

Image vs. Sound: A Comparison of Formal Feature Effects on Presence, Video Game Enjoyment, and Player Performance

Paul Skalski, Robert Whitbred, & Pete Lindmark

Cleveland State University
{p.skalski, r.whitbred, p.lindmark@csuohio.edu}

Abstract

This study investigates the relative influence of two formal features of video games—image quality and sound quality—on presence, enjoyment, and player performance. A 2 x 2 between subjects experiment was conducted manipulating image quality (high definition vs. standard definition) and sound quality (Dolby 5.1 surround sound vs. Dolby stereo). Results indicated that, while image quality had no effect on outcomes, sound quality almost universally impacted outcomes of interest, including multiple measures of presence and enjoyment. Implications of these findings are discussed.

Keywords--Video Games, High Definition (HD), Surround Sound, Enjoyment, Player Performance

1. Introduction

Video games have become a serious subject of scholarly inquiry in recent years, no doubt due in part to their growing popularity. In 2008, the game industry had record profits of \$21.33 billion in the U.S. alone, up 19 percent from the previous year [1]. Much of the rise in gaming's popularity can be attributed to technological advancements. Game industry growth has traditionally been fueled in part by technical innovation [2], and many exciting developments have happened in recent years, including the Nintendo Wii's motion controllers and gradual improvements in graphics and sound that have persisted since the early days of gaming [3]. These latter characteristics are the focus of the present investigation.

Despite the many intriguing technological features of video games, including their interactivity, visuals, and sound, most of the literature on games to date has focused on game content such as violence. In a review of the gaming literature, Lee and Peng [4] lament the lack of research on formal features and call for more attention to them, since some evidence suggests formal features may be as important as content in determining outcomes of media exposure [5]. This paper helps answer their call. It presents the results of a study examining how two prominent features of emerging game technology—high definition (HD) visuals and surround sound—impact presence, game enjoyment, and player performance in a game.

2. Literature Review

As Tamborini and Skalski [6] suggest, an immediate outcome of exposure to advanced game technology should be the experience of presence, due to the rich combination of sensory and motor engagement games provide. This section begins by reviewing the literature on presence before shifting to reviews of scholarship on formal features, enjoyment, and player performance outcomes.

2.1. Presence

The International Society for Presence Research (ISPR) [7] defines presence as “a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience.” Beneath this broad umbrella of “presence,” scholars have identified even more specific types of the concept, including spatial presence, social presence, and self presence [8]. Lombard and Ditton [9] break presence down even further into immersion, realism, social richness, and other dimensions getting at subtle distinctions in presence experiences. All of these share in common the notion of the “perceptual illusion of nonmediation,” and this should be more likely occur in response to certain technologies. Although the relationship between video game formal features and presence has received little attention to date, there are a few noteworthy studies that address the link between presence, image quality, and sound quality. These will now be reviewed.

2.2. Image Quality and Presence

Image quality has been the focus of several presence-related studies in this decade. The forced diffusion of high definition (HD) television has made it a timely consideration, and image quality has been shown to positively impact presence and additional outcomes of television exposure [10]. In the case of games, only one published study to date has investigated the impact of high definition (HD) gaming on presence. In an experimental study, Bracken and Skalski [11] found that a HD version of a video game led players to experience more immersion than a standard definition

version of the same game, though spatial presence was unaffected. More research on high definition gaming is important for several reasons. First, due to the mandated switch to HD broadcasting in the U.S. this year, more and more consumers will be purchasing and using televisions with HD capability. Second, the game industry has actively promoted HD as a prominent feature of the new generation of gaming consoles and is expected to produce increasingly realistic HD games in the coming years [12]. As a result, game image quality remains an important formal feature in need of further inquiry.

2.3. Surround Sound and Presence

Compared to image-related variables, sound has received considerably less attention in the presence literature. Lessiter and Freeman [13] found that a 5.1 mix (five sound channels plus bass) had a greater effect on presence than a stereo or mono mix, and that the effect was likely due to the inclusion of the bass. No study to date has examined the impact of video game sound on presence, however, despite considerable advances in game sound over time. Games have progressed from very limited, technologically constrained sound in their early days (“beeps” and “bloops,” essentially) to real synthesized music and sound today [14]. In addition, the current generation of games incorporates cinema-like sound mixing allowing for multi-channel surround output, which is the basis for the sound manipulation in this study.

2.4. Game Enjoyment

Recent attempts have been made to direct more attention to the study of media enjoyment [15], given that it is perhaps the most basic reason for engaging in media use and has tremendous theoretical and applied implications. Some scholars have attempted to theoretically link enjoyment and entertainment to presence [16], and some research supports this connection [17], but more is needed.

2.5. Player Performance

A final outcome considered in this study, player performance, has to do with success and failure in a game. This is a fairly unique outcome in the experience of video game play (compared to other forms of media) that is beginning to receive attention from scholars. Klimmt, Hefner, Vorderer and Roth [18] examined the relationship between player performance, self esteem, and enjoyment and found that performance did impact enjoyment of expert players in particular. Performance has yet to be linked to advanced formal features of games, even though there are some intuitive connections. One might expect the player of a high definition action game, for example, to be able to see enemies more clearly and therefore perform better than the player of a standard definition game. Similarly, one might

expect players of a surround sound action game to be able to hear enemies better, including their gunshots, footsteps, etc., resulting in better performance than players of a normal (two-channel) sound game.

3. Hypotheses

The first two hypotheses and research question address the individual and joint effects of image quality and sound quality on presence dimensions, based on the logic presented earlier.

H1: High definition (HD) players will experience more presence than standard definition (SD) players.

H2: Surround sound players will experience more presence than two-channel sound players.

RQ1: What is the relative influence of image and sound quality on presence?

The next two hypotheses and research question address the individual and joint effects of image quality and sound quality on enjoyment, again based on logic from the literature review:

H3: High definition (HD) players will experience more enjoyment than standard definition (SD) players.

H4: Surround sound players will experience more enjoyment than two-channel sound players.

RQ2: What is the relative influence of image and sound quality on enjoyment?

A final research question considers the role of image quality and sound quality in player performance:

RQ3: How do image and sound quality relate to success and failure in the game?

4. Methods

In a 2 x 2 between subjects experiment, participants were randomly assigned to play a first-person shooter video game in either high definition (1080i lines) or standard definition (480 lines) and either surround sound (Dolby 5.1) or two-channel sound (Dolby stereo). They then completed measures of presence dimensions and game enjoyment, along with control variables. A researcher also recorded their game performance in terms of kills and deaths.

4.1. Participants

Participants in this study (N = 74) were undergraduate Communication students at a medium-sized Midwestern

university who received course credit for their participation. The age range was 18 to 26 years ($M = 20.96$; $SD = 1.60$), and 35 of the 74 participants (48%) were male.

4.2. Stimulus

Participants played the Xbox 360 version of the Tom Clancy video game *Ghost Recon Advanced Warfighter*. This highly realistic and highly rated first-person shooter title (www.metacritic.com) puts players in the role of a U.S. Army soldier from the near future that must battle insurgents in Mexico City (see screenshot, Figure 1). To avoid narrative elements and maximize experimental control, the game was set up on a multiplayer map simulating part of an urban environment, with a 10 minute time limit and 50 computer controlled “bots” for players to fight against. All players were equipped with an assault rifle, handgun, and grenades and started play at the same location in the city, after which time they were free to explore and eliminate as many enemies as possible. When players were killed, they respawned at the start and began again. This repeated until the time limit expired.



Figure 1 *Ghost Recon Advanced Warfighter*

4.3. Procedure

Upon arriving at the research laboratory, participants were asked to fill out a consent form. They were then escorted into a 7 x 12-foot carpeted room containing a 52-inch screen television and a comfortable couch, which sat 4.77 feet from the screen. Once seated, the experimenter briefly explained how to play and control the game. This process took approximately one minute per participant, after which the game was started and the participant was left to play alone for 10 minutes. After the allotted time, the experimenter returned to the room and administered the questionnaire to the participant at a table away from the playing area. While the participant filled out the survey, the

experimenter stayed in the playing area and wrote down the player performance numbers, which were recorded by the game. Once finished with the survey, the participant was debriefed and dismissed by the experimenter. The entire process took 30-40 minutes.

4.4. Independent Variables

Image quality was manipulated by randomly selecting participants to play the game in high definition (1080i lines) or standard definition (480 lines) before the study began. The Xbox 360 has a switch on the video cable that allowed for quick switching back and forth.

Sound quality was manipulated by randomly selecting participants to play the game with surround sound (Dolby 5.1) or two-channel sound (Dolby stereo). A Yamaha receiver with 5 speakers and a subwoofer was used for this manipulation. Volume was kept comparable through a dial on the receiver, which provided a precise digital readout of the levels.

In both cases, the intent was to compare features of a traditional gaming experience (i.e., standard definition, stereo) to features of a gaming experience with maximized image and sound quality given current technology (i.e., 1080i HD, Dolby 5.1). This provided strong manipulations of both independent variables.

4.5. Dependent Measures

Five dimensions of presence were measured for this study, using the Temple Presence Inventory (TPI) [19]. The dimensions and their corresponding Cronbach's alphas were as follows: engagement (.73), spatial presence (.78), social richness (.82), social realism (.82), and perceived realism (.74).

Enjoyment was measured using eight items on a scale ranging from “1” (strongly disagree) to “7” (strongly agree). Indicators of enjoyment included “This was a fun game” and “I would like to play this game again.” These items were summed to create an index of enjoyment, the reliability of which was $\alpha = .96$.

Player performance was measured by the game. It kept track of the number of enemies the player defeated (kills) and the number of times the player was defeated (deaths). These numbers were recorded by a research assistant at the conclusion of each playing session.

4.6. Control Variables

A variety of control variables were also accounted for in this study, including a pre-test of game playing skill using the GaPS scale [20] and post-test measures of sex, age, and game playing experience.

5. Results

A series of two-way analyses of variance with image quality and sound quality as independent variables were used to test the hypotheses and research questions. The control variables were included in the analyses as covariates.

Figures 2 and 3 illustrate the results for the first two hypotheses and research question one. Hypothesis one predicted players in the high definition condition would experience greater presence than those in the standard definition condition. The ANOVA analysis showed there were no significant differences for any of the five dimensions of presence. Hypothesis two predicted players in the surround sound condition would experience greater presence than those in the normal (two-channel) sound condition. Results show this was supported for the following four dimensions of presence: a) engagement ($F(3,73) = 8.88, p < .05$); b) spatial presence ($F(3,73) = 7.53, p < .05$); c) social richness ($F(3,73) = 7.80, p < .05$); and d) perceived realism ($F(3,73) = 6.41(3,73), p < .05$). Only social realism was not significantly different as a function of sound. There were also no significant interactions.

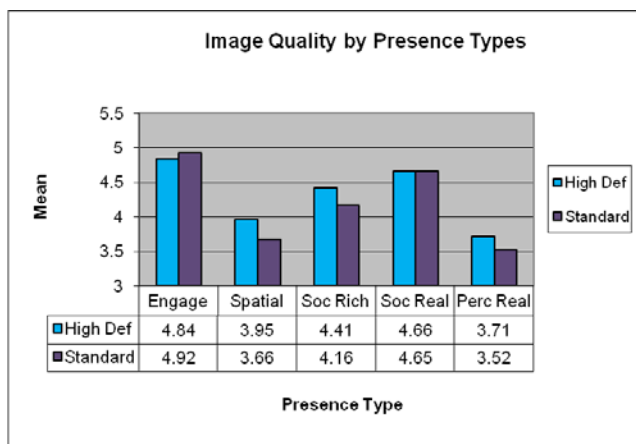


Figure 2

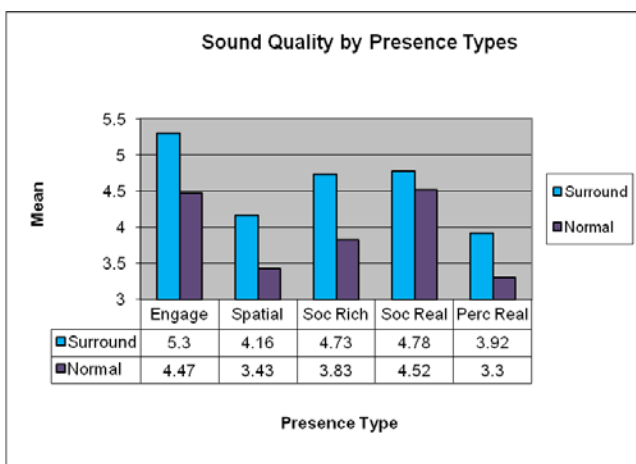


Figure 3

Figure 4 illustrates the results for hypotheses three and four and the second research question, which predicted that enjoyment would vary as a function of image and sound quality. These findings were similar to those for hypotheses one and two. Specifically, while there was no significant difference between the high and standard definition groups, participants who played with surround sound reported more enjoyment than those with normal sound ($F(3,73) = 4.33, p < .05$). There was no significant interaction.

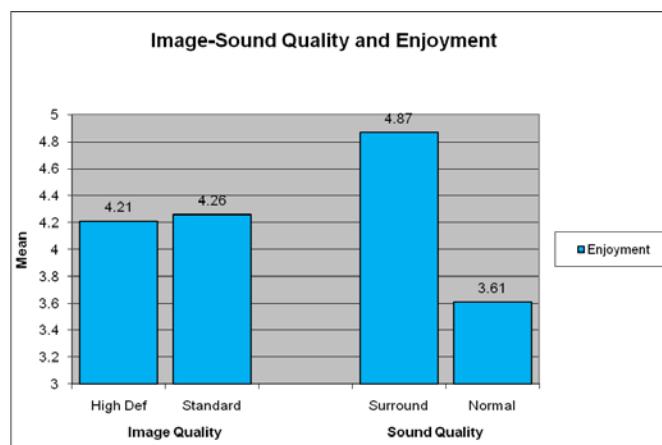


Figure 4

The final research question asked about player performance as a function of image and sound quality. The effect of sound on the number of times the player died approached significance. Players in the surround sound condition died less (M deaths = 6.55) than those in the normal sound condition (M deaths = 8.15), $F(3,73) = 3.08, p = .08$. But the only positive predictor of deaths was the covariate game playing skill, $F(3,73) = 4.29, p < .05$. In the case of kills (or the number of enemies the player defeated), neither of the formal features had a significant impact, though players had more kills in the surround sound condition ($M = 16.55$) than in the normal sound condition ($M = 14.40$). Instead, maleness ($F(3,73) = 16.07, p < .05$) and age ($F(3,73) = 5.30, p < .05$) emerged as significant predictors.

6. Discussion

A very clear pattern emerged in this study—surround sound had a much more pronounced effect on player presence and enjoyment than normal sound or image quality. One exception was the lack of impact of surround sound on social realism. It may have been that the violent nature of the game was so far removed from participants' realities that presence was not appropriate for this dimension. Regardless, the sheer number of significant findings for surround sound, which were well above what would be expected by chance, call attention to the importance of sound in the experience of

video games. Even the non-significant findings for social realism and player performance were more favorable with surround sound and may not have emerged as significant simply as a function of statistical power or measurement error. The pattern of results in this study tells a story, and it speaks loudly in favor of the merits of sound.

Sound quality may indeed be more important to video game play than image quality, at least in the case of high definition versus surround sound. Although the game industry has been pushing HD with its latest generation of consoles [12], they may draw players in even more through sound, either by promoting the value of adding surround equipment to a gaming setup or by developing their own innovative technologies to engage the senses of players. Given the recent focus on graphics and interface improvements, sound seems like a logical next “frontier” for the industry to explore.

The failure of image quality to affect outcomes in this investigation was surprising, given some evidence to contrary [11]. It may be that, since HD gaming is still in its infancy, the differences between HD and standard definition game graphics are still not pronounced enough to have an effect with certain titles, or as they do in the more realistic medium of television. As image quality improves even further in games and titles are developed to maximize this potential, these findings may change, and historical evidence comparing generations of games points to this likelihood [3].

This study also sheds light on predictors of player performance, an important new consideration in video game research [18]. Although sound did not affect either player performance outcome in this case, it bears further exploration, given the overall dominant pattern for surround sound in this study. In addition, this study highlights the need to consider control variables such as game playing skill, which are especially important in determining player performance outcomes.

There are some questions raised in this study that need to be addressed in subsequent work. First, the role of presence dimensions as a mediator between formal features and enjoyment should be tested, given that presence likely functions in this manner. Second, the exact determinant of surround sound effects should also be parsed out. Since the goal of this study was to create a strong manipulation of sound quality, it did not do this, but future research should test, for example, if bass was the primary determinant of the sound findings, as has been discovered in past work [13]. If bass *was* found to be the primary reason for the consistent effects on multiple presence dimensions *and* enjoyment *and* (though non-significantly) player performance observed in this investigation, this would raise many fascinating questions, but until further work is completed we simply cannot be sure.

Overall, this study advances knowledge of formal feature effects on outcomes of video game exposure. Future work should continue to examine image quality, sound quality, and other formal features, along with their interaction with

content, to gain a better understanding of the experience of video game play.

References

- [1] B. Sinclair. NPD: 2008 game sales reach \$21 billion, Wii Play sells 5.28M. *GameSpot*. 2009.
- [2] D. Williams. A structural analysis of market competition in the U.S. home video game industry. *International Journal on Media Management*, 4(1), pp. 41-54. 2002.
- [3] D. J. Ivory, S. Kalyanaraman. The effects of technological advancement and violent content in video games on players' feelings of presence, involvement, physiological arousal, and aggression. *Journal of Communication*, 57, 532-555. 2007.
- [4] K. M. Lee, W. Peng. (2006). What do we know about social and psychological effects of computer games? A comprehensive review of the current literature. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences*. Mahwah, NJ: Lawrence Erlbaum. 2006.
- [5] B. Reeves, C. Nass. *The media equation*. Cambridge University Press. 1996.
- [6] R. Tamborini, P. Skalski. The role of presence in the experience of electronic games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences*. Mahwah, NJ: LEA. 2006.
- [7] International Society for Presence Research. *The concept of presence: Explication statement*. 2000. Retrieved June 20, 2009 from <http://ispr.info/>.
- [8] K. M. Lee. Presence, explicated. *Communication Theory*, 14, 2004.
- [9] M. Lombard, T. Ditton. At the heart of it all: The concept of presence. *Journal of Computer Mediated Communication*, 3, 27-50. 1997.
- [10] C. C. Bracken. Presence and image quality: The case of high definition television. *Media Psychology*, 7(2), 191-205. 2005.
- [11] C. C. Bracken, P. Skalski, P. Presence and video games: The impact of image quality. *Psychology*, 7(1), 101-112. 2009.
- [12] J. Cross. "HD Era" coming to gaming. ExtremeTech. 2005. Retrieved June 26, 2009 from <http://www.extremetech.com/>
- [13] J. Lessiter, J. Freeman. Really hear? The effects of audio quality on presence. *Proceedings of the 4th international workshop on presence*. Philadelphia, PA. 2001.
- [14] S. M. Zehnder, S. D. Lipscomb. The role of music in video games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences*. Mahwah, NJ: LEA. 2006.
- [15] M. B. Oliver, R. L. Nabi. Exploring the concept of media enjoyment: An introduction to the special issue. *Communication Theory*, 14(4), 285-287. 2004.
- [16] C. Klimmt, P. Vorderer. Media psychology “is not yet there”: Introducing theories on media entertainment to the presence debate. *Presence: Teleoperators and Virtual Environments*, 12(4), 346-359. 2003.
- [17] P. Skalski, R. Lange, R. Tamborini. Mapping the way to fun: The effect of video game interfaces on presence and enjoyment. *Proceedings of the ninth annual international workshop on presence*. Cleveland, OH: Cleveland State University. 2006.
- [18] C. Klimmt, D. Hefner, P. Vorderer, C. Roth. Exploring the complex relationships between player performance, self-

esteem processes, and video game enjoyment. Paper presented at the annual meeting of the International Communication Association, Montreal, Canada. 2008.

- [19] M. Lombard, T. B. Ditton. Measuring presence: The Temple Presence Inventory (TPI). 2007. Retrieved on June 29, 2009 from <http://astro.temple.edu/~lombard/research/>
- [20] Bracken, C. C. & Skalski, P. Presence and video games: The impact of image quality and skill level. *Proceedings of the ninth annual international workshop on presence*. Cleveland, OH: Cleveland State University. 2006.