutorial environment. Therefore, values reported here represent the subject's heart rate during each epoch as a proportion of baseline value heart rate. These proportions were subsequently log-transformed to control skew and kurtosis.

During the in-culvert epoch, videogame play trended towards a negative effect on maximum heart rate value across both priming conditions, $t[15]=-1.88$, $p=0.08$ (see Table 3).

Table 3: Results of regression analysis on maximum heartrate inside the culvert.

Parameter	B	Std. Error	T	P
Intercept	-.035	.027	---	---
Videogame play	-.008	.004	-1.880	.080
Serious priming	.055	.027	2.061	.057
Interaction of game play and priming	.000	.004	.105	.918

This indicates the possibility that subjects with lower game scores had a higher maximum heart rate during the in-culvert epoch. No effect appeared on mean heart rate, indicating that the differences in maximum heart rate suggested by this trend may have been momentary. This is the first indication that more frequent videogame play and immersion results in less dramatic increase from baseline arousal levels. Game-style priming also showed a nearly significant negative effect on maximum heart rate value, controlling for the effects of videogame play, $t[15]=2.06$, $p=0.06$. This is a still stronger indicator of the conclusion above, that association with videogames may result in less dramatic rises in arousal. If this is the case, it might follow that videogame players would show less accurate memory for the environment, and require more intensive training.

No effects were found for any predictors during the out-of-culvert epoch.

The most apparent effects on heart rate appeared during the end-of-scenario epoch, an intentionally stressful period during which the subject knows he has been discovered and is about to be caught or killed. During this epoch, game-style priming had a negative effect on minimum heart rate value when controlling for the effects of videogame play, $t[15]=-2.15$, $p=0.05$ (see Table 4).

Table 4: Results of regression analysis on minimum heart rate during end-of-scenario.

Parameter	B	Std. Error	t	p
Intercept	.066	.037	---	---
Videogame play	-.003	.006	-.435	.670
Serious priming	.079	.037	2.146	.049
Interaction of game play and priming	.004	.006	.612	.549

The omnibus test for maximum heart rate during end-of-scenario showed that the model predicted a significant amount of variance, $R^2=0.41$, $F[3,15]=3.42$, $p=0.05$. In agreement with the effect on minimum heart rate, described in the paragraph above, tests of individual predictors showed that with videogame play held constant at the mean, game-style priming displayed a near-significant negative trend on maximum heart rate during end of scenario, $t[15]=-2.05$, $p=0.06$ (see Table 5). However, priming group appeared to have no significant effect on the mean heart rate of the participant.

Table 5: Results of regression analysis on maximum heartrate during end-of-scenario.

Parameter	B	Std. Error	t	p
Intercept	-.013	.036	---	---
Videogame play	-.013	.006	-2.261	.039
Serious priming	.073	.036	2.051	.058
Interaction of game play and priming	.007	.006	1.190	.253

In concert with the findings listed above, this leads to the conclusion that the differences in maximum and minimum heart rate that appeared between priming groups, while of great enough magnitude to appear on tests of statistical significance, may have been only momentary; were insufficiently frequent, in any case, to affect the mean heart rate of the participant. It would therefore not be accurate to say that game-primed subjects had lower heart rates, but it may be concluded that they showed a lower *range* of values than subjects in the serious-primed group.

In addition, videogame play had a significant negative effect on maximum heart rate across priming groups, $t[15]=-2.26$, $p=0.04$. Taking into account the effects of priming (or context), subjects with more frequent videogame play showed a lower maximum heart rate during the end of scenario sequence, indicating that they may have been less momentarily reactive to startling or stressful stimuli. As stated above, the higher maximum heart rate values of subjects with a lower games score may have occurred only once; this therefore serves better as an indicator of momentary reactivity than overall arousal state.

The effects and trends observed on heart rate indicate the possibility that greater videogame play frequency led to lesser momentary arousal, both inside the culvert and during the end-of-scenario epoch. This may have occurred exclusively in these two epochs due to startling or generally stressful stimuli, which the outside-culvert epoch was generally lacking. In this case, it could be speculated that frequent game play tempered the magnitude of response to momentarily arousing events. This might be indicative either of game playing subjects' reactions solely to games, or their arousal characteristics in general. This effect demonstrates that on a nonconscious level, users with more videogame experience approach the environment differently than those with less.

Let it be assumed for the moment that the differences cited above were momentary in nature (as they must have been, in order to be significant without affecting mean levels). Subjects with less videogame experience showed greater maximum heart rates than those with more experience. This indicates activity in the sympathetic nervous system, colloquially referred to as the "fight or flight" response, which is responsible for increases in arousal. (Pumprla et al., 2002). Videogame-playing subjects may have been able to disengage themselves from the virtual danger of the end-of-scenario period, such that their fight-or-flight response was less dramatic. It appears that non-playing subjects, on the other hand, were not able to respond in this way - the threat was perceived to be genuine, and therefore resulted in a typical response to danger. It is not at all likely that these effects occurred on a conscious level; rather, they reflect users' nonconscious response to virtual danger.

CONCLUSIONS AND CONTRIBUTIONS

As shown above, the context from which a trainee approaches a virtual environment has an effect on his response. This effect is influenced also by his prior experience in videogames. The trends observed in the examination of subjects' immediate recall of their experience were unexpected, but point to the importance of further studies focusing on the attention and memory characteristics of frequent game-players. Games seem to provide users with skills that are useful for the training exercise, but they can also be associated with poorer performance. This difference may arise either through self-selection (in the case that people with more game experience are likely to share certain characteristics) or through a change in behavior and response that is actually caused by videogame play. It is impossible to make this determination without further study.

Whatever the origin of the difference, this study demonstrates that experience in this area must be taken into account when using VE scenarios for training or evaluation. Since videogame experience leads users to respond very differently, as shown above, the environment may be much less effective for them if they approach it as another game. Physiological data seems to indicate that on a nonconscious level they view a threat presented in a virtual scenario as less dangerous than do their counterparts.

In addition, further study on this topic must differentiate between particular game types. If game-players' lessened physiological responses were in fact due to disengagement from the scenario, two possibilities present themselves. The first is that game-playing subjects were able to disengage due to the familiar *mechanics* of the VE, such as the controller and computer graphics. In this case, the results are relevant to training methodology, and apply to players of all types of videogames. Novel methods may be required in order to ensure that the training environment is distinct from other videogames in the trainee's experience. As indicated by the effects of the priming manipulation, game-playing subjects can perform well, but may require greater motivation to do so.

The second possibility is that game-players were able to disengage due to their familiarity with the *content* of the scenario, an armed reconnaissance exercise in hostile territory. The danger provokes less of a response in this case not because it is virtual, but because the subject has encountered it before in a game-like setting. In this case, the results would seem to apply specifically to players of first-person shooter videogames, speaking not only to the effectiveness of training, but also raising serious questions about these trainees' future performance on the battlefield. On one hand, this disengagement may indicate game-playing soldiers' ability to keep a cool head in stressful or dangerous situations. On the other hand, the reason for their cool heads may be that they perceive their actions as less serious: remaining calm under pressure, but acting with less of the regard to consequences that their duty requires.

This is an obvious way in which the above results apply to the practical business of combat training. While attention to individual differences in the educational setting tends to be minimal, for the purpose of giving each soldier identical training, these appear to be areas in which background is likely to make a very important difference to behavior – namely, with regard to the trainee's perception of his actions as consequential. It is important that a soldier maintain calm and focus during a combat situation, but the possibility exists that this may occur at the expense of caution and responsibility. Trainees with a great deal of background with military-like videogame play may require more deliberate instruction regarding the seriousness of their actions in the real world.

The above clearly demonstrates that it is essential to distinguish the root cause of game-players' decreased reactivity to danger in a virtual training scenario. Overall, if research into videogame-like simulations as training exercises is to continue, the individual user characteristics of trainees' background experience must be studied.

REFERENCES

Anderson, C. A. (2004). An update on the effects of playing violent video games. *Journal of Adolescence, 27 (1)*, 113 – 122.

Christakis, D. A., Ebel, B. E., Rivara, F. P., & Zimmerman, F. J. (2004). Television, video, and computer game usage in children under 11 years of age. *The Journal of Pediatrics, 145 (5),* 652 – 656.

Darken, R. P., Bernatovich, D., Lawson, J., & Peterson, B. (1999). Quantitative Measures of Presence in Virtual Environments: The Roles of Attention and Spatial Comprehension. *Cyberpsychology and Behavior, 2 (4)*, 337 – 347.

Guy, S. C., & Cahill, L. (1999) The role of overt rehearsal in enhanced conscious memory for emotional events. *Consciousness and Cognition, 8*, 114–122.

Held, R. M., & Durlach, N. I. (1992). Telepresence. *Presence: Teleoperators and Virtual Environments, 1 (1)*, 109 – 112.

Judd, C. M., & McClelland, G. H. (1989) Data Analysis: A Model-Comparison Approach, 1st ed. Harcourt Brace Jovanovich, New York.

Kennedy, R. S., Lane, Berbaum & Lilienthal, M. G. 1993. A simulator sickness questionnaire (SSQ): A new method for quantifying simulator sickness. *International Journal of Aviation Psychology, 3 (3)*, 203-220.

McGaugh, J. L. (2000). Memory – a century of consolidation. *Science, 287 (14),* 248-251.

Pumprla, J., Howorka, K., Groves, D., Chester, M., & Nolan, J. (2002). Functional assessment of heart rate variability: physiological basis and practical applications. *International Journal of Cardiology, 84*, 1 – 14.

Tortell, R., Luigi, D. P., Dozois, A., Bouchard, S., Morie, J. F., & Ilan, D. (In press.) The effects of scent and game play experience on memory of a virtual environment. *Journal of Virtual Reality*.

Usoh, M., Arthur, K., Whitton, M., Bastos, R., Steed, A., Slater M. & Brooks F. (1999). Walking > Walking-In-Places > Flying In Virtual Environments. In *Proceedings of ACM SIGGRAPH 1999.*

Witmer, B.G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators and Virtual Environments, 7 (3)*, 225-240.