Influence of Gaming Display and Controller on Perceived Characteristics, Perceived Interactivity, Presence, and Discomfort*

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Abstract. The purpose of this study is to examine gamers' psychological experience according to the display and controller. The research used 2D and 3D as gaming display and joypad and Move as gaming controller. It examined the effects of those variables on perceived characteristics, perceived interactivity, presence, and discomfort. Sixty four participants joined the experiment and the main findings are as follows: First, the interaction effect of the display and controller was not significant for any of the variables. Second, the main effect of the display was significant in the perceived characteristics of clarity and materiality. Finally, the main effect of the controller was significant in the perceived interactivity, spatial involvement, dynamic immersion, and realistic immersion. Although the present research found significant effects of those independent variables, a follow-up study is needed to investigate why the interaction effects are not supported.

Keywords: 3D, controller, discomfort, display, game, perceived characteristics, perceived interactivity, presence.

1 Introduction

Since the success of the movie Avatar and the resultant interest in the format, 3D technology has influenced much visual media and the field is working to expand its area from broadcasting to the gaming industry. In fact, games have already used 3D technology for a long time; for instance, graphics have different depth levels, which are not seen in traditional 2D games. 3D graphics enhance user's perception through a variety of depth levels compared to 2D [1] and for the same reason, 3D displays are assumed to give us a greater perception of 3D than simply 3D graphics on 2D displays. In addition, this will have an effect on enjoyment while playing a game; flow will help the game industry keep their growth on track.

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Games also spur 3D display adoption. A good combination of interaction and realism, in other words, a good combination of motion control and 3D stereo display will serve as a new game condition and experience. Although this game condition has never been seen before, there has been little research on the comparative analysis of 2D and 3D displays [2][3], or about controller difference [4]. However, we do not know what would happen when combining the display with the controller. Therefore, the purpose of this study is to examine gamers' psychological feedback, such as perceived characteristics, perceived interactivity, and presence as effects of the combination of the display and controller. Furthermore, discomfort from wearing 3D glasses is often one of the most talked-about topics among media today, so we looked at that as well.

2 Related Work

A great deal of research is being carried out to discover the benefits of stereoscopic 3D since 3D stereo games first came out. Takatalo et al. [5] set three different display disparities (2D, medium stereo, high stereo separation) according to their pilot testing, and found that medium stereo separation offered the best user experience, such as involvement and presence. However, Mahoney et al. [6] showed that games converted to stereoscopic 3D that were basically designed for 2D did not transfer well and caused tiredness in one's eyes. They also said that using 3D stereo in games did not improve the game-play but did improve the visuals.

What matters to game research is not only the display but also the controller. In prior studies, researchers reported that 3D stereo was different from 2D in display [5][6] and that the keyboard was different from the Joystick in regard to the game controller [7]. It is reasonable to infer that game users may have different experiences with different game displays and controllers. Kulshreshth et al. [8] studied user performance benefits of playing video games using a motion controller in a 3D stereoscopic view in relation to 2D and found that a 3D stereo display helped user performance significantly compared to a 2D display. Even though they found that 3D stereo was perceived to be more enjoyable and immersive than 2D, it was only qualitative data.

Unfortunately little research is interested in the combination of display and controllers and there is no guarantee that one study will explain it all. Despite the interest in 3D effects and the introduction of various controllers in the game industry, it is not clear why interaction effects are not focused. It is necessary to evaluate how viewers recognize the features that 3D displays provide because it is a different matter as to whether or not they really perceive 3D stereo [9]. Also, in terms of controller, the same point of view will be applied; for instance, whether a controller that involves the gamer's body using so called state-of-the art technology is better than a traditional controller in any game. Thus, the present research would disclose the effects of display and controllers on various psychological outcomes, such as perceived characteristics, which are how users perceive five levels of characteristics displayed images; perceived interactivity, which is how users perceive three levels of interactivity from the controller; presence, which is a perceptual flow composed of four levels requiring directed attention; and the discomfort which came from wearing 3D glasses.

RQ1. Will the display (2D vs. 3D) interacting with the controller (joypad vs. Move) make a difference in the gamer's perceived characteristics of the display?

RQ2. Will the display (2D vs. 3D) interacting with the controller (joypad vs. Move) make a difference in the gamer's perceived interactivity?

RQ3. Will the display (2D vs. 3D) interacting with the controller (joypad vs. Move) make a difference in the gamer's presence?

RQ4. Will wearing 3D glasses interacting with the controller (joypad vs. Move) make a difference in the gamer's comfort?

3 Method

3.1 Participants

Sixty-four students were recruited from a university in Seoul, Korea. 32 males and 32 females joined this experiment and the age range is from 18 to 28. The mean age is 22.31 (*SD*=2.44).

3.2 Procedure

Before the participants played the game, they were asked to fill out a questionnaire that asked about their age, gender, previous game experience, and other such information. Then all participants entered a game lab and a researcher explained how to play the tennis game (Top Spin 4) on the PS3. The researcher demonstrated how to play the game ('X', '○', '□' button of the joypad are a flat shot, topspin and slide, respectively) and they were asked to practice for 2 minutes each as a training session. After confirming that no problems existed, the researcher restarted the game and the participants played for 15 minutes. The game was then stopped and the participants were given a main questionnaire that asked about perceived characteristics, perceived interactivity, presence, and discomfort from wearing 3D glasses.

3.3 Instrument

The questionnaire was mainly composed of four parts: perceived characteristics, perceived interactivity, presence, and discomfort from wearing 3D glasses. Perceived characteristics were composed of four parts: proximity, clarity, materiality, message transmit and tangibility, coined by Chung and Yang [9]. Proximity had six items (e.g., I felt the perspective very well), materiality had four items (ex. I could distinguish the edge of things). Clarity had three items (e.g., I felt it had a sharp picture), message transmit (e.g., I understood very well what message they wanted to deliver) and tangibility (I felt like the picture seemed to leap off the screen). Perceived interactivity was composed of three parts: speed, range and mapping, made by Steuer [10]. Speed had four items (e.g., I could move my character more quickly), range (ex. My

character's position changed as I controlled it) and mapping (e.g., The reaction appeared natural as I controlled the character). Presence was composed of four parts: spatial involvement, temporal involvement, dynamic immersion and realistic immersion, revised from Chung and Yang's questionnaire [9]. Spatial involvement had four items (e.g., I felt like I was in the game), and so did temporal involvement (e.g., I lost all track of time as I was playing the game). Dynamic immersion (e.g., I felt I had to move actively) and realistic immersion (e.g., I felt that the image in the game was real) each consisted of three items. Finally, discomfort from wearing 3D glasses had eight items, revised from Knight et al. [11] and Kim et al.'s questionnaire (e.g., I felt awkward wearing 3D glasses) [12]. All the items used a 5-point Likert scale.

Table 1. Variables' mean, SD and reliability

		Items	*M*	*SD*	*α*
perceived characteristics	proximity	6	3.59	.60	.81
	clarity	3	4.05	.75	.91
	materiality	4	3.32	.66	.72
	transmit	3	3.96	.80	.86
	tangibility	3	2.61	.87	.87
perceived interactivity	speed	3	2.68	1.03	.91
	range	3	3.07	.98	.85
	mapping	3	3.01	.95	.86
presence	spatial involvement	4	2.89	1.04	.94
	temporal involvement	4	3.72	.99	.91
	dynamic immersion	3	2.63	.85	.73
	realistic immersion	3	2.73	1.03	.86
3D glasses discomfort		8	1.98	.70	.87

3.4 Gaming System

The PS3 was chosen for this research and the game title is the full 3D sport game, Top Spin 4 by the 2K Sports company. It supports gaming options including whether users can choose 2D or 3D environment and joypad or Move. Users grab the Move stick, which is one of the PS3 controllers, and swing it as though they are really playing tennis.

Fig. 1. Experiment environment

4 Result

To analyze the performance data, a mixed ANOVA was conducted in order to examine the effect of gaming display and controller on the user-perceived psychological experience. The results show that the interaction effect of the display and controller was not significant for every part of perceived characteristics. In contrast, the main effect of the display was significant in clarity [$F(1,62)=4.65$, $p<.05$] and materiality [$F(1,62)=4.06$, $p<.05$]. Concretely, 2D ($M=4.23$) reported much more clarity than 3D ($M=3.86$), and 2D ($M=3.46$) reported much more materiality than 3D ($M=3.18$).

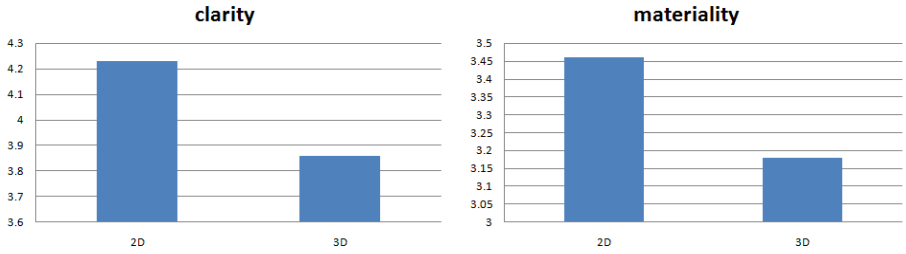

Fig. 2. Clarity and materiality on the gaming display

The results show that the interaction effect of the display and controller was not significant in every part of perceived interactivity. Yet the main effect of the controller was significant in range [$F(1,62)=4.15$, $p<.05$], and joypad ($M=3.23$) reported much more range than Move ($M=2.91$).

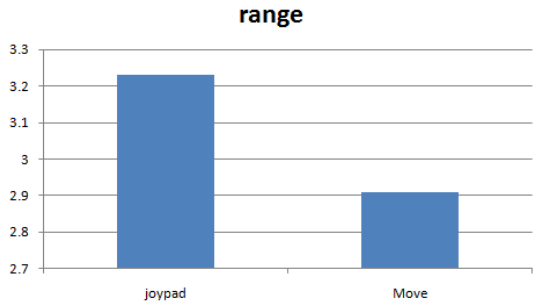

Fig. 3. Range on the gaming controller

The result shows that the interaction effect of the display and controller was not significant for presence. In contrast, the main effect of the controller was significant for spatial involvement [$F(1,62)=17.00$, $p<.001$], and the Move ($M=3.15$) had much more spatial involvement than the joypad ($M=2.63$). Also, the main effect of the controller was significant in dynamic immersion [$F(1,62)=36.78$, $p<.001$] and realistic immersion, too [$F(1,62)=13.87$, $p<.001$]. Concretely, Move ($M=2.96$) has much more dynamic immersion than joypad ($M=2.92$), and Move ($M=2.93$) has much more realistic immersion than joypad ($M=2.52$).

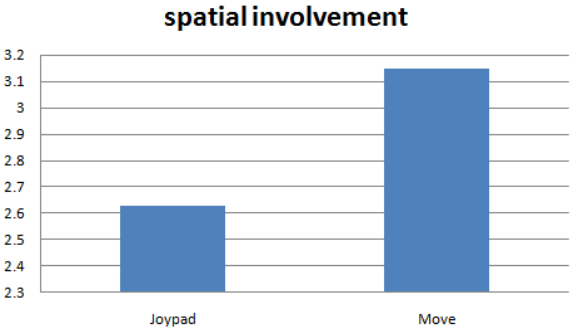

Fig. 4. Spatial involvement on the gaming controller

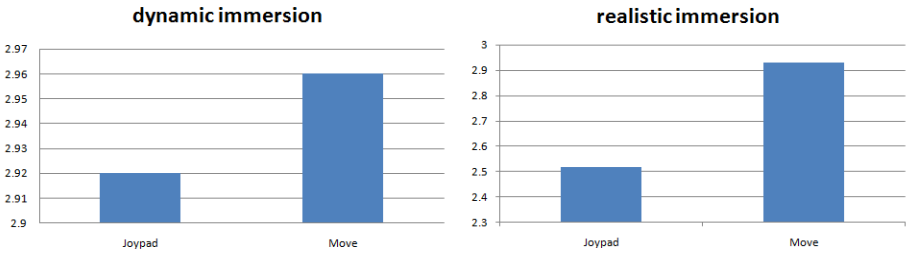

Fig. 5. Dynamic and realistic immersion on the gaming controller

Finally, discomfort from wearing 3D glasses was not significant between joypad and Move 〔$F(1,30)=1.71$, $p>.05$〕.

5 Discussion

This study examined the effects of display and controller type on gamers' perceived characteristics, perceived interactivity, presence, and discomfort from wearing 3D glasses. From the data analysis, we could see that the interaction effect between those two independent variables provided no significant perceived psychological experience. The implication of this research can be described in following way. First, the quality of the gaming title may be a factor. In most cases, 2D effect is more positive in this research. For instance, subjects had rated perceived characteristics (clarity and materiality) on 2D higher than 3D which is quite the opposite outcome than that based on common sense. However it is clearer when we understand the characteristics of 3DTV. Active Shutter Glasses have insufficient brightness to reduce image crosstalk and ghosting [13] which leads to problems with viewing comfort. Also, how 3D game titles provides quality may be another issue in 3D gaming which is distinct from the 2D or 3D issue. This means that the display effect may be more reliant on the title itself, not 3D overall, and therefore various titles should be tested to mention a 2D and 3D comparison. Third, perceived interactivity and presence had rated the motion controller (Move) highly as earlier studies came up with similar results [14][15]. This means that a future gaming system should point to having gamers move their own bodies. Finally, wearing 3D glasses while playing with both the joypad and the Move was not significant. We assume that it is cumbersome for game users to move themselves while wearing 3D glasses, but it was not different from playing with a joypad, and the mean score of the discomfort variable was relatively low in both cases. This means that we cannot say that just wearing 3D glasses is a factor to bring a feeling of discomfort, but there may be other moderating variables such as fun, enjoyment, or others.

There may be many reasons why the hypotheses of this research were not supported. It may come from the game title itself, the level of difficulty and entertainment, or some other factor. It is necessary for future research to find out various cause-and-effect psychological variables according to the level of the display and controller.

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