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It's not the model that doesn't fit, it's the controller! The role of cognitive skills in understanding the links between natural mapping, performance, and enjoyment of console video games

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ABSTRACT

This study examines differences in performance, frustration, and game ratings of individuals playing first-person shooter video games using two different controllers (motion controller and a traditional, push-button controller) in a within-subjects, randomized order design. Structural equation modeling was used to demonstrate that cognitive skills such as mental rotation ability and eye/hand coordination predicted performance for both controllers, but the motion control was significantly more frustrating. Moreover, increased performance was only related to game ratings for the traditional controller input. We interpret these data as evidence that, contrary to the assumption that motion controlled interfaces are more naturally mapped than traditional push-button controllers, the traditional controller was more naturally mapped as an interface for gameplay.

1. Introduction

Imagine Jack and Jill. Jack and Jill both own different video game systems, and they want to play the latest first-person shooter video games. They purchase similar versions of the same game franchise (such as Infinity Ward's *Call of Duty* games), and go to their respective homes to try out their new games. Jack and Jill are about equal in video game skill, have similar tastes in games, and have similar playing habits and experience. The next time Jack sees Jill, Jack expresses how much he loves the new game and how much he's enjoyed playing it. Jill, dumbfounded, claims the game was frustrating and too difficult. Jack and Jill feel so differently about their experiences, they even wonder if they were playing the same type of game. Through their conversation, they discover that they were playing the same game but they make a stark realization: Jack was playing with a traditional video game controller and Jill was using a motion-sensor controller. As a result, Jack was able to use his video game skills and apply them directly to beating the on-screen challenges, but Jill – although expecting a more natural experience using her own motions as the game inputs – had to spend a lot more time learning a new control scheme and, as a result, she was unable to devote as much time to enjoying the game. Jill explained that the controllers for her console were supposed to be more "natural," but now, both of them wonder what that means for the video game experience.

Games vary on many dimensions, such as graphics and gameplay, but one dimension germane to the current empirical investigation is the controller used for the game – the device, either wired or wireless, held by the gamer and used to manipulate on-screen objects and characters. Each video game console uses a different controller, and games often allow players to use different controller schemes and layouts based on their personal preferences. Importantly, the enjoyment of a game can be tied to which type of controller is used (Joeckel & Bowman, 2012), and some even argue that the aesthetics and ergonomics of the controller are a qualitative part of the gaming experience (Cummings, 2007).

Notably, console game controllers are shifting toward motion-controlled interfaces, as opposed to traditional push-button controllers. The three major seventh-generation video game consoles have each implemented motion control devices (Nintendo Wii, Playstation Move and Xbox Kinect), and the newest eighth-generation console, Xbox One, includes advanced motion-control computing technology as a central feature of game design. Based on this trend toward motion-controlled interfaces, it is worth developing an understanding of how differences in controller type can have diverging impact on the end-user experience of gameplay.

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Developers seem to be assuming that enhancing the perceived naturalness of a control scheme (such as using the human perceptual system to control on-screen action rather than a push-button system) should automatically enhance a game's playability and resultant enjoyment, but quick scans of game reviews (Alam, 2008; Tamborini & Bowman, 2010) have found that individual game ratings for Nintendo Wii titles, on average, fall considerably behind their traditional-controller counterparts. To this end, our study will examine the difference between players performance, frustration and game rating as predicted based on use of a motion controller and traditional controller.

2. Mapping and natural mapping in video games

Often, motion-controlled interfaces require players to physically mimic the actions to be performed in the game. For example, some games in the *Call of Duty* franchise, a first person shooter, requires the player "aim" and "shoot" in their living room as the motion-control device tracks the players' body movements. Meanwhile, other games in the *CoD* franchise do not use a motion-controlled interface but rather a traditional controller where button presses cause the player's avatar to perform a variety of actions.

The difference between these interfaces can be described as a difference in mapping, or a match between virtual actions and natural actions in the world (Reeves & Read, 2009). Broadly, mapping is an interface design attribute. Natural mapping – a specific type of mapping involving consideration for the natural human perceptual system (Biocca, 1997) – is achieved when an interface's controls correspond to their actual physical actions (Norman, 1988). Norman (1988) suggests that when interface controls are highly naturally mapped, they should be intuitive to the extent that labeling the controls is unnecessary; Clark (2003) refers to this phenomenon as an indication of transparent technology – one that is used without consideration.

Skalski, Tamborini, Shelton, Buncher, and Lindmark (2011) suggest that realistic tangible mapping is the most natural. Realistic tangible models should most closely mirror real-world action and therefore allow users to readily access mental models associated with those actions (Tamborini & Skalski, 2006). In other words, mapping creates isomorphism between a controller action and the action on screen (Norman, 1988), reducing awareness of the controller and enhancing spatial presence (a psychological sense of feeling physically part of a virtual environment; Tamborini & Bowman, 2010). In a sense, highly naturally mapped controllers do not require users to learn new mental models in order to be effectively used.

The connection between natural mapping and interactivity is well documented (Reeves & Read, 2009; Skalski et al., 2011). Generally, it is accepted that natural mapping leads to perceptions of interactivity (Reeves & Read, 2009). Perceptions of interactivity lead to feelings of immersion and telepresence (Smith & Graham, 2006; Steuer, 1992; Tamborini et al., 2004) as well as positive attitudes toward content, more engagement with content, and retention of content (Ariely, 2000; Sundar & Kim, 2005; Teo, Oh, Liu, & Wei, 2003).

Further, mapping has been connected to enjoyment. Skalski et al. (2011) demonstrated that natural mapping led to more perceived naturalness which led to enjoyment. Tamborini, Bowman, Eden, Grizzard, and Organ (2010) provided evidence that natural mapping in a bowling video game had a positive relationship with intrinsic needs, such as competence and autonomy, and players derived enjoyment from the satisfaction of those intrinsic needs.

However, in the context of video games, we argue that mapping might function differently than what has been suggested in the preceding literature. In fact, we predict the opposite pattern will emerge. Namely, when controls are closely mapped to mirror real-world actions in video games, they will be considered less "natural" than when actions are mapped to presses of a button on a traditional controller. For example, many video games feature extraordinary settings and circumstances, like magic and monsters in *World of Warcraft* or aliens and spacecraft in *Halo*. Therefore, many of the actions in the games have no real-world analogue, like casting a healing spell or flying a fictional vehicle. We should not expect players of these games to have strong mental models or accurate reference points for these behaviors.

Consequently, while players do not have a strong mental model of these physical behaviors named above – casting spells and fighting enemy insurgents – they may have a strong mental model of these behaviors when playing video games. If it is the case that players' mental models of these behaviors are more a function of their video game experiences than their real-world experiences, then it makes sense that traditional push-button controllers might be perceived as more mapped for the mental model of playing a video game war simulator. Moreover, most video games – regardless of how realistic they are programmed to be – are rarely authentic to the actions they are portraying. Game designers focus more on presenting an idealized version of otherwise-banal activities that can be romanticized (Farokhmanesh, 2013). In some respects, players' reactions to so-called naturally mapped game controllers might even be understood in terms of Mori's (1970) uncanny valley, which suggests that as virtual activities become more similar to their real-world analogies, audiences' reactions become increasingly negative when those virtual actions are not able to fully match the real-world.

3. Video games and flow experiences

In their exploratory model of play, Csikszentmihalyi and Bennett (1971) attempted to identify the psychological motivations for playing games. Across several different cultures, the authors found evidence of games and other forms of play that seemed to serve no purpose beyond the activities themselves. These autotelic (re: self-motivated) activities were found to be intrinsically enjoyable because they provided enough of a challenge to be self-perpetuating while not over-taxing the skills of the players. The result of this optimal balancing of challenge and skill was the flow state—a self-motivated state of immersion and loss of self that results in optimal levels of enjoyment (Csikszentmihalyi, 1993; Nakamura & Csikszentmihalyi, 2002). Expanding the notion of flow to understand media enjoyment, both Sherry (2006) and Hsu and Lu (2004) argued that video games, among other entertainment products, are an ideal medium for inducing flow experiences given that elements of challenge and skill are so core to their design.

As specifically outlined by Sherry (2006), flow in video games can be understood as the optimal balance of challenge and skill that sits between frustration (challenge outweighs skill) and boredom (skill outweighs challenge). Recent evidence suggests that frustration elicited by video games can provoke aggressive affect, thoughts and behaviors (Przybylski, Deci, Rigby, & Ryan, 2014). Notably, this effect was found regardless of the level of violence in the game played. Accordingly, attention to frustration is important in present and forthcoming video game research.

Past work (Bowman, Weber, Tamborini, & Sherry, 2013; Sherry, Rosaen, Bowman, & Huh, 2006) has demonstrated that we can also understand players' flow experiences by analyzing their cognitive abilities as indicators of game skill. Sherry et al. (2006) demonstrated that game-related cognitive skills – such as verbal fluency when playing a word-puzzle game, memorization when playing a