Mapping the Road to Fun:
Natural Video Game Controllers, Presence, and Game Enjoyment

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Abstract

This study examines the potential for natural mapping to affect presence-related outcomes of video game exposure. Interactivity in the form of natural mapping has been advocated as a possible contributor to presence experiences, yet few studies to date have investigated this potential, particularly as it applies to video games, which are expected to make extensive use of naturally mapped controllers in the future. This paper formulates a preliminary typology of natural mapping and subsequently addresses how two types of natural mapping impact the experience of a video game, with the expectation that more natual mapping leads to increased spatial presence affecting game enjoyment. A total of 78 subjects took part in an experimental investigation manipulating the type of controller used to play a PC driving video game (steering wheel, gamepad, joystick, or keyboard). Following play, subjects completed measures of perceived controller naturalness (included to provide a manipulation check and continuous measure of naturalness), spatial presence, and game enjoyment. Results of the study were generally consistent with expectations, and the implications of the findings are discussed.

Mapping the Road to Fun: Natural Video Game Controllers, Presence, and Game Enjoyment

The popularity of video game entertainment has soared in recent years. In 2005, the game industry reaped record profits of $10.5 billion in the U.S., up from $9.9 billion the previous year (NPD Group, 2006). According to a 2005 Nielsen Entertainment study, males are now spending more money on video games than on music, lending support to the suggestion that video game play is displacing other media use (Slocombe, 2005). One reason for the ascendancy of video games is technological advancements. Game industry growth has traditionally been fueled in part by technical innovation (Williams, 2002), and many exciting new developments are on the horizon, including High Definition (HD) game graphics (Cross, 2005) and new game playing controllers, the primary focus of this investigation.

Game playing controllers have progressed considerably over time, from single-button joysticks of the late 1970s to the multi-button and stick controllers of today (Skalski, 2004). These advanced control devices allow players to perform a range of actions conducive to the experience of *presence* (Tamborini & Skalski, 2006), "the perceptual illusion of non-mediation" (Lombard & Ditton, 1997). However, few studies have explored the effect of game controllers on presence and resultant game enjoyment, despite the attention interfaces have received from the industry in recent years. Sony, for example, intends to make its camera tracking *EyeToy* controller a standard feature of the next-generation *Playstation 3* (Fahey, 2006), and Nintendo plans to unveil an inventive new control device with its next-generation *Wii* system that allows players to control games through realistic hand and arm movements (Totilo, 2005). These developments point to the potential importance of *natural mapping* as a determinant of video game responses.

Natural mapping, defined by Steuer (1992) as "the ability of a system to map its controls to changes in the mediated environment in a natural and predictable manner" (p. 47), has been

suggested as a possible determinant of video game-induced presence (Tamborini et al. 2004) due to its ability to complete "mental models" people have for real-world activities (Tamborini & Skalski, 2006). However, it has received little attention in the literature on presence and video games. The present study therefore attempts to (a) specify dimensions of natural mapping, and (b) empirically test the notion that natural mapping affects presence and other outcomes of game expoure. It accomplishes this through an experiment manipulating the types of control devices used to play a driving video game. It is expected that a game controller high in natural mapping will lead to more perceived controller naturalness, which should affect spatial presence and resultant game enjoyment.

Video Games and Mapping

Efforts to provide video game players with more "natural" modes of interaction have taken place throughout the history of the medium. In the early days of the video game industry, arcade games often incorporated realistic controllers such as handlebars, wheels, and flight sticks (Skalski, 2004). The classic arcade game *Night Driver* (1976), for example, allowed players to control a car using a realistic steering wheel, and a home driving wheel was even introduced in 1983 for use with the Colecovision gaming console (Skalski, 2004). In spite of this, highly natual game controllers have been confined almost exclusively to arcade gaming. The vast majority of console players, who represent the largest segment of the industry (Williams 2002), continue to interact with games using joystick or gamepad controllers. As Poole (2000) indicates, this may be the most glaringly "unreal" aspect of video games, given that video game *control systems* (aka "cybernetics") are frequently "radically removed" from what happens on the screen. Simple, everyday actions like walking and jumping are controlled not through real movements but by pressing buttons, pushing sticks, and performing other minor, unrealistic actions. This restricts

the physical involvement of game players and has historically diminshed the potential of home gaming experiences to induce presence.

Several developments on the horizon suggest that cybernetic realism in gaming may be on the rise, however, in "revolutionary" ways. The most prominent of these developments is the Nintendo Wii console (intially called the "Revolution"), scheduled for release in November 2006. This game system features an innovative, wand-like conroller that responds to player hand and arm movements in space (Totilo, 2005). In lieu of pressing a button to make a game character swing a golf club, for example, the club can be swung by performing a real golf swing holding the controller. It remains to be seen if this bold leap by Nintendo will translate into commerical success, but some prognosticators are suggesting the Wii could transpire into "the future of gaming," as the sub-headline of a recent story in *The Economist* read ("Playing a Different Game", 2006). Industry leader Sony also aims to support a mapping interface, the Eyetoy, as part of its next-generation Playstation 3 system. This camera device places players on the TV screen and allows them to interact using natural body movements in conjunction with events happening on the screen (Fahey, 2006). Both of these advances suggest that mapping may be an important element of the experience of electronic games in coming years, but what, exactly, *is* mapping?

Mapping and Mental Models

In simple terms, *mapping* refers to the manner in which the actions performed by users of interactive media are connected to corresonding changes in the mediated environment (Steuer, 1992). It can range from arbitray (unrealted to the function performed) to natural (related to the function performed). An example of a device with *arbitrary* mapping would be the QWERTY keyboard, since the keys are not arranged in an immediately sensible maner (e.g., alphabetially). An example of a *natural* mapping device would be a bat controller used to hit in a baseball video

game, given that swinging the bat would correspond to the exact same action in the game. The level of mapping in an interactive system can span from completely arbitray to completely natural, and the extent to which mapping exists is expected to directly affect a media users' perception of controller naturalness.

The value of having more mapped controllers might best be understood as a function of *mental models*, or cognitive representations of situations in real or imagined worlds, along with the entities and events within those situations and interrelationships between them (Roskos-Ewoldsen, Roskos-Ewoldsen, & Dillman Carpentier, 2002). Mental models form to represent many different types of actual situations or possible worlds (vanDijk, 1998), and some have argued that our ability to understand actions and events is determined by the mental models we construct (Halford, 1993; Wyer & Radvansky, 1999). Applied to video games, Tamborini and Skalski (2006) argue that more naturally mapped gaming controllers should allow players to quickly access mental models of real-world behavior, thereby providing more accurate and available information about how to interact with the game. This is expected to facilitate *spatial presence*, the sense of being physically located in a virtual environment (Ijsselsteijn, de Ridder, Freeman, & Avons, 2000), as well as additional outcomes of game exposure.

A Typology of Natural Mapping

Despite the budding popularity and seeming importance of natural mapping in interactive entertainment, not much attention has been directed toward explicating this concept. Uncovering the dimensions of mapping and empirically testing them can help predict the effectiveness of interactive control devices such as those used to play electronic games as well as strengthening our understanding of how and why they work. The present work formulates and discusses three possible types of mapping and the likely relationship of each to mental models and gaming experiences. Note that these mapping types are not orthogonal and may overlap with one

another. The three types are: (1) Directional Natural Mapping, (2) Kinesic Natural Mapping, and (3) Realistic Tangible Natural Mapping.

Directional Natural Mapping. The most basic manner in which controllers can be more naturally mapped is by producing a correspondence between the directions used to interact via a control device and the results in the world or on a screen. As Norman (1986, 1988) points out in his seminal work on the topic, natural mapping takes advantage of physical analogies and cultural standards, leading to "immediate" understanding. Norman (1998) provides an example of directional mapping by discussing stoves with four burners arranged in the traditional 2 X 2 square. Most stove controllers are laid out in a straight line, making it difficult to tell which controller affects which burner; more naturally mapped stove controllers would also be set up in 2 x 2 rectangular form. Even though there may be a disconnect between the actions used to control and the specific actions that happen in response, as in the case of using a joystick to make a game character walk, simply having "up" on the stick lead to "forward" movement, "left" lead to "left," etc. represents a basic form of natural mapping. Without these natural directions, confusion and frustration may result, since unnatural actions work counter to existing mental models for behavior.

Kinesic Natural Mapping. A second type of natural mapping involves body movements that correspond to real-life actions *without* having a realistic and tangible controller. This type of mapping is perhaps best exemplified by video games played using the Sony EyeToy, such as *Air Guitar*. In this mini-game, the image of the player is captured by the EyeToy camera and placed on screen in front of a virtual guitar, which players must "strum" along with using guitar-like motions. As Biocca (1997) suggests, close mapping of actual body movements to mediated body movements strongly influences media exposure outcomes. The extremely close mapping of a kinesic controller should call up mental models for real-life behavior and be perceived as fairly

natural. However, kinesically mapped interfaces are missing the tangible stimulation of a real-life objects, such as holding a guitar, which should reduce naturalness to some extent by not completing a user's mental model for the behavior as easily as a realistic and tangible controller would (e.g., a held guitar control device, such as the one used in the popular *Guitar Hero* video games).

Realistic Tangible Natural Mapping. The final type of natural mapping discussed in this paper incorporates the properties of the first two mapping types and adds a realistic, tangible controller to provide the highest level of natural mapping relative to the other two. Many current arcade video games incorporate this highly-realistic type of mapping in the form of driving wheel, handlebar, or gun controllers (Skalski, 2004). Realistic tangible mapping is also the main function of the Nintendo Wii controller, since players grasp it as they would grasp real objects on the game screen (e.g., a tennis racket or baseball bat). Realistic and tangible controllers such as steering wheels for driving games should allow users to easily access mental models for the behaviors they are performing, allowing them to quickly close the gap between the disconnected controller and the actions that occur on the screen. The increased accessibility of these mental models is expected to enhance spatial presence and potentially even strengthen existing mental models for behavior over time, given the similarity between the game actions and real actions (Tamborini & Skalski, 2006).

The forementioned types of natural mapping are not intended to be exhaustive, but rather to highlight a way of expanding current understandings of mapping for use and refinement in the future. They also suggest directions for research on mapping, and the present study attempts to compare controllers with directional mapping (like a common game controller) to an interface with realistic tangible mapping (saving kinesic mapping for a future study). The direct result of

exposure to more a naturally mapped controller should be higher levels of perceived naturalness, which is expected to affect spatial presence leading to enjoyment.

Rationale and Hypotheses

A controller with realistic tangible natural mapping should cause players to experience more perceived controller naturalness than an interface with directional natural mapping, given that the realistic tangible controller aligns most closely with the pre-existing mental models of players for real-world behavior (Tamborini & Skalski, 2006). Since the present study is a preliminary investigation, the decision was made to compare four commercially available types of game controllers with the hope of creating a range of perceived naturalness scores. The following was expected:

H1: Players of a driving game who use a steering wheel controller will experience a higher level of perceived controller naturalness than those play the game with a keyboard, joystick, or gamepad controller.

Perceived controller naturalness, which represents a continuum of responses to natural mapping, should relate positively to spatial presence, as suggested by Tamborini and Skalski (2006). The reasoning behind this claim is that natural interfaces require less thinking about controlling the game and therefore allow players to more effortlessly feel "in" the game. In additon, controls with highly natural mapping, such as a steering wheel for a driving game, help "complete" being in a mediated space (e.g., the driver's seat of a car) and should also contribute to spatial presence by affecting perceived controller naturalness, as suggested in the following hypothesis:

H2: Perceived controller naturalness positively predicts spatial presence.

Being present in the "space" or environment of a video game is expected to relate directly to game enjoyment. The concept of media enjoyment has received considerable attention from scholars of late, and attempts have been made to direct more attention to the study of media

enjoyment (Oliver & Nabi, 2004). Games that create a sense of spatial presence should cause players to feel more "there" in exciting places (e.g., a race car track or battlefield), leading them to enjoy their experience more:

H3: Spatial presence positively predicts video game enjoyment.

Finally, given the importance of enjoyment to the game industry, questions remain about other variables that may impact this outcome. What, exactly, causes people to enjoy video games? This study explores a number of possibilities, and uncovering these predictors can increase our understanding of why people play games:

RQ1: What other variables predict video game enjoyment?

Methods

Overview

A total of 78 participants played a driving video game as part of a lab experiment. The manipulated independent variable in the study was *type of controller* used to interact with the game, and players were assigned to conditions designed to vary the level of natural mapping they would experience. Each condition had them play the game for ten minutes using either a (1) keyboard, (2) joystick, (3) gamepad, or (4) steering wheel (most mapped). Following their gaming session, they completed measures of perceived controller naturalness (included as a manipulation check), spatial presence, enjoyment, prior game use, skill, and demographic characteristics.

Participants

Participants in this study were undergraduate communication students at a medium-sized Midwestern university who received course credit for their participation. The age range was 18 to 25 years ($M = 21.08$; $SD = 1.39$), and 45 (58%) of the 78 players were male. Participants were

randomly assigned to the four conditions, resulting in cell sizes of 20 across all conditions except the keyboard, which had 18. In each condition, players were informed they would be taking part in a study on people's reactions to video games.

Stimulus and Controllers

All participants played the PC version of the video game *Need for Speed Underground 2*. In this popular auto racing game, players race through city streets against computer controlled opponents. The object of the game is to finish races in the fastest times. For this study, the game was set up so that players could not finish the race, which was done to reduce the likelihood that their success/failure would affect their responses. To create a more realistic driving experience, point of view was set to first-person.

Four different controllers were used in this study, and all but one (the gamepad, explained last) were mounted to a two-foot wide table in front of the seat from which the game was played. In the keyboard condition, players interacted with the game using a Logitech wireless keyboard and controlled their car using the arrow keys, with the left and right keys being used to steer left and right, the up key being used to accelerate, and the down key being used to brake. In the joystick condition, a Logitech Attack 3 joystick was the mode of interaction. Players controlled the game in the same manner as in the keyboard condition, only they moved the stick in the four directions as opposed to pressing buttons. In the steering wheel condition, a Logitech Momo Racing wheel was the mode of interaction. This highly rated interface (e.g., Day, 2005) simulates a real race car wheel that turns to move left and right and includes an accelerator and brake pedal for speeding up and slowing down. Finally, a gamepad condition was included as a "control condition" to match how most users play video games today. Given that Sony leads the console gaming market, the number one segment of the industry (Williams, 2002), a Logitech-replica Sony Playstation controller was used in this condition. This controller is very similar to those

used on the other two popular gaming consoles (Xbox and GameCube) and features a gamepad and analog stick on the left side and buttons on the right. Participants in this study used the analog stick to steer left and right and the buttons to accelerate and brake, using both hands (as in the wheel condition). Since console game players hold this type of controller without mounting it, this condition did not include the table.

Procedures

Upon arriving at the research laboratory, participants were asked to fill out a consent form. They were then escorted into a 7 x 12-foot carpeted room containing a 52-inch screen television and a comfortable couch, which sat 4.77 feet from the screen. They were asked to sit in the middle of the couch in front of the table upon which the controller sat (in all except the gamepad conditions). Once seated, the experimenter briefly explained how to play and control the game. This process took approximately one minute per participant, after which the game was started and the participant was left to play alone for 10 minutes. After the allotted time, the experimenter returned to the room and administered the questionnaire to the participant at a table away from the playing area. While the participant filled out the questionnaire, the experimenter stayed in the playing area and wrote down what place the participant was in (first through fourth) to test for differences in player performance as a function of game controller. No differences were observed. Once finished with the questionnaire, the participant was debriefed and dismissed by the experimenter. The entire process took 30-40 minutes.

Measures

Perceived Controller Naturalness. The extent to which participants perceived their game controller to be natural was measured using four items created specifically for this study, since prior measures of "naturalness" have focused on media content instead of form variables such as control mechanism (e.g., Lessiter, Freeman, Keogh, & Davidoff, 2001). The perceived

controller naturalness measure included items such as "The game controls seemed natural" and "The actions used to interact with the game environment were similar to the same actions in the real world." These items were measured on a 7-point scale (ranging from "strongly disagree" to "strongly agree") and then summed to create an index of perceived controller naturalness. The reliability of this index was $\alpha = .77$.

Spatial Presence. The degree to which players felt located in the game environment was measured using the Spatial Presence subscale of the ITC-Sense of Presence Inventory (ITC-SOPI) (Lessiter, Freeman, Keogh, & Davidoff, 2001). This cross-media measure of spatial presence experiences (adapted to video games in the present study) has been show to be reliable and valid in work by Lessiter et al. Consistent with validation work, the subscale used in this investigation had an acceptable level of reliability. *Spatial Presence* ($\alpha = .93$) included 19 items, such as "I felt like I could interact with the video game environment" and "I felt I was visiting the places in the video game environment." Each item was assessed using a 5-point scale ranging from "strongly disagree" to "strongly agree."

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

Prior Game Use. Several measures of prior game use were included in this study. First, participants were asked to estimate the amount of time (in hours) they spend playing video games during (a) an average day and (b) an average weekday. These items were summed to create a composite measure of video game use frequency. Second, they were asked to indicate how often they play (a) driving games in general, (b) the driving game used in the study, and (c)

driving games with a wheel controller on a 7-point scale, with "1" indicating "not at all" and "7" indicating "very often."

Skill Level. Using the game playing skill scale created by Bracken and Skalski (2006), participants responded from "1" (strongly disagree) to "7" (strongly agree) to eight statements designed to asses skill level. The items included: "I am a good video game player," and "I often win when playing video games against other people." The reliability of this additive index was α = .97.

<div align="center">Results</div>

ANOVA and multiple regression analyses were used to test the hypotheses and research question advanced in this study. ANOVA was used to test the first hypothesis, and subsequent tests of mean differences were conducted using LSD analysis with α set at p<.05. The remaining hypotheses and research question were tested using multiple regression analyses.

Controller Type and Perceived Controller Naturalness

Hypothesis 1, which predicted that a driving wheel controller would be perceived as more natural than keyboard, joystick, or gamepad controllers, was supported. Univariate analysis of variance performed on perceived controller naturalness as a function of controller type was significant, $F(3,74) = 4.98$, $p<.01$, $eta=.17$. Subsequent LSD analyses reveal that the effect was induced by the driving wheel condition, as expected. The driving wheel condition was perceived as significantly more natural ($M=4.74$, $SD=1.18$) than the keyboard ($M=3.67$, $SD=1.34$), joystick ($M=3.25$, $SD=1.32$), and gamepad ($M=3.78$, $SD=1.22$) conditions, which were not significantly different from one another.

Perceived Controller Naturalness and Spatial Presence

Hypothesis 2, which maintained that perceived controller naturalness predicts spatial presence, was also supported. This hypothesis was tested by regressing sex, age, skill level, prior game use, prior driving game use, prior steering wheel game use, prior use of *Need for Speed* games, and perceived controller naturalness on spatial presence, in two blocks. The first block contained all variables except perceived controller naturalness, which was added in the second block to see if it would account for a significant portion of the variance on top of the other variables in the equation. Block 1 accounted for a significant portion of the variance in spatial presence, $R^2 = .27$, $F (7, 69) = 3.45$, $p < .01$. The individual regression coefficient for prior steering wheel game use ($\beta = .28$, $t (69) = 2.03$, $p < .05$) achieved significance. No other coefficient was significant.

In the second step, perceived controller naturalness was added to the model. This block significantly increased variance accounted for, $R^2\Delta = .19$, $F (1, 68) = 24.07$, $p < .01$. Significant regression coefficients were found for perceived controller naturalness ($\beta = .47$, $t (68) = 4.91$, $p < .01$) and skill level ($\beta = .36$, $t (68) = 2.29$, $p < .05$). The important role of perceived controller naturalness in predicting spatial presence strongly supports Hypothesis 2.

Spatial Presence and Other Predictors of Game Enjoyment

Hypothesis 3, which stated that spatial presence predicts enjoyment, was not supported. This hypothesis was tested by regressing the variables used in the prior hypothesis test and spatial presence on game enjoyment, in two blocks. The first block contained all variables except spatial presence, which was added in Block 2 to see if it would account for a significant portion of the variance on top of the other variables in the equation. Block 1 accounted for a significant portion of the variance in spatial presence, $R^2 = .50$, $F (8, 68) = 8.52$, $p < .01$. The individual regression coefficients for perceived controller naturalness ($\beta = .49$, $t (68) = 5.39$, $p < .01$) and

prior driving game use ($\beta = .30$, $t (68) = 2.38$, $p < .05$) were significant. In Block 2, spatial presence was added to the model. This block did not significantly increase variance accounted for, $R^2\Delta = .02$, $F (1, 67) = 2.89$, $p < .10$, contrary to expectations.

Research Question 1 inquired about predictors of game enjoyment. Block 2, with all study variables, accounted for a significant portion of the variance in enjoyment, $R^2 = .52$, $F (9, 67) = 8.11$, $p < .01$. Significant regression coefficients included perceived controller naturalness ($\beta = .40$, $t (67) = 5.39$, $p < .01$) and prior driving game use ($\beta = .30$, $t (67) = 2.42$, $p < .05$). Predictors that approached significance included prior game use ($\beta = .19$, $t (67) = 1.75$, $p = .08$) and spatial presence ($\beta = .19$, $t (67) = 1.70$, $p = .94$).

Discussion

This investigation began with the expectation that natural mapping would both directly and indirectly impact outcomes of video game play, including perceived controller naturalness, spatial presence, and enjoyment. Findings were generally consistent with predictions and lend preliminary empirical support to claims that mapping may "radically" change how consumers respond to electronic games (e.g., "Playing a Different Game," 2006). Specifically, participants who played using a controller offering realistic tangible mapping reported more perceived controller naturalness than those who played using a controller offering simple directional mapping. More importantly, even though spatial presence did not relate to game enjoyment as expected, perceived controller naturalness was a positive predictor of both spatial presence *and* game enjoyment.

Playing with Power: Implications of Natural Mapping

This research suggests that natural mapping may be a powerful determinant of responses to video game technology. It answers the call of Lee & Peng (2006) and others to examine form variables in video games such as interactivity instead of focusing strictly on content as the majority of traditional media research has. Natural mapping is a type of interactivity with the potential to make users perceive interactive control devices to be more natural, as the present findings indicate. Although this investigation only examined four types of naturally mapped interfaces, the findings should generalize to a wide-range of mapping experiences due to the inclusion of a new measure of perceived controller naturalness. This variable represents the immediate effect of natural mapping and can be used in future research to test the effects of other naturally mapped devices. In addition to proving a manipulation check, it provides a range of scores on natural mapping instead of limited categories such as experimental conditions.

Future work should attempt to determine how closely perceived controller naturalness and presence dimensions are related. Several presence scholars suggest that naturalness *is* a presence dimension (e.g., Lombard & Ditton, 1997; Lessiter, Freeman, Keogh, & Davidoff, 2001), but most standardized measures of presence only tap content naturalness and not form naturalness (presumably to remain applicable to non-interactive media experiences). Given the growing use of mapping in the video game industry and elsewhere, some attempt should be made to reconcile perceived controller naturalness and presence dimensions to better account for their joint impact on outcomes of media exposure.

This work also proposed several types of mapping—directional natural mapping, kinesic natural mapping, and realistic tangible natural mapping—and these should be refined and more thoroughly investigated in future work. Although much attention has been focused on High-Definition graphics of next generation gaming platforms (e.g., Bracken & Skalski, 2006), natural mapping represents another new direction for gaming and one worthy of investigation, as the present findings suggest. Future work should attempt to define other types of mapping and investigate the relative importance of each to outcomes of game exposure such as presence sensations, game enjoyment, and prosocial and antisocial attitudes and behaviors.

Impacts on Spatial Presence and Enjoyment

This research examined two potential outcomes of natural mapping—spatial presence and enjoyment—and found both to be affected by perceived controller naturalness. The finding that perceived controller naturalness strongly and positively predicts spatial presence was in line with expectations. However, the strong direct effect of perceived controller naturalness on enjoyment was unexpected, as spatial presence was predicted to affect game enjoyment. The unexpected importance of perceived controller naturalness may simply indicate that perceived controller naturalness and spatial presence are both dimensions of presence, as discussed above. It also

confirms the expected importance of perceived naturalness to outcomes of video game play and suggests that more naturally mapped interfaces that are capable of generating even higher levels of perceived naturalness will be especially enjoyed by players in the future.

In addition to perceived controller naturalness (the most powerful predictor of both outcome variables in this study), other variables also predicted spatial presence and enjoyment. In the case of spatial presence, player skill level emerged as a predictor, consistent with work by Bracken and Skalski (2006) on skill level and presence reactions. This finding makes sense given that low skill players are likely to struggle keeping up with the fast pace of current games, while high skill players are likely to be able to focus in on the action more and feel spatially present in a virtual environment. One the game enjoyment side, the second most powerful predictor was past experience with driving video games. This intuitive finding indicates that game genre preference impacts players' responses to games, and this lends more support to the consistent finding in game research that prior game use predicts exposure outcomes (e.g., Tamborini et al., 2004).

Potential Moderators of the Mapping Effect

Although the present study establishes a foundation for research on natural mapping-related reactions to video game technology, several questions remain unanswered, particularly about moderators of mapping effects. First, how does *time* affect perceived controller naturalness? Even though some interfaces may lack natural mapping on the surface, they may become more "natural" over time as a function of repeated use. The QWERTY keyboard, for example, has an arbitrarily mapped layout, but it has become the dominant way of typing, and most users perceive it as natural (Steuer, 1992). The present investigation only examined short-term mapping effects, but future work should examine long-term effects of controller use, both to test if perceived naturalness increases over time in response to any controller and to discover the

long term effects of natural interfaces, which may only have a short-term effect on enjoyment due to their novelty.

A second set of questions deals with the effectiveness of natural mapping within different games genres and for different types of players. Do all game genres lend themselves to natural mapping, and if not, which are most and least likely to benefit from it? Driving, flying, and sports games are obvious beneficiaries of naturally mapped interfaces, but for other types of games, mapping may detract from the experience. As Poole (2000) points out, very close mapping can sometimes even take away from the fantasy of engaging in amazing activities in video games, such as super-heroic moves and powers, given that people cannot perform those actions in real life.

In addition, the desire for natural may vary as a function of player type. Do all players even want mapping? Across dominant game uses and gratifications motives (Sherry, Lucas, Greenberg, & Lachlan, 2006), players who play for social interaction, for example, may be more likely to want natural mapping than those who play for diversion. Some are suggesting that the highly mapped Nintendo Wii will appeal more to casual games than "hardcore" gamers (e.g., "Playing a Different Game", 2006), and future work should attempt to address the relationship between both player and game type and mapping.

Long Term Implications of Natural Mapping

The important role of game mapping revealed in this research points to the exciting potential of naturally mapped controllers, both in gaming and in other contexts. Natural mapping and resulting spatial presence may not only positively impact video game enjoyment, but also other positive outcomes such as training. In the case of training, natural mapping in simulators can provide users with a more complete mental model for how to perform the real-life actions they are learning, resulting in greater skills transference (Skalski, Tamborini, & Westerman,

2003). At the same time, the downside of natural mapping must also be addressed. If natural mapping can enhance the learning of prosocial skills, it can also create stronger mental models for antisocial behavior, such as firing a weapon or punching and kicking, as players of highly-mapped violent video games might do (Tamborini & Skalski, 2006). Future work should address the many possible outcomes of natural mapping in an attempt to better understand this important and increasingly popular feature of video game technology.

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