In the Mind's Eyes: No Evidence for an Effect of Stereoscopic 3D on User Experience of Digital

Games

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Introduction

Advancements in stereoscopic technologies have not only lead to an explosion in 3D content, but also made it possible to enjoy 3D movies and games with home entertainment systems. Many studies have been carried out into the visual fatigue and (dis-)comfort of watching 3D (for a review see Lambooij, IJsselsteijn, Fortuin, & Heynderickx, 2009), as well as other rather detrimental side-effects like simulator sickness (e.g., Häkkinen, Pölönen, Takatalo, & Nyman, 2006). With the rise of its popularity, there have also been high expectations of an added value in enjoyment, immersion, and excitement especially of 3D games (IJsselsteijn, Bouwhuis, Freeman, & de Ridder, 2002).

However, only little research has been done into the effects of stereoscopic presentation on the user experience. IJsselsteijn and colleagues found that an increase in depth through stereoscopic displays can increase users' sense of spatial presence (IJsselsteijn, de Ridder, Freeman, Avons, & Bouwhuis, 2001; IJsselsteijn, de Ridder, Hamberg, Bouwhuis, & Freeman, 1998). In the experiment of Rajae-Joordens (2008), playing games in 3D evoked a greater sense of presence and positive emotions than their 2D counterparts. We conducted three experiments to investigate the effects of graphical presentation mode on several experience variables.

Experiment 1: Sly 2

In our first experiment, we recruited a total of $N = 65$ participants counterbalanced for gender and overall gaming expertise. They played the platform game *Sly 2: Band of Thieves* (Sucker Punch Productions, 2010) on a 46 inch 3D television screen connected to a PlayStation 3 in either SD, HD, or 3D (with shutter glasses) for 40 minutes. Afterwards, we assessed several experience variables with a battery of self-report measures including challenge, skill, enjoyment, identification, positive affect, spatial and embodied presence, and visual discomfort, on a 7-point

Likert scale. Surprisingly, results show virtually no difference in any variable between the conditions, and also not between males and females, or participants with and without expertise.

Experiment 2: Uncharted 3

One of the major issues we saw in our first study was the quality of the stimulus material. The 3D version of *Sly 2: Band of Thieves* is only a remake of the PlayStation 2 game from 2004, which was then certainly not created with 3D in mind. We considered that a more recent game created with stereoscopic 3D graphics from the beginning could have a stronger impact on the user experience. Thus, we used *Uncharted 3: Drake's Deception* (Naughty Dog, 2011) for this study, a critically acclaimed adventure game[1], praised for its 3D graphics in particular.

$N = 60$ participants played the game for 45 minutes in SD, HD, or 3D (with shutter glasses) on a 46 inch 3D television screen connected to a PlayStation 3, and filled in several scales to measure user experience variables afterwards (see above) on a 7-point Likert scale. They were counterbalanced for gender and overall gaming expertise.

Again, we did not discover a significant main effect of display mode on any of the subjective measures. Looking at simple effects, participants experienced a significantly lower embodied presence with the main character in the 3D condition ($M = 3.72$, $SD = 1.28$) compared to HD ($M = 4.45$, $SD = 1.28$) and SD ($M = 4.60$, $SD = 1.11$).

Experiment 3: PONG

In the third study, we investigated whether stereoscopic 3D could impact user experience by fulfilling an actual function in a game. Stereoscopic displays contain additional spatial cues that can be encoded by the user (Jones, Lee, Holliman, & Ezra, 2001). Thus, players of a game that requires a lot of spatial information processing should perform better when it is displayed in stereoscopic 3D.

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[1] see e.g. http://www.metacritic.com/game/playstation-3/uncharted-3-drakes-deception

In collaboration with the game developer GriN, we created a new variant of the game PONG. This version is not played sideways like the original, but in a three-dimensional space in which players are behind their paddle and play the ball backwards and forwards (see figure 1). Because we suspected the effect of 3D on performance only to show under a certain level of challenge, we created 2x3 different versions of the game (2D vs. 3D x easy vs. medium vs. hard). Difficulty was operationalized with the movement speed of the computer opponent's paddle. Moreover, we expected a greater sense of control over the game (due to the increased predictability) in 3D mode. The increase in performance and control was expected to impact the enjoyment of the game as well. Objective performance was measured with three parameters: outcome of a round (win/loss), player's score, and computer's score. To assess enjoyment, perceived challenge, and perceived control, we used a short questionnaire with 5 items for each variable.

A sample of $N = 38$ students played all six versions of the games in a random order on a 46 inch (diagonal) 3D television screen, connected to a computer. One round lasted until either the participant or the computer scored 10 points (i.e., the other party missed the ball 10 times). After each round, they filled in a short evaluation questionnaire. For the ease of the procedure, they left on the shutter glasses at all times.

Results show that there was no effect of 3D on objective and subjective measures whatsoever. As expected, participants won more often and had higher scores on lower difficulty levels, but the display mode had no impact. There was a medium to large correlation between enjoyment and perceived challenge ($r = .45$, $p < .05$), but not between enjoyment and actual performance. The display mode showed no significant effects on any of the subjective measures.

Conclusion

Summarizing the findings of our three studies, it appears that stereoscopic presentation plays on a secondary role at best in many facets of the user experience of digital games. While it is

certainly possible that under certain configurations some users will experience a game

significantly different when displayed in 3D, this is not a generalized effect. Aspects in the

content of a game seem to play a more important role than how they are presented to the user.
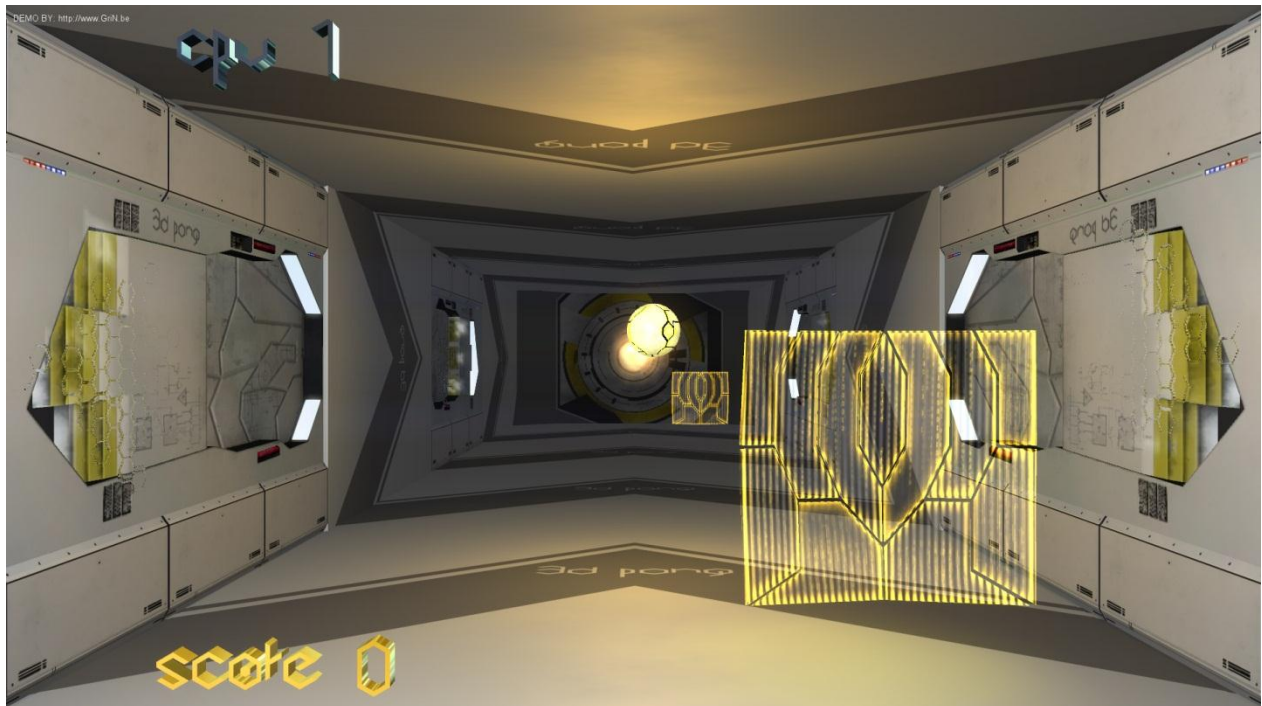
Figure 1. 3D PONG, made by GriN

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