More Naturalness, Less Control: The Effect of Natural Mapping on the Co-located Player Experience

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ABSTRACT

In the past years, there has been a surge in game controllers that allow players to play in a more physical, more natural way. In this paper we present an experimental study of the effect of gaming using these naturally mapped controllers on the player experience in a social setting. Results support the hypothesis that more naturally mapped controllers augment spatial presence. Furthermore, the results suggest that gaming with more naturally mapped controllers augment social presence for female players, but not for male players. However, gaming via naturally mapped controllers decreases perceived control and actual performance. Hence, users with high performance expectations might not benefit from gaming via naturally mapped controllers.

Author Keywords

Gaming, game experience, spatial presence, social presence, natural mapping, input device.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g., HCI): User Interfaces – Input devices and strategies

General Terms

Human Factors; Design; Measurement.

INTRODUCTION

In the past years, there has been a surge in game controllers that allow players to play in a more natural way. The Nintendo Wii-mote was successfully released in November 2006, the PlayStation Move in September 2010 and finally the Microsoft Kinect camera in November 2010, all three with impressive sales figures [10]. The transition from early single-button joysticks, through multiple button and stick devices, to these new types of controllers provides an example of how digital gaming has changed over a short period of time.

What these controller devices and most of the related games have in common is that they offer a potentially more physical and more natural way of controlling the game, i.e., they exploit a more direct relation between the physical actions of the player and the virtual response within the game world. A player that swings a club in the real world, swings his virtual club as well. In contrast, a traditional controller might use a series of button pushes to swing the virtual club. The similarity between the movements of controls in the virtual and the real world, is defined as *natural mapping* [31,35]. Natural mapping takes advantage of physical analogies between the gamer in the real world and the actions within the virtual world.

Within the domain of human-computer interaction, natural mapping is considered as a principle underlying good design [31], rendering interfaces more user-friendly. Natural mapping is also considered as a driver for spatial presence, to be understood as the illusion of immersion in a virtual world [17]. It is therefore warranted to theorise that gaming via naturally mapped controllers has a positive effect on the game experience, which might partially explain the popularity of this type of gaming. However, notwithstanding the popularity of gaming via naturally mapped controllers, not all game lovers are equally positive. Several forums run active 'bashing' threads featuring contributions such as: *"Nintendo [Wii] actually is a pathetic piece of garbage, I will most definitely never get one*" [12]. Sarcastic gamers put out spoof trailers and parodies [1], testifying to the frustration of some gamers that gaming via naturally mapped controllers is "*ruining the game market*" [30]. These forum posts and parodies suggest that despite its popularity, gaming via naturally mapped controllers, cannot provide certain game experiences that players might seek in digital games. It is the aim of this research study to better understand the appeal of gaming via naturally mapped controllers: *how does it impact the player experience, in a social setting?*

Related work on game controllers offering natural mapping

Researchers have studied the potential of gaming via natural mapped controllers before, addressing the opportunities for an altered player experience. Skalski, Tamborini and Shelton [34] have studied the potential of gaming via natural mapping, by manipulating the type of controller -a steering wheel, gamepad, joystick or keyboard- while playing a racing game. Their results show that more natural mapping, rated by participants as higher *perceived controller naturalness*, leads to increased spatial presence [15] and higher game enjoyment.

Bowman and Boyan also investigated the effect of natural mapping offered by the Wii-mote. The researchers evaluated how natural mapping affected spatial presence, flow and cognitive skills. Flow can be understood as a psychological state of higher concentration and involvement, bringing an enjoyable and intrinsically motivating experience to an actor carrying out an activity [8]. The researchers conducted an experiment in which participants played Call of Duty (a first-person shooter game) using a traditional game controller and a Wii-mote. Results show that both systems facilitated high levels of flow and game performance. Yet, the researchers found that different controllers required subjects to use different sets of cognitive skills to achieve the same goals in the game. Surprisingly, they did not find support for the aforementioned hypothesis that playing with the Wii-mote resulted in more spatial presence.

Limperos et al. [26] explored the relationship between the control scheme (i.e. Wii-mote or Playstation 2 controller) and feelings of control, flow and enjoyment in the context of playing Madden EA (an (American) football game). Their results indicate that both males and females experienced greater feelings of control and enjoyment with a traditional control scheme than with the Wii-mote. The authors suggested that the lack of control experienced with the wii-mote leads to a lack of flow.

Bianchi-Berthouze and colleagues conducted a series of experiments to investigate how the use of body movements (also involving natural mapping) creates engagement in digital game play. In one of their experiments, participants played Guitar Hero with either a guitar-shaped controller or a classic game pad [2,4]. Their results revealed that participants playing with the guitar controllers reported a higher feeling of presence and higher game engagement. In a follow-up experiment, the researchers also noticed that in the condition where players were more restricted in the use of body movements for controlling the game, when showing more body movements they actually reported less game engagement. It was noted that these body movements were non-functional and not used for game controlling (e.g. dropping the arms in despair or shaking and leaning back to disengage). Bianchi-Berthouze hypothesized that players can show different levels and types of engagement: *"In condition D [with restricted body movements] players may be driven by a desire to win the game (hard fun), leading to an increased focus on the display. In condition G [with body movements], instead, engagement may also derive from the feeling of becoming a guitar player (fantasy) and from the higher level of arousal and positive experience that it generates.* [4:19]".

Johnson et al. [19] similarly studied the benefits of playing games with 'physically controlled peripherals' in an experimental set-up. Users were given the opportunity to play two games with either a standard controller or a physically controlled device (a snowboard-shaped device for a skiing game and a hand-held imitation pistol which is aimed at the screen for a shooter game). The findings of Johnson et al. indicate that 'player experience' is a multidimensional construct that includes intuitiveness, amount of control, realism and fun. Interestingly, qualitative and quantitative findings indicated that while physically controlled peripherals consistently led to fun on the part of the user, they did not necessarily lead to greater ease of control. Johnson et al. demonstrated that physical controllers are not always preferred, especially by male or more experienced players, who might have higher "*performance expectations"*[19:8]. The observation that high performance expectations steer preferences towards non-physically controlled peripherals, aligns with the hypothesis by Bianchi-Berthouze that hard fun correlates negatively with gaming via body movements.

Finally, most recently, McEwan et al. [29] explored the differences in player experience across three types of controllers for a racing game (Forza Motorsport 4). The controllers used by participants (from least to most naturally mapped) were the classic Xbox 360 controller, the Microsoft SpeedWheel (an approximation of a steering wheel that players hold in front of them and twist left and right to steer while using buttons to accelerate and brake) and a Microsoft force-feedback steering wheel (which most closely approximates a real steering wheel, providing force feedback and employing pedals for accelerating and braking). McEwan et al. found that on average, players performed better the less naturally mapped the controller (i.e. performed better with the controller, than the Speed Wheel, than the force feedback racing wheel). However, feelings of autonomy, presence, intuitive controls, challenge and flow all followed the reverse pattern (i.e. the greater, the more naturally mapped the controller). Additionally, players indicated a preference for the more naturally mapped controllers.

Related work on game controllers offering natural mapping, in a social setting

The aforementioned studies above were conducted in a single-player configuration. However, with natural mapping, the visibility of the player actions increases the opportunity for others to monitor actions, performance and emotions. Dalsgaard & Hansen [9] argue that playing

games using highly visible physical player actions transforms players into performers and spectators alike. De Kort and IJsselsteijn[20] argue that such 'sociality characteristics' are highly important in gaming and may be crucial when playing games that are controlled on the basis of body movement. It is therefore reasonably to hypothesize that gaming via natural mapping, as compared to gaming via traditional controllers, affects game enjoyment and involvement through social presence –i.e., the feeling of being with others [5].

Few researchers have experimented with natural mapping within a social context. To the best of our knowledge, we could only trace two such studies. In one contribution with 20 female novice players, Lindley et al. [27] experimented with body movements in a collocated multiplayer setting, where playing a game (Donkey Konga) via replica drums (or bongos) was compared to playing the game with a standard controller. Results showed that playing with bongos was more engaging and that social interaction between players was significantly higher. However, in a similar experimental set-up with 20, more game-experienced, male students, Boguslawski found results that contradict those of the previous experiment. Dyads of participants played the game Dragon Ball Z: Budokai Tenkaichi (a fighting game) with either the Wii-mote or the classic controller. Based on self-reports, no significant differences were found between the conditions. Boguslawski found that game engagement did not correlate strongly with the type of controller. However, game engagement did correlate with player performance and players performed better with the classic controller. Boguslawski suggested that this might be due to the difficulty of handling the movement-based controller [6:75].

Summarizing the findings of the previous studies

In summary, the aforementioned studies provided varying and somewhat conflicting results. Perhaps these differences can be attributed to the different instantiations of natural mapping. Skalski et al. relied on a Logitech steering wheel [34], McEwan et al., on two Microsoft steering wheels [29] Bianchi-Berthouze et al. [2,4], relied on a guitar controller, Johnson et al. used a gun [19] and a board controller [19], Bowman and Boyan [7], Limperos et al. [26] and Boguslawski [6] relied on the Wii-mote and finally, Lindley et al. used a drum peripheral. Furthermore, different games were used, Skalski et al. used Need for Speed Underground 2 (a race game), McEwan et al. used Forza Motorsport 4 (a race game as well), Bianchi-Berthouze et al. relied on Guitar Hero (a music game), Johnson et al.[19] used Time Crisis 2 (a shooter game) and SSX Snowboarding (a snowboarding arcade game), Limperos et al. [26] used Madden EA (a football game), Bowman and Boyan [7] used Call of Duty (a shooter game), Lindley et al. [27] used Donkey Konga Bonga (a music game) and Boguslawski [6] Dragon Ball Z: Budokai Tenkaichi (a fighter game). Additionally, the player experience was operationalized in different ways, either as 1) a uni-dimensional construct measuring game enjoyment [34], game engagement [2], or a flow experience [7,26], or 2) as multi-dimensional construct providing fun, intuitiveness, realism and control [19], or multi-dimensional constructs measuring both need satisfaction and game enjoyment [29]. Only Lindley et al. and Boguslawski measured social presence.

Some conclusions can nevertheless be drawn. The research results tend to support the hypothesis that natural mapping augments spatial presence [2,19,29,34], with the exception of the study of Bowman and Boyan [7]. With respect to overall game enjoyment, the findings are mixed. Whereas Bianchi-Berthouze et al.[2,4], Skalski et al.[34] and McEwan et al.[29], find that natural mapping results in greater game enjoyment or a preference for more naturally mapped controllers, this is only partly supported by Johnson et al. [19], who distinguish between preferences based on fun and preferences based on performance [34]. Johnson found that while controllers offering natural mapping deliver more fun, they are often more difficult to perform well with, as their accuracy and precision are less than that associated with more traditional, less naturally mapped controllers. Finally, higher measures of flow and resulting game enjoyment was found by neither Limperos et al. [26], nor by Bowman and Boyan [7]. Explanations for a lack of flow or enjoyment are given by Limperos, who similar to Johnson attributed it to a lack of precision or control.

With respect to social presence, no clear results were found. Lindley et al found an increase whereas Boguslawski did not. It is however notable that Lindley et al. involved novice female players, whereas Boguslawski relied on male, game-experienced participants. It is well researched that female players play less often and show weaker video game gratifications [14,28]. More than men, women tend to be casual gamers while men more than women tend to be hardcore gamers [14,32,33]. Moreover, it has been suggested that female gamers use gaming as a vehicle for social interaction rather than as a means for being *"intellectually challenged"* [36]. These findings suggest that different motives held by male and female players may explain the different results with respect to the social presence experienced during gaming via naturally mapped controllers.

From the above studies, we can conclude that empirical results regarding the benefits of gaming via natural mapping within a social setting are scarce and yield conflicting results. Hence, it is necessary to conduct further research and *study the influence of controller type - on the basis of natural mapping - on player experience in a social setting.*

AIM OF THE PRESENT STUDY

In this study we will build upon the aforementioned studies and extend them. Similarly to Skalski et al. [34], and McEwan et al. [29] we will investigate the effect of gaming with a naturally mapped controller, operationalized by a steering wheel, versus gaming without natural mapping (via a classic controller or typical game pad), on the player experience when playing a racing game. However, gaming will take place in a highly social setting: co-located dyads of players will race against each other. As discussed, in many earlier studies, the player experience was treated as a uni-dimensional construct. In this study the game experience will be measured as a multi-dimensional contruct relying on the Game Experience Questionnaire with its seven subscales (Positive Affect, Negative Affect, Flow, Immersion, Frustration, Challenge and Competence). Additionally, we will measure social presence, spatial presence, perceived controller naturalness, perceived control and actual performances.

Hypotheses and research questions

First of all, we suppose that similar results will be found as by Skalski et al.[34], Bianchi-Berthouze et al.[2], Johnson et al.[19], and McEwan et al.[29], supporting the hypothesis that states that gaming with natural mapping augments spatial presence.

- ⇨ Hypothesis 1A: Players who use a steering wheel controller will experience a higher level of perceived controller naturalness than those who play the game with a gamepad controller.
- ⇨ H 1B: Players who use a steering wheel controller will experience a higher level of spatial presence than those who play the game with a gamepad controller.

Second, based on the findings of Johnson et al. [19], Limperos et al. [26] and McEwan et al.[29], we expect that gaming via natural mapping will lower the amount of control experienced, and that it will result in a reduced performance. Additionally, we argue that this will result in less flow as well, considering that a sense of control is considered a core element of flow (Csikszentmihalyi) [8:191]. We can therefore hypothesize that when playing with steering wheel controllers, players will experience less flow.

- ⇨ H 2A: Players who use a steering wheel controller will experience a lower level of control than those who play the game with a gamepad controller.
- ⇨ H 2B: Players who use a steering wheel controller will perform worse than those who play the game with a gamepad controller.
- ⇨ H 2C: Players who use a steering wheel controller will experience less flow than those who play the game with a gamepad controller.

Thirdly, based on the study of Lindley et al. [27] and the theoretical accounts of Dalsgaard and Hansen [9] and de Kort et al. [21], we expect that playing via a steering wheel will induce more social presence than playing with the classic controller.

- ⇨ H 3: Players who use a steering wheel controller will experience a higher level of social presence than those who play the game with a gamepad controller.

Although we expect there might also be differences found across controller types for other game experience components, measured by the GEQ subscales (i.e. Positive Affect, Negative Affect, Immersion, Frustration, Challenge and Competence), given the conflicting previous research we did not derive any specific hypotheses.

Since previous research [6,19,27] suggests that differences may be found according to gender groups and prior experience, we will equally control for gender of dyad (either two males or two female players), game skill and performance in the main experiment.

METHOD

Experimental design

To address the research questions and hypotheses above, a (2 x 2) experimental design was employed with Controller Type (Classic Controller vs. Steering Wheel) as within-subjects factor, and Gender of Dyad (Female vs. Male) as a between-subjects factor. Participants were told that the researchers wanted to understand the player experience. Participants entered as dyads and competed against each other in a racing game. After each condition (i.e., having played with the classic controller or having played with the steering wheel), every participant individually filled out a questionnaire (which is described in detail below) to measure the player experience. The researcher made sure to leave the room once the game was started. In many cases, participants were already familiar with one another but this was not a prerequisite.

Participants

Participants were approached on the university campus.. This resulted in a final dataset of 78 participants (41 males, 37 females) from 21 male dyads and 19 female dyads. (The data of one male and one female player were lost due to a data storage error.)

Experimental manipulations

In both conditions participants sat in a twin seat, approximately 90 cm from each other in front of a 50-inch-diagonal Plasma Television screen (see figure 1). They played Mario Kart Wii, a popular multi-player racing game that can be played either with a steering wheel using the tilting condition, or with a classic controller (by manipulating a small joystick and some buttons). All participants were assigned to play in both conditions; the order in which each controller was played with was counterbalanced to rule out order effects.

Measurement instruments

Spatial presence was measured via selected items from the ITC-SOPI questionnaire [24]. Ten items were taken from the Spatial Presence factor. They were translated into Dutch and where necessary slightly adapted to a gaming experience. The scales contained items such as *"I felt myself being 'drawn in"*, *"I felt as though I was in the same space as the characters and/or objects"*, and *"I felt that the characters and/or objects could almost touch me"*. These items were measured on a five-point scale, ranging from strongly agree to strongly disagree).

Figure 1. The research setup.

Perceived controller naturalness was measured via three items taken from Skalski et al. [34]: "*The way I could operate the game felt natural", "The action I had to undertake to control the game were similar to the actions in the real world", "I felt that controlling the game was very natural compared to how I would operate in real life"*. These items were measured on a five-point scale, ranging from strongly agree to strongly disagree).

Perceived control was measured via three items: *"I had a lot of control over the game input device", "I could precisely control the game", "the game reacted exactly to my actions as I wanted"*. All items were measured on a five-point scale, ranging from strongly disagree to strongly agree.

Social presence was measured by the Social Presence in Gaming Questionnaire [21], consisting of three subscales: 'Psychological Involvement-Empathy' including items such as "*I empathized with the other (s)"*, *"I sympathized with the other(s)"* and *"When the other(s) were happy, so was I"*, 'Psychological Involvement-Negative Feelings' including items such as *"I was jealous of the other(s)"*, "*I was revengeful*", "*I felt schadenfreude (malicious delight)*" and 'Behavioral Engagement' including items such as "*My actions depended on the actions of the other(s)*", "*What they other(s) did influenced my actions."* These items were measured on a five-point scale ranging from 'not at all' to 'a great deal'. Given the low alphas for 'Psychological Involvement-Negative Feelings' (see table 1), this subscale was removed from the analysis.

Player experience was measured as a multidimensional construct by means of the GEQ [13,16]. As aforementioned, this instrument consists of seven subscales: Positive Affect, Negative Affect, Flow, (sensory and imaginative) Immersion, Frustration, Challenge and Competence. All items were measured on a five-point scale ranging from 'not at all' to 'a great deal'. Given the low alphas for Negative Affect and Challenge, these subscales were removed from the analysis (see Table 1).

Age and gender were collected as well as prior game experience, and actual game scores (measured as the player's finishing position in the race; 1st through 12th). Each race consisted of 12 competitors (the two human participants and 10 artificial intelligence controlled players). The measure for player performance (i.e., winner versus loser) was created post-hoc, and computed as the difference between the achieved in-game rankings of the two players of one dyad in the race.

Table 1. An overview of the measured items and their Chronbach's alphas

Chronbach's alpha	Classic controller	Steering wheel
Spatial Presence	.906	.927.
Soc.Pr. – Psycho.Inv.-Empathy	.782	.804
Soc Pr. – Psycho. Inv.-Neg.feeling	.561 [a]	.661 [a]
Soc Pr. - Behavioral Engagement	.884	.906
Game Experience - Positive Affect	.85	.755
Game Experience - Negative Affect	.623 [a]	.532 [a]
Game Experience - Flow	.900	.908
Game Experience - Immersion	.875	.872
Game Experience - Frustration	.777	.777
Game Experience - Challenge	.566 [a]	.591 [a]
Game Experience - Competence	.946	.915
Perceived controller naturalness	.711	.822
Perceived control	.823	.788

[a] While there are no strict rules or clear cut-off levels for chronbach alphas, a general rule of thumb in social sciences is that alphas above .7 are acceptable [11:583], therefore we decide to drop subscales that did not achieve chronbach alpha above .7

RESULTS

Linear Mixed Model Analysis (LMMA) was performed on the self-report data for each of the measured concepts of perceived control, perceived controller naturalness, spatial presence, social presence (i.e., psychological involvement-empathy), social presence behavioral engagement and for each of the five GEQ components (i.e., competence, immersion, flow, positive affect and frustration), with gender of dyad as between subjects and controller type as within-subjects factor. Skill and player performance were included as covariates.

Perceived controller naturalness and spatial presence

Regarding hypothesis 1A, the type of controller had a significant main effect on perceived controller naturalness, $F(1, 74.95) = 29.12$, $p < .01$. Participants perceived controlling the game with the steering wheel (M_{STEER} = 2.87, SD = 0.1) as more natural than controlling the game with the classic controller ($M_{CLASSIC}$ = 2.18, SD = 0.1). In addition, a significant interaction was found between gender of dyad and type of controller, $F(1, 76.1) = 6.88$, p <.05. Male players perceived the steering wheel as more natural and the classic controller as less natural, compared to female players, see figure 2.

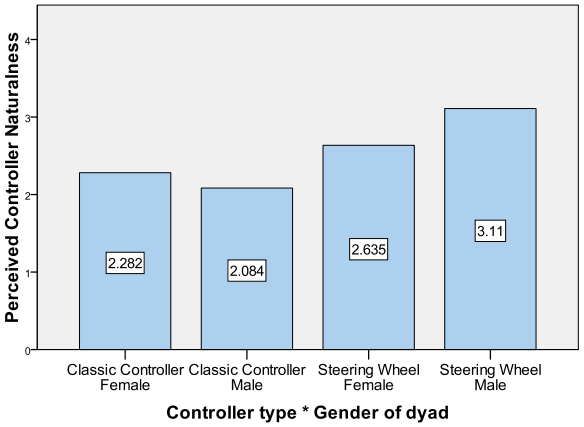

Figure 2. Perceived controller naturalness, according to gender of dyad and controller type

Regarding hypothesis 1B, the type of controller has a significant main effect on spatial presence, $F(1, 75.07) = 8.02$, $p < .01$. When playing with the steering wheel (M_{STEER} = 2.48, SD = .11), participants experienced more spatial presence than when playing with the classic controller ($M_{CLASSIC}$ = 2.31, SD = .11), see figure 3. No significant interaction effect of gender of dyad was found.

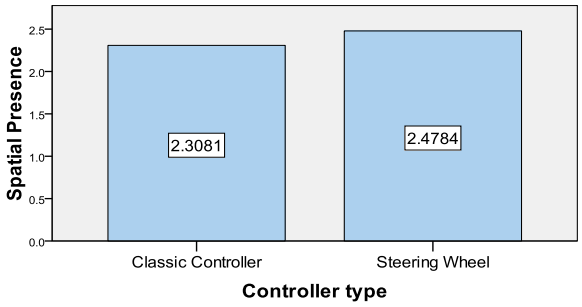

Figure 3. Spatial presence, according to gender of dyad and controller type

Perceived control game scores and flow

Regarding hypothesis 2A, players who use a steering wheel controller experienced a lower level of control than those who play the game with a gamepad controller, $F(1, 75) = 29,68$, $p < .001$. Players perceived having more control over their game when playing with a classic controller ($M_{CLASSIC}$ = 3.5, SD = .1) than with a steering wheel controller (M_{STEER} = 2.76, SD = .1). No significant interaction effects were found between gender of dyad and controller type, both men and women experienced less control when playing with the steering wheel controller. Although there was no significant effect of gender of dyad on perceived control, $F(1, 79.7) = 3.26$, p = n.s., we see a trend where men perceived more control (M_{MEN} = 3.27, SD = .1) than women (M_{WOMEN} = 2.95, SD = .11), see figure 4.

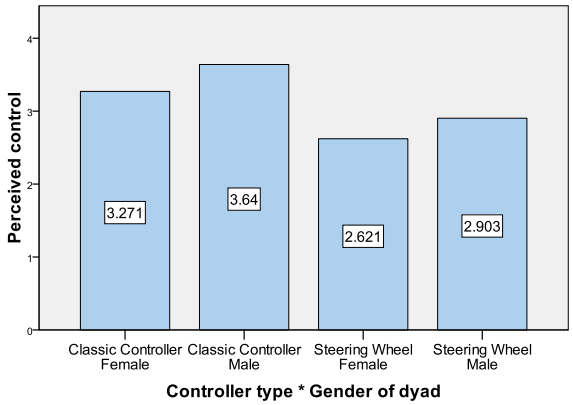

Figure 4. Perceived control, according to controller type and gender

Regarding hypothesis 2B, a main effect of controller type on the scores was found, $F(1, 150) = 9.41$, $p < .005$. When playing with the classic controller, players maintained better finishing positions ($M_{CLASSIC}$ = 7.05, SD = .37) than when playing with the steering wheel (M_{STEER} = 8.67, SD = .37), bear in mind that lower scores actually point towards higher performance (ranking 1st is the best possible score, ranking 12th is the worst possible score). Additionally we found a main effect of gender of dyad on high scores, $F(1,150) = 5.49$, $p < .05$, male players achieved higher positions in the game than female players (see figure 5), and an interaction effect, as men more than women increased their scores when playing with the classic controller, $F(1,10) = 3.29$, $p < .05$.

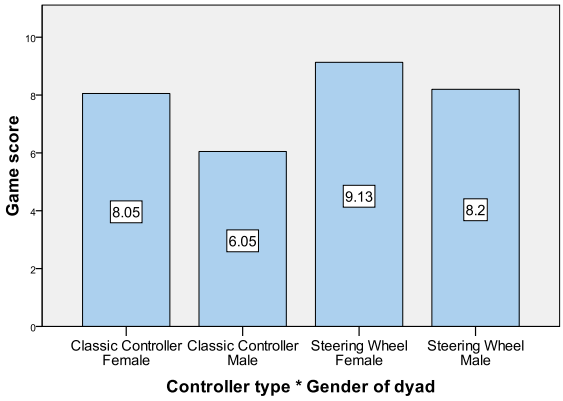

Figure 5. Achieved in-game scores (i.e. finishing positions), according to controller and gender.

Regarding hypothesis 2C, we found a marginally significant effect of controller type, $F(1, 74.89) = 3.19$, $p = .04$. When playing with the classic controller, players perceived more flow ($M_{CLASSIC} = 2.07$, $SD = .12$) than when playing with the steering wheel ($M_{STEER} = 1.95$, $SD = .12$).

Social presence

Hypothesis 3 was partially supported. Results show a main effect of controller type on 'social presence: psychological involvement-empathy', $F(1, 74.9) = 8.53$, $p < .01$. Participants experienced more involvement-empathy when playing with the steering wheel ($M_{STEER} = 1.96$, $SD = .07$) than when playing with the classic controller ($M_{CLASSIC} = 1.75$, $SD = .07$). Additionally, a main effect was found of gender on involvement-empathy, $F(1, 84.05) = 13.91$, $p < .001$, with women reporting more involvement-empathy ($M_{WOMEN} = 2.13$, $SD = .1$) than men ($M_{MEN} = 1.58$, $SD = .09$). A main interaction effect was also found between controller type and gender, $F(1, 75.42) = 4.047$, $p < .05$. As can be seen on figure 6, higher involvement-empathy was mainly experienced by women. As for 'social presence-behavioral engagement', no significant main effect could be found of controller type, $F(1, 75.24) = .019$, $p =$ n.s.

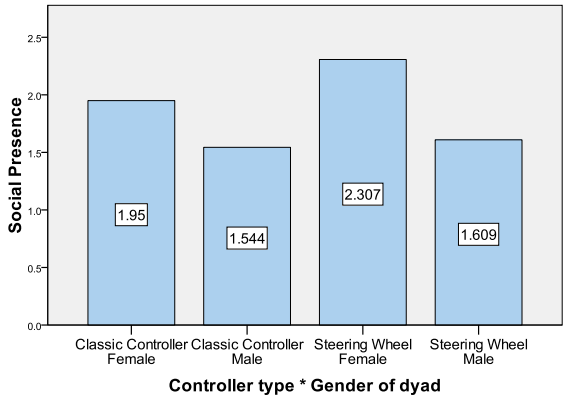

Figure 6. Psychological involvement-empathy, according to controller type and gender

Game experience components

Finally, the four remaining dimensions of the GEQ were explored, namely competence, immersion, positive affect and annoyance. For *competence*, a main effect was found, $F(1, 71.43) = 11.94$, $p < .01$. Players reported experiencing more competence with the classic controller ($M_{CLASSIC} = 1.75$, $SD = .1$) than with the steering wheel ($M_{STEER} = 1.40$, $SD = .1$). Again, we also found a main effect of gender group, $F(1, 80.49) = 5.21$, $p < .05$, with men experiencing more competency ($M_{MEN} = 1.81$, $SD = .13$) than women ($M_{WOMEN} = 1.34$, $SD = .14$). As for *immersion*, we did not find a significant effect of controller type, $F(1, 74.55) = .12$, $p =$ n.s.), neither did we for *positive affect*, $F(1, 74.97) = .21$, $p =$ n.s.). For *frustration*, we found a significant effect of controller type, $F(1, 75.34) = 4.58$, $p < .05$), as players experienced more frustration when playing with the classic controller ($M_{CLASSIC} = .39$, $SD = .06$) than when playing with the steering wheel ($M_{STEER} = .25$, $SD = .05$).

DISCUSSION

Perceived controller naturalness and spatial presence

In line with Skalski et al. [34], Berthouze et al. [2,3,4] and McEwan et al. [29], our results reveal that -also in social settings- playing via the steering wheel augments perceived controller naturalness, and augments spatial presence. Nevertheless, we found that effect to be somewhat modest compared to the former studies. We propose two possible explanations for these modest results. First, steering via the Wii-mote inserted in a steering wheel is very different from steering via a force feedback steering wheel such as the Logitech Momo Racing wheel that was used by Skalski et al. or the Microsoft Racing wheel used by McEwan et al. These racing wheel controllers are arguably *more* naturally mapped (than the Wii-mote racing wheel) as they employ an accelerator and brake pedal, are secured to a table, and offer 240-270° rotation and force feedback. Therefore, the features of the casual Wii-mote steering wheel are not fully comparable to the hardcore simulation that is intended by the Logitech and Microsoft steering wheels, and might not induce perceived controller naturalness as strongly, and explain the modest increase in spatial presence. A second explanation might be that, within a social setting, players are less likely to experience spatial presence. However, this hypothesis remains highly speculative and cannot be verified via the findings of our study, hence it deserves further study.

Perceived control and flow

As suggested by Johnson et al. [19] and Limperos et al. [26], when playing with the steering wheel controllers, players reported less perceived control. In fact, based on the actual game scores, we may conclude that gaming via the steering wheel decreases not only *perceived* but also *actual* control. When playing with the steering wheel, players obtained lower scores than when playing with the classic controller. These findings are further strengthened by the results on the GEQ Competence dimension; male and female players felt less competent when playing with the steering wheel controller than the classic controller.

The idea that gaming via natural mapping might actually offer less control runs contrary to the belief that playing via naturally mapped controllers is 'easier'. Johnson et al. [19] already emphasized that intuitiveness and amount of control are different constructs. Our study confirms the difference between perceived controller naturalness and perceived control. While playing with the steering wheel controller was perceived as more natural, at the same time it was perceived as offering less control. We suggest that future work might concentrate on researching which factors underlie the feeling of less control. Is it caused by a lack in precision or accuracy when gaming with naturally mapped controllers, as suggested by Johnson [19] and Limperos [26]? Or are higher feelings of control and higher scores caused by the accumulated experience of gaming with a classical gamepad. The design of this experimental study does not allow to answer that question.

A sense of control is a condition for experiencing flow, [8:191], therefore we hypothesized that when playing with steering wheel controllers, players experience less flow. Support for this hypothesis can be found in the results on the GEQ flow dimension, which showed that players experience less flow when playing with the steering wheel controller than when playing with the classic controller. However, this finding is only marginally significant and should be interpreted with caution. We acknowledge that we measured flow by a sub-scale of the GEQ, which contains five items only. While our analysis showed that these items had good internal consistency, it still might be questioned whether such a complex, multidimensional construct can be measured with five items only. We recommend that future work measure flow with a more comprehensive instrument. For instance, the flow scales by Jackson and Eklund [18] might yield more insight and allow for a more accurate measurement of flow experiences.

Surprisingly, the GEQ frustration dimension also shows that playing with the classic controller is more frustrating than playing with the steering wheel controller. Perhaps, an explanation can be found in the fact that frustration is essential to hard fun [23] and flow, whereas frustration is not mentioned as a emotion that is common for 'people-fun' [22] or the fun derived from playing with others.

We conclude that the preference for either a naturally mapped or a more classical controller might be hinging upon the extent that players desire a higher sense of control and be willing to trade this in for perceived controller naturalness. High performance expectations, mostly held by men and experienced players [19], may steer preferences towards the classic controllers and away from controllers offering natural mapping. Indeed, we found an interaction effect between gender and controller type on game scores, men more than women increase their scores when playing with the classic controller. This supports the findings of Johnson and colleagues [19] and reinforces the hypothesis by Bianchi-Berthouze [2,4] that body movements and gaming via natural mapping might not favor hard fun.

Social Presence

Our research results also lend support to the hypothesis that social presence is higher when playing with the steering wheel controller than when playing with the classic controller. Nevertheless, the overall difference was rather small and only reached significance for 'Psychological Involvement-Empathy'. Moreover, male dyads did not report an increase in social presence, which is in accordance with Boguslawski's findings [6]. In that study, the researcher did not find an increase in social presence among experienced, male participants. In the present study, the increase in social presence was mainly due to female dyads, supporting the research results by Lindley et al.[27]. Again, an explanation for these differences in social presence by gender of dyad may be found in different playing motives held by male and female players. Thomas and Walkerdine found that female gamers use gaming as a vehicle for social interaction rather than as a means for being *"intellectually challenged"* [36]. Indeed, our findings suggest that female gamers, more than male players, experience social presence while gaming via naturally mapped controls and therefore might prefer naturally mapped controllers. However, we also note that complex constructs such as

Voida et al. [37] suggested that game consoles (particularly the Wii) can be considered as computational meeting places. When designing console games 'as meeting places' the authors suggest to provide modes of play that downplay competition between players (e.g., fostering non-serious competition or competition between the gaming group as a whole the computer). Our study suggest that particularly the natural mapping offered by the sensors in the Wiimote can contribute to augmenting social presence. However, further research is necessary to investigate the relationship between social presence and the different motives underlying different preferences for controllers. We also suggest that future researchers note the relationship or familiarity of co-players, as this might equally effect the amount of social presence experienced.

Limitations and future work

On a final note, we acknowledge that the same experiment with other controllers and/or other games genres, may lead to other results. The fact that different instantiations of gaming via natural mapping can lead to different results partially limits the generalizability of studies such as this one. Therefore, it will remain important to build on our results using other controllers and games with the ultimate goal of developing a complete understanding of the impact of natural mapping across devices and games.

CONCLUSION

In this study, we present the results of an experimental design where we manipulated the type of controller (either a classic controller or a steering wheel) when playing a racing game in dyads. To measure the player experience and the characteristics of gaming via natural mapping, self-reports were administered after playing with either controller. We found that gaming via natural mapping augments perceived controller naturalness. Our results also reveal that players experience more spatial presence when playing with the steering wheel, although the effect was rather small. While gaming via natural mapped controllers augments perceived controller naturalness, it decreases perceived control; players felt less competent with the steering wheel and obtained lower scores. Furthermore, our results suggest that playing via the steering wheel results in less flow for players. Additionally, the experimental study demonstrated that gaming via natural mapping increases social presence, but only for players in female dyads. Male co-players did not report an increase in social presence. Hence, we conclude that naturally mapped controllers offer more naturalness, yet less control.

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