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The Psychology of the 3D Experience

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THE PSYCHOLOGY OF THE 3D EXPERIENCE

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ABSTRACT

With 3D televisions expected to reach 50% home saturation as early as 2016, understanding the psychological mechanisms underlying the user response to 3D technology is critical for content providers, educators and academics. Unfortunately, research examining the effects of 3D technology has not kept pace with the technology's rapid adoption, resulting in large-scale use of a technology about which very little is actually known. Recognizing this need for new research, we conducted a series of studies measuring and comparing many of the variables and processes underlying both 2D and 3D media experiences. In our first study, we found narratives within primetime dramas had the power to shift viewer attitudes in both 2D and 3D settings. However, we found no difference in persuasive power between 2D and 3D content. We contend this lack of effect was the result of poor conversion quality and the unique demands of 3D production. In our second study, we found 3D technology significantly increased enjoyment when viewing sports content, yet offered no added enjoyment when viewing a movie trailer. The enhanced enjoyment of the sports content was shown to be the result of heightened emotional arousal and attention in the 3D condition. We believe the lack of effect found for the movie trailer may be genre-related. In our final study, we found 3D technology significantly enhanced enjoyment of two video games from different genres. The added enjoyment was found to be the result of an increased sense of presence.

Keywords: S3D, 3D video games, 3D entertainment, physiological arousal, enjoyment, transportation, 3D storytelling

1. INTRODUCTION

With the swift arrival of 3D technology in our living rooms, content creators are pressured to keep up with increased demand by consumers. Unfortunately, simply applying 2D storytelling conventions to 3D content is not the best option to meet this demand. So, developing new forms and approaches to storytelling within a 3D environment is critical. But how do we go about this? Our study will contribute to the exploration of this question from the perspective of media psychology. Our project investigates several variables underlying a positive 3D entertainment experience, as well the process through which entertainment narratives can impact a viewer's attitudes about particular issues (i.e., narrative persuasion). We look specifically at the process of transportation into the narrative world, an experience that has been shown to be critical to both entertainment and narrative persuasion. We contend that the immersive nature of 3D lends itself to a heightened sense of transportation (or presence in the genre of video game play) for the viewer, which ultimately should impact his enjoyment and narrative persuasion. In addition to the traditional media psychological assessments of the user experience, we also investigated physiological reactions (i.e. heart rate) to various forms of 3D content. Our project involves three experimental studies, using a variety of 2D and 3D content. Our work takes a first step to better understanding the 3D entertainment experience from a media-psychological perspective, offering a model of how academic research can assist in the advancement of this technology.

2. ENJOYMENT AND NARRATIVE PERSUASION IN 3D

2.1 Literature review

Since the release of *Avatar* in 2010, Stereo 3D entertainment has enjoyed sudden and strong consumer interest. With 3D televisions expected to reach 50% home saturation as early as 2016, understanding the psychological

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mechanisms underlying the user response to 3D technology is critical for content providers, educators and academics. Clearly, 3D entertainment offers a rich media environment and viewing experience that should have a profound impact on various psychological processes. Our first study concentrates on the psychological processes involved in the enjoyment of entertainment fare, as well as the power of narrative persuasion.

Enjoyment has been defined by media psychologists as an experience of pleasure, motivated by mainly hedonic concerns.^[1] Over decades, media psychologists investigated the aspects leading to enjoyment of entertainment fare across various genres, including factors of transportation^[2], suspense^[3], emotional arousal^[4], perceived realism^[5], empathy^[6], and identification^[7], among others.

Of course, research has shown that entertainment media can do much more than just elicit enjoyment. Ongoing research consistently demonstrates that consumers' real-world beliefs about a variety of issues can also be shaped by narrative storylines. For example, attitudes and beliefs regarding family planning^[8], HIV prevention^[9] or organ donation^[10], have all shown to be susceptible to influence through narrative persuasion. This is especially true if existing attitudes and beliefs about those issues are weakly held. In some cases, the persuasive efforts are intentional—even hoped for—as with so-called entertainment-education content designed to change specific (often health-related) attitudes and behaviors. In content often designed to only entertain, such as primetime dramas, the persuasive effects are the unintentional consequences of a rich and engaging storyline. Regardless of intentionality, the process underlying the shifts in consumers' attitudes and beliefs is referred to as narrative persuasion.

Over the past decade, researchers have attempted to better understand the mechanisms most responsible for narrative persuasion. Their work has identified transportation as a key attentional mechanism leading to narrative persuasion as well as media enjoyment^[2, 11].

In literature, transportation is described as an experience where the media user feels as if he or she is within the narrative, being lost in a story, with no regard or recognition of their “real world” surroundings^[12]. We know that while transported or absorbed in the narrative, viewers temporarily lose or disengage certain frames of reference for information processing^[13]. Consequently, they avoid critical evaluation of the messages presented, because most of their cognitive and emotional resources are dedicated to the storyline and their intent to “enjoy” the story. As a result, they become more likely to adopt message consistent beliefs^[14, 15, 16]. This research suggests that enjoyment and belief change are positively related to each other because the act of enjoyment depletes the cognitive resources viewers need to effectively evaluate the congruency of persuasive messaging.

A main aspect that Green and Brock^[14] have identified in their *transportation imagery model* is the importance of visual imagery in transportation-based belief change. Essentially, research suggests that through imagery, users can construct mental models of the narrative that include not only the storyline, but also the related beliefs, attitudes and behaviors of the characters. Consequently, subsequent recalling of attitudes or beliefs that was presented in the storyline is more likely to be activated and assimilated into the existing attitude structure of the consumer.

Because 3D entertainment offers increased potential for depth, richness, and vividness of visual imagery, narratives presented in 3D may immerse the audience deeper in the stories, thereby enhancing transportation. Recognizing transportation as a key mechanism for narrative persuasion – as well as enjoyment – our primary research questions for the first two studies were: What persuasive power do narratives hold? What role does 3D technology have in facilitating narrative persuasion? And finally, what features make 3D narratives enjoyable?

Generally, we know that not all media content results in transportation. So, what exactly are the features of narrative content that results in transportation? Research has shown that *perceived realism* of the story characters^[17, 18] as well as the process of *identification*, are both important variables in the appearance of transportation^[19, 20]. Furthermore, transportation is also related to emotional arousal^[21], with elevated arousal leading to a greater sense of transportation. Therefore, we assume that if all these variables are highly engaged, then the likelihood and sense transportation will be maximized, resulting in stronger narrative persuasion and content enjoyment.

Of course, we are not without some precedent for our assumptions regarding the influence of enhanced viewing technologies. Research into the effects of high-resolution displays showed that the presentation of fictional narratives on high definition (HD) televisions heightened perceived reality, transportation, and enjoyment, compared to the same content presented in standard definition^[22]. Furthermore, Green^[17] showed that the more realistic the content was perceived to be, the more transportation the consumer experienced. Assuming that 3D has even more

potential than HD to activate these processes, we believe the power of narrative persuasion may be even more pronounced in a 3D environment.

It should be noted that our assumptions are based entirely on studies conducted in a 2D environment. We must rely on 2D studies because academia is only slowly beginning to investigate “old” media psychological concepts within the “new” 3D environment. One reason for the lack of scientific investigation of 3D technology is the scarcity of content appropriate for research purposes. Also, the rapid advances in 3D technology – coupled with the confusion of competing formats – has prevented researchers restricted by academic budgets from acquiring the equipment needed for experiments (see Raney, Ellis & Janicke, 2012 for a more extensive review on the methodological shortcomings of academic 3D research^[23]). Despite these challenges, our 3D Media Team in the School of Communication at Florida State University was able to conduct several pilot studies in the summer of 2011, investigating the relative advantage of 3D entertainment on the aforementioned concepts.

2.2 Method of study 1

In order to conduct highly generalizable research (high in ecological validity^[24]), our first study used two popular 2D TV shows converted into 3D using a JVC IF2D3D1 image processor. Recognizing the quality issues often associated with real-time conversion, we also measured the perceived quality of converted material and its impact on the viewer’s satisfaction. The episodes were from the broadcast television series *Grey’s Anatomy* (Enough is Enough, 2005) and *Numbers* (Harvest, 2006), both addressing the positive impact of organ donation.

The study sample consisted of 196 undergraduate students enrolled in communication courses at a large public university. In exchange for their participation, the students received course or extra credit. The majority of the participants were female (67.1%) and white (61.1%), with an average age of 20.52 years. Participants were tested in groups of up to 9 people during a 3-week time period in summer 2011. The sessions were conducted in a conference room equipped with a JVC 3D television screen. The participants were not aware of which episode they were to see, nor did they know that the study investigated the effects of 3D television, effectively controlling for any 3D related expectations across groups. Both the episode and viewing condition were randomly assigned for each session. Overall, 50 participants watched *Grey’s Anatomy* in 2D and 48 in 3D; 44 participants watched *Numbers* in 2D and 54 in 3D.

Upon arrival, participants were welcomed by the lead investigator, provided with an IRB-approved consent form, and given an overview of what would occur during the study. Next, the subjects were given a pre-exposure questionnaire to collect information regarding demographics, previous experience with 3D entertainment, and familiarity with the shows featured in the study. Following the pretest, the subjects viewed the complete episode of the show called for in the randomization process. The subjects were then asked to complete a posttest questionnaire measuring transportation, enjoyment, emotional arousal, identification, and narrative persuasion. Finally, after completion of the posttest, participants were debriefed, thanked, and dismissed. All items appearing in the questionnaires were validated in previous studies, assuring high scientific standards.

2.3 Results of study 1

In terms of the overall power of narrative persuasion, we found that the beliefs promoted in the episodes did influence the belief structures of viewers in both the 2D and 3D conditions. When viewers were exposed to the episodes of “Numbers”, they were more likely to believe that there is a “black market for organ donation” in the US, compared to people that saw “Grey’s Anatomy,” where this notion was not portrayed (Figure 1).² This finding agrees with previous research suggesting media content can prime viewers toward specific beliefs^[25], regardless of the accuracy of the beliefs presented within the narrative.

² A one-way MANOVA was conducted with TV shows as independent variable and the belief items as dependent variable to investigate if beliefs about organ donation are significantly correlated with the content presented in the entertainment TV storyline.

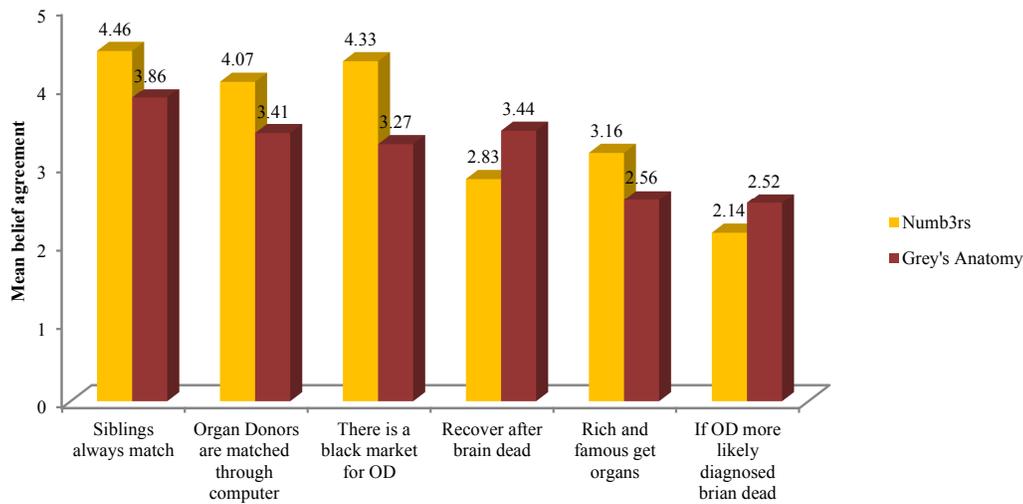


Figure 1. Mean values on the beliefs about organ donation as a result of study one.

Knowing that the episodes watched indeed influenced viewers' beliefs, our research next worked to determine if narratives presented in 3D are more persuasive than narratives presented in 2D. Our research assumed that the variables that predict narrative persuasion and enjoyment – transportation, perceived realism, emotional arousal and identification— would be stronger in the 3D condition than in the 2D condition. Surprisingly, our results showed no significant³ differences between the 3D and 2D conditions in terms transportation, perceived realism, arousal, identification, or narrative persuasion.⁴ Even overall enjoyment did not differ across the research conditions. Based on these findings, it seems 3D technology does not significantly influence the persuasive power of narrative content.

2.4 Discussion of study 1

Our failure to find significant differences between the 2D and 3D conditions may not point to the ineffectiveness of 3D, but rather to its finicky nature. As previously mentioned, real time conversion of 2D content to stereoscopic 3D is notoriously problematic, often resulting in a product far inferior to native 3D content. In our study, we used a consumer-grade conversion device, designed more for ease of use than quality of product. This type of conversion offers little control over the stereoscopic effect, forgoing scene-by-scene depth control with preset, one-size-fits-all parameters. In contrast, it took a room-filling team of experts more than 15 months to convert James Cameron's Titanic from 2D to 3D, at a cost of more than \$18 million dollars^[26]. Using our device, the conversion would have taken only a few hours. Therefore, it is reasonable to consider the low quality of our 3D content as a possible alternative explanation for our findings.

Another reason we may have failed to find significant differences can be found in the highly complicated nature of 3D storytelling. The episodes we selected for this study were conceptualized and shot specifically for playback in a 2D environment. Consequently, the unique requirements of 3D production and storytelling were never considered in any phase of their creation. While this concern may appear exaggerated to those unfamiliar with 3D production, the emerging belief across the industry is that 3D production should be treated as a unique art, wholly independent of 2D production. In other words, the entire lifecycle of a 3D product, from scripting to camera positioning to exhibition, should account for the unique requirements of successful 3D production. James Cameron himself noted at the 2011 3D Entertainment Summit that even with the most skillful conversion, 2D content can never fully be 3D^[26].

³ A significant result means that the observed effect is in 95% of all cases not due to chance.

⁴ A two factorial MANOVA analysis was conducted with condition (3D vs. 2D) and episode (Numbers vs. Grey's Anatomy) as independent variables on the 6 dependent variables.

In light of the above concerns, we believe our findings do not reflect 3D's influential power, but rather reveal its sensitivity to quality and reliance on unique production standards. Simply put, 3D storytelling is much more than 2D storytelling with an added dimension. To effectively isolate the effects of 3D technology, we believe research efforts should work to account for this distinction in experimental design.

2.5 Method of study 2

Our second study also explored 3D's influence on content enjoyment, but this time our design featured content shot in 3D, but intended for playback in both 2D and 3D environments. While this new design effectively addresses our concerns regarding 2D content presented in a 3D environment, it creates a new – and opposite – concern regarding the effectiveness of 3D content presented in a 2D environment. Fortunately, this concern is somewhat tempered by the fact the creators intended for the content to be enjoyed in both 2D and 3D environments. Still, this is not an ideal solution, as some compromises were likely made in the effort to create dual-format content. We assume these compromises may weaken the observed effects, but to a lesser extent than seen in the first study.

As in the first study, we compared content across 2D and 3D conditions, this time using an ESPN3D sports clip and a movie trailer from the blockbuster movie “Resident Evil 3D”, both of which were available in Sony's 3D library. All study sessions were conducted in the media research laboratories in the School of Communication at Florida State University, using a 32-inch, Sony Bravia 3D monitor. Sessions were all conducted individually (i.e., one participant at a time) and each session lasted approximately 50 minutes. As in the previous study, participants were introduced by the experimenter, completed an IRB consent form and familiarized with the procedure. In addition to the posttest, which measured transportation, emotional arousal, presence (a feeling of nonmediation the viewer derives by forgetting about the technology that creates the image^[4]), and enjoyment, participants' heart rates were also monitored. We added the heart rate data as an indirect measure for attention, where lower pulse rates indicate heightened states of attention (for a recent overview, see Lang, Potter, & Bolls^[27]). The heart rate data was collected on a second-by-second basis throughout the exposure period using a wireless, reference heart monitor and specialized data collecting software.

A total of 57 (66.7% females, age range, 18-32 years, age mean = 19.93) individuals participated in this second within-subject design study, with 26 watching the sports clip in 3D and 31 in 2D, and 31 watching the “Resident Evil” clip in 3D and 26 in 2D. Activating the TV's preset 3D function enabled 3D playback, whereas disabling the 3D function created the 2D image,

As in the first study, this research aimed to uncover the influence of stereoscopic 3D technology on variables known to influence enjoyment, including transportation, emotional arousal, enjoyment and heart rate (attention).

2.6 Results of study 2

Our results support our assumption regarding the importance of format compatible storytelling. Most notably, we found that overall, participants enjoyed 3D content more than 2D content. However, when we examined the conditions individually, we only found a significant difference in enjoyment for the sports clip (Figure 2).

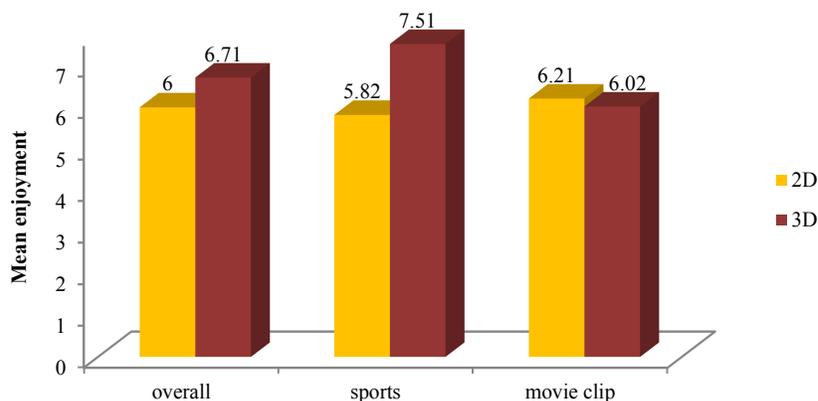


Figure 2. Mean values of enjoyment across the two video clips in study two.

In determining what underlying variable was most responsible for 3D’s added enjoyment, we found that emotional arousal – not the sense of non-mediation – was the significant predictor of enjoyment in the 3D sports clip condition. In contrast, for the 2D sports clip condition, neither presence nor emotional arousal contributed significantly to enjoyment. Though significant influence was only found for the sports clip, our findings suggest that 3D content created for 3D playback can lead to greater consumer enjoyment.

In addition to emotional arousal, viewers of the 3D sports clip paid more attention to the content (as indicated by the lower heart rate) than viewers of the 2D clip, suggesting that 3D content may demand different allocation of cognitive resources (i.e. thought processes) than 2D content (Figure 3). In conclusion, the 3D sports clip was found to be more enjoyable than the 2D clip because it was more emotionally arousing and captured more of the viewer’s attention than the 2D clip.

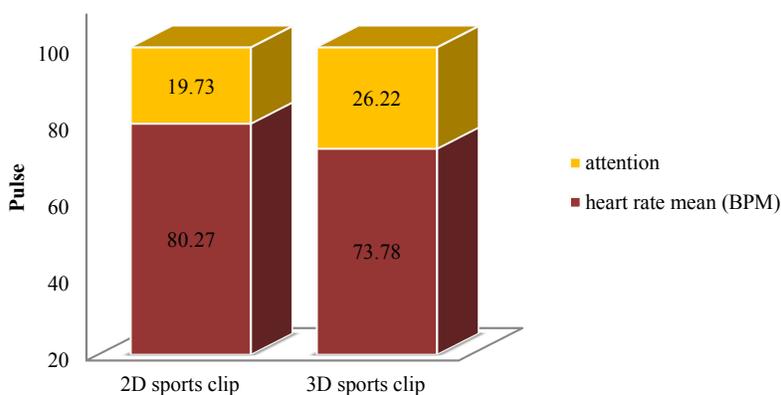


Figure 3. Heart rate and attention distribution in the sports clip between the 2D and 3D condition in study two.

For the narrative clip (Resident Evil), another pattern emerged. As previously mentioned, enjoyment was not significantly different between the 2D and 3D version of the clip. However, viewers felt more transported in the 3D clip than the 2D version of the narrative clip (Figure 4), which is what we expected. What is surprising, however, is that transportation did not predict enjoyment, which contradicts extensive 2D literature about the relationship of transportation and enjoyment [2].

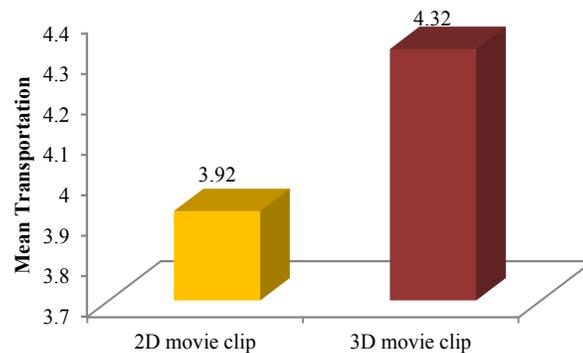


Figure 4. Feeling of transportation into the movie clip between the 2D and 3D version in study two.

Additionally, viewers paid less attention to the movie clip in 3D compared to the movie clip in 2D (higher heart rate and therefore less attention), which was in contrast to the results of the sports clip (Figure 5). One possible explanation for this finding is that the added realism of the 3D environment was “too much” for the participants, causing them to disengage entirely from the narrative. This explanation is even more plausible when you consider the graphic and suspenseful nature of the *Resident Evil* trailer.

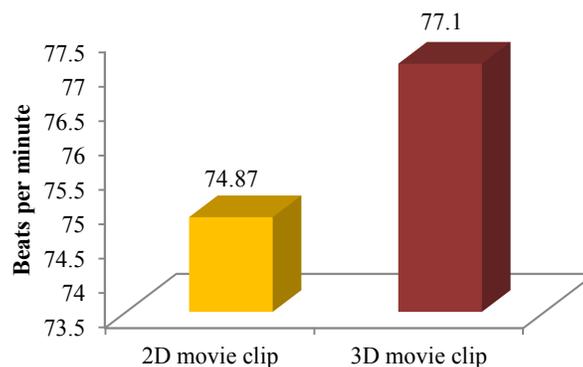


Figure 5. Mean heart rate in the movie clip for the 2D and 3D version in study two.

2.7 General discussion

The results of our first study agree with previous research findings, suggesting narratives do have a significant influence (at least in short-term) on a viewer’s beliefs. We believe the influence of 3D on narrative persuasion, however, is subject to technology and production practices used in the creation of the narrative content. Generally, our studies indicate enjoyment certainly seems to be influenced by specific features of the 3D content, strongly suggesting an effect on narrative persuasion may be found in future studies.

Our research also suggests that content matters. It seems viewers experience 3D differently across different genres, likely resulting from different storytelling processes. Whereas narratives in 3D may benefit from a stronger sense of transportation, sport content may benefit from an increase in emotional arousal, attention and enjoyment. Of course, additional studies are needed to make more generalizable conclusions regarding these findings. These studies may consider questions such as: Are the effects found in our study consistent for sports other than football and basketball? What consequence might the slower pace of sports, such as baseball, gymnastics, or golf have on 3D’s effects? Also, how permanent are these effects? Do the positive qualities of 3D sports viewing carry over to other

aspects of the same production? Are the ads remembered more during the games? Is fanship enhanced? What about the impact of 3D narratives on the change of attitudes? Can transportation be increased with a specific 3D storytelling procedure? What are the consequences for enjoyment? Ratings? Profit? How much are the enhanced viewing experiences of 3D bound to the genre? What about narratives found in other entertainment content, such as video games?

3. PSYCHOLOGICAL AND PHYSIOLOGICAL DIFFERENCES BETWEEN THE 3D AND 2D GAMING EXPERIENCE

3.1. Literature review

From the humble wireframe graphics of Atari's 1980 arcade hit, *Battlezone*, to the reality-bending, animated environment featured in Crytek's 2011 blockbuster, *Crysis 2*, the digital gaming industry has consistently managed to leverage improvements in technology for improvements in gameplay.^[28] For this legacy to continue, game developers must better understand how to leverage stereoscopic 3D technology in the gaming experience. To do so, developers first must identify the unique effects of 3D technology on key aspects of the gaming experience. To that end, in our third research project we investigated the effects of 3D technology on the enjoyment of two different video games.

Without question, the gaming experience is a complex and multifaceted phenomenon. In this study, we focus on key psychological and physiological phenomena likely to be influenced by stereoscopic technology: presence, engagement, immersion, arousal, and enjoyment. We examine these phenomena in both 3D and 2D conditions to effectively identify the unique qualities associated with "good" 3D games. Our goal is to better understand how current gaming features differentially impact these key variables.

Of course, this study is certainly not the first to examine the influence of new technology on the media experience.^[29] For example, Lee and Lee^[22] found that the enhanced resolution offered in high definition television (HDTV) increases perceived reality, presence and enjoyment of the content compared to standard definition. While technology has influenced virtually all media experiences in some way, we believe the interactive video game experience is especially sensitive to new technologies, as features critical to enjoyable gameplay, such as vividness^[30] and presence^[31] are likely to be affected. Furthermore, we believe the added realism of 3D gameplay will offer an ideal environment to study the effects of stereoscopic technology on game enjoyment. Specifically, we believe 3D technology will effectively increase a player's sense of presence, resulting in greater game enjoyment.

Presence is often conceptualized as the "perceptual illusion of nonmediation"^[4], arising when the individual disregards the existence of a medium or technology. Though common to most media consumers, the phenomenon is quite fickle, often varying considerably across users and time.^[32] Generally, the experience is thought to result from the user's interaction with various characteristics of the medium, including technological features^[4] and content.^[33]

Recognizing the role of technology, we can assume that stereoscopic 3D technology provides a richer and more immersive environment, capable of eliciting greater experiences of special presence. As for the influence of content, we can assume different games will elicit different degrees of presence across different users, regardless of the technology employed in the game's presentation. To test these assumptions, our study compared game enjoyment across two genres in both 2D and 3D conditions.

3.2 Method

The same sample of individuals participating in study 2 also participated in study 3. Likewise, the same methods were also employed in both study 2 and study 3. For stimulus materials, all the participants played either the racing game *Gran Turismo 5* (GT5) or the first-person shooter game *Killzone 3* on a Sony PlayStation3. As in study 2, all data were collected individually. Twenty-seven of the participants played the racing game in 3D, with the remaining 30 playing it in 2D. For *Killzone 3*, 31 participants played the game in the 3D condition, while 26 played it in the 2D condition. After a brief overview of the nature of each game and general gameplay functions, participants played GT5 for approximately three minutes and *Killzone 3* for approximately 10 minutes. Both GT5 and *Killzone 3* are

designed to be played in either 2D or 3D, with the on-screen gameplay otherwise equivalent. Participants were randomly assigned to play in one of the four research conditions upon arriving for the research session.

As in the previous studies, participants were given posttest questionnaires designed to measure various psychological constructs, including presence, immersion, involvement and overall game enjoyment. Likewise, the participants were also fitted with a reference-grade continuous heart monitor to measure both attention and physiological arousal.

3.3 Results

As we expected, 3D gameplay resulted in greater enjoyment, presence, immersion, and involvement than equivalent play in a 2D gaming environment (Figure 6).

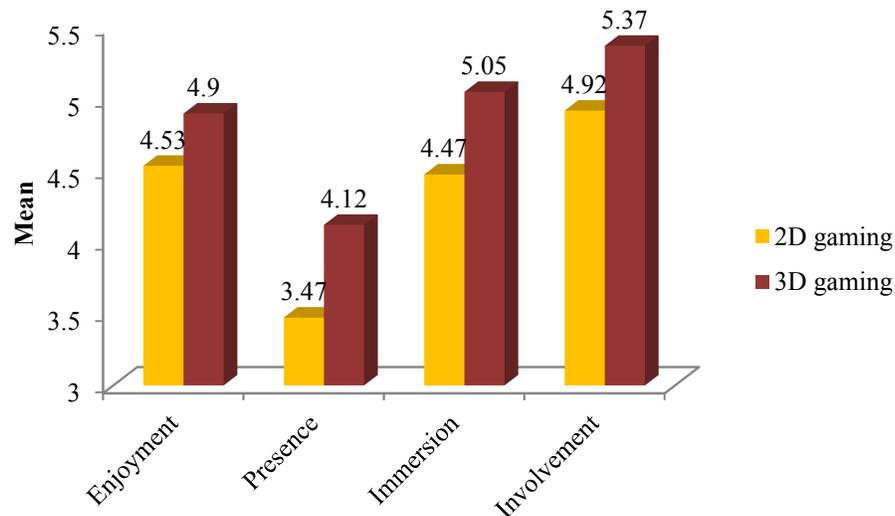


Figure 6. Mean differences in psychological measures across 2D and 3D gaming conditions.

While our hypothesis regarding 3D resulting in greater enjoyment was supported in the above analysis, the mechanism responsible for the added enjoyment was still unknown. Was the significant increase in presence responsible for the increase in enjoyment, as suggested by previous studies? If so, did 3D technology enhance presence through immersion, involvement, or both?

Factor analysis revealed, as expected, that enjoyment was highest for participants who reported the greatest sense of presence. Furthermore, presence was shown to be strongly associated with immersion. Interestingly, despite scoring higher in the 3D condition, no significant relationship was found between involvement and presence (Figure 7).

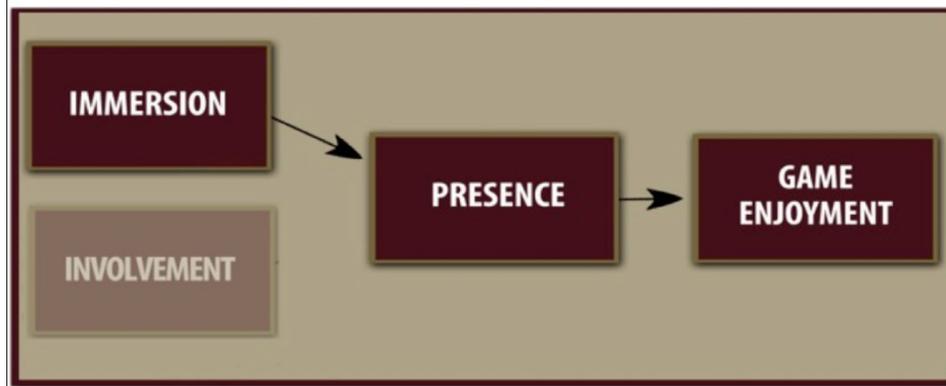


Figure 7. Factors contributing to game enjoyment.

In addition to psychological factors influencing game enjoyment, we also considered several physiological factors likely to influence the gaming experience, including arousal, heart rate (attention), and physical discomfort. Specifically, we expected arousal and attention to be associated with increased gaming enjoyment, and discomfort to be associated with decreased gaming enjoyment.

As was expected from the added realism of a stereoscopic gaming environment, users reported a greater sense of physiological arousal in the 3D condition compared to the 2D condition (Figure 8).

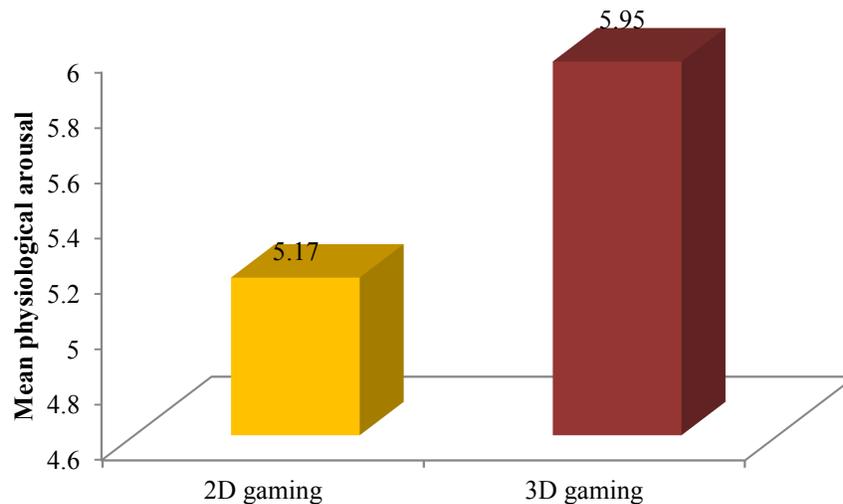


Figure 8. Mean arousal across research conditions.

While the mean scores for self-reported physiological arousal were significantly higher in the 3D condition, mean heart rate was significantly lower in the 3D condition (Figure 9). While this finding may appear contradictory, it is in full agreement with previous studies showing reduced heart rates to be associated with heightened states of attention. Therefore, we can assume players in the 3D condition paid more attention to the gameplay than players in the 2D condition.

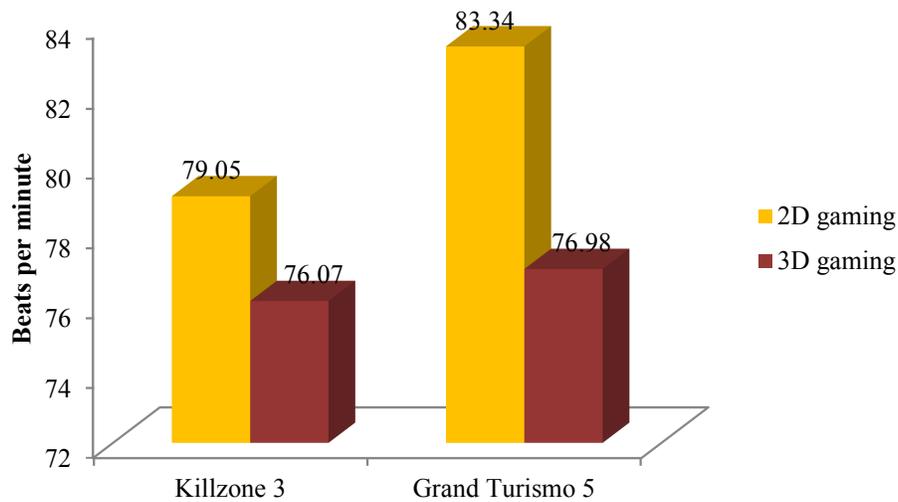


Figure 9. Average heart rate across game and technology conditions.

Surprisingly, of the physiological variables we measured, only arousal was shown to be an effective predictor of game enjoyment (Figure 10). These findings suggest that attention paid to the game, and physical discomfort experienced during gameplay, did not influence a user's overall enjoyment of the game. That discomfort did not affect enjoyment is especially important to the 3D industry, where discomfort is often associated with viewing stereoscopic material.

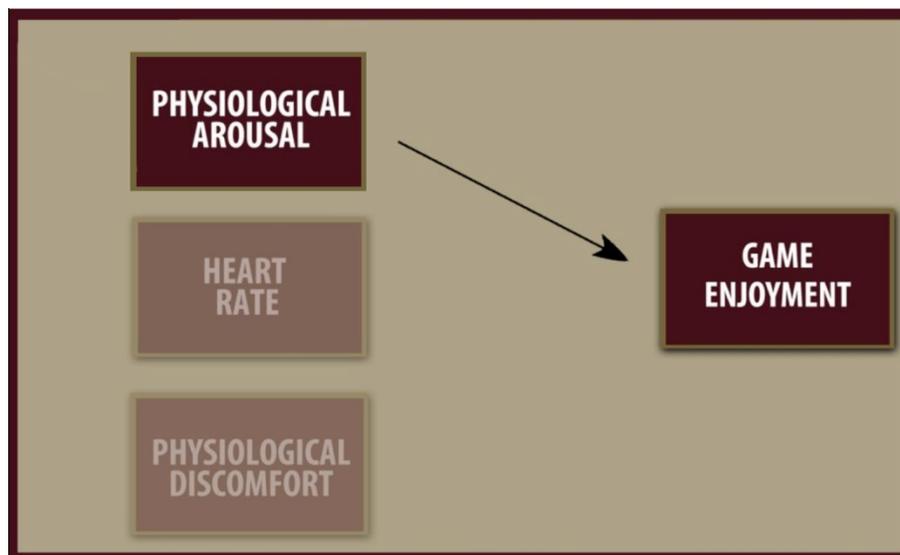


Figure 10. Physiological factors contributing to game enjoyment

3.4 Discussion

Once again, it appears the video game industry is on the forefront of new technology adoption, offering an ever-expanding library of 3D capable games. In fact, thanks to the relative ease in which 3D games can be produced (compared to video content), video games are sure to represent a significant proportion of all future 3D content. Game marketers have recognized the value in this innovation, spending more money every year touting the enhanced enjoyment of 3D gameplay.

But is 3D gameplay actually more enjoyable? Our research suggests it is, with players of both games reporting more enjoyable gameplay in the 3D condition. Furthermore, our research suggests this added enjoyment is a result of the heightened sense of presence associated with the more immersive 3D world. Our study also found that subjects reported more physiological arousal in the 3D condition, also contributing to overall enjoyment. Interestingly, enjoyment was not found to be associated with discomfort. Like roller-coaster riders ill from the ride but thrilled by the experience, 3D game players appear to accept discomfort as an inconsequential part of the enhanced gameplay.

Of course, this study only included two games, so generalizing the findings to all games is risky. Future research should include games from an assortment of other gaming genres, as certain types of gameplay may not benefit as significantly from 3D technology. Also, other researchers should consider more robust measures of physiological factors, as they may offer a more complete explanation of arousal's role in enjoyment of 3D games.

4. GENERAL CONCLUSION

The results of our three studies distilled the complex variable interactions outlined in our research agenda into a few small, yet strong relationships. Generally, we learned that 3D technology influences the media experience, though often in unpredictable ways. We also learned that psychological processes known to exist in the 2D environment, such as narrative persuasion, also exist in the 3D environment. Finally, and perhaps most importantly, we learned that 3D is a finicky format, seeming to exert influence only in ideal conditions. For researchers, this means careful consideration must be given to research design, especially in the selection of 3D content. Furthermore, it has been our experience that 3D technology does not exhibit a fixed, universal effect and is fully dependent on the content to which it is applied. Until we can effectively control for the countless variables influencing the 3D experience, we will have to continue examining the specific effects of selected 3D content instead of the broad effects of the technology in general.

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