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Music Game Enjoyment and Natural Mapping Beyond Intuitiveness

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Abstract

Introduction and statement of problem. Despite the success of music games with instrument-shaped controllers, little is known about what makes these kind of controllers entertaining. The aim of this article is to shed light on the enjoyment mechanisms of such music games and their particular controllers.

Review of the literature. The literature's theoretical foundation lies in the concept of natural mapping, i.e. the similarity of actions performed in the real world and their representation within the videogame. A review of the literature finds that most approaches are too simplistic, as they limit game enjoyment with natural mapping to higher intuitiveness. In contrast, challenge can also foster game enjoyment.

Methodology. Two parallelized sample groups (N=20) played three levels of a music game with increasing difficulty with either a Guitar Hero controller or with a real guitar. Perceived difficulty and game enjoyment were collected via questionnaires.

Analysis. A 2x3 mixed-design ANOVA was conducted for significance testing. It revealed a significant increase in enjoyment and perceived difficulty both for advanced game levels and the real guitar. A *posteriori* multiple regression showed that the increase in enjoyment with the real guitar could not be attributed to the higher challenge it produced alone.

Conclusions and recommendations for further research. The results suggest that intuitiveness is not the single factor for music game enjoyment with natural controllers. Further research might investigate the role of simulation and

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identification with attractive roles, as both could act as sources for game enjoyment and natural mapping might facilitate these factors. Applications for learning and teaching should consider debriefing as a method to facilitate transfer of the game experience into the real world.

Keywords
engagement, enjoyment, game controllers, music games, natural controllers, natural mapping, simulation

Game enjoyment is a concept that arises in many investigations at the intersection of games and learning. The idea is simple: with enjoyment comes engagement with the game, and "ideally, game outcomes will align with learning outcomes, so that engagement with a game is equivalent to engagement with the intended learning activities" (Whitton & Moseley, 2014, p. 440). It is surprisingly complex to differentiate the many different concepts assembled under the umbrella termed "engagement" (e.g. Bouvier, Lavoué, & Sehaba, 2014; Crookall, 2014) and how they relate to game enjoyment. This article selects a broad definition and subsumes under the term enjoyment all the intrisically motivating affects caused by playing a game. Engagement into a game is seen as a player's behavioural inclination to play the game, driven by the expected enjoyment.

I focus this article on a particular game genre: music games featuring controllers that resemble real instruments. These music games, e.g. the Guitar Hero Franchise (Guitar Hero, 2005-2010), have been remarkably successful (Berardini, 2008). But where does this success come from? On first sight, one might be tempted to look for the reasons in the role of audio in video games: the sensation of presence it facilitates (Turner, McGregor, Turner, & Caroll, 2003), the formal gameplay functions of sound effects (e.g. feedback on the player's actions, creating atmosphere, guiding the player) (Jørgensen, 2006), or the role of the players' participation in dynamic game audio composition (Collins, 2009). On second sight, it seems more plausible to concentrate on the unique peculiarity of these games: their instrument-shaped controllers. In the scientific community around Simulation and Gaming, Karppi and Sotamaa (2012, p. 422) have investigated the relation of gameplay and turntable-resembling controllers in DJ Hero (DJ Hero, 2009). They argue that one and the same game provides different links for many different players: for some, they reflect turntablism culture, for others, they provide the expressive joys of music games. Castell, Jeson and Thumiert (2011, p. 341) see new and more opportunities for authentic practice in these controllers, enabling players to use their embodied competence (Castell et al., 2011, p. 333). In scientific communities more oriented towards human computer interaction and media psychology, these lifelike controllers are subsumed under the term natural mapping. In general, a fair amount of research on natural mapping exists, but these theoretical concepts seem quite simplifying. In the end, most of them trace game enjoyment to the alleged intuitiveness that comes with natural mapping.

I wrote this article from a media psychologist perspective and focus on the unique relation of natural mapping and game enjoyment in music games. However, the article questions the simplistic mechanisms postulated by recent works in this area both theoretically and empirically. The first part of this article is about the theoretical aspects. Current approaches to the relation of natural mapping and game enjoyment are presented and discussed. It is argued that challenge might have a key role in this relation. The second part consists of an empirical study investigating the relation of natural mapping, challenge, and game enjoyment. Finally, I discuss the implications of the study in terms of general theory of natural mapping, methodology and practical applications for learning and teaching.

The Concept of Natural Mapping

The most obvious feature of music games covered by this article is their use of game controllers that imitate the appearance and the handling of musical instruments. In video game research, this concept is known under the term, *natural mapping*. It refers to the similarity of actions performed by a player in the real world and their representation within the videogame (Skalski, Tamborini, Shelton, Buncher, & Lindmark, 2010, p. 3). Skalski et al. distinguish four grades of natural mapping: (1) *Directional natural mapping* relies on physical analogies or cultural standards. For example, within a side-scrolling videogame, the angles of a joystick correspond to the directions the avatar can be moved to. (2) With *kinesic natural mapping*, real-life body movements are mapped to corresponding actions within the videogame without any tangible controller, but by motion capturing (e. g. via Microsoft Kinect). (3) By *incomplete tangible natural mapping* Skalski et al. describe the use of game controllers that emulate the handling of the object represented within the game. For example, Nintendo's Wiimote simulates the feel of a racket within a tennis game. (4) Finally, *realistic tangible mapping* refers to the use of highly lifelike controllers like driving wheels or gun controllers.

According to Skalski et al. (2010), with more naturally mapped controllers, a player could more quickly access pre-existing mental models of the action represented within the video game. By this, he or she is supposed to have more accurate and available information on how to interact with the game, which reduces the need to focus actively on the controls. Tamborini et al. (2010) share the assumption that naturally mapped game controllers provide intuitive handling. Castell, Jeson, and Thumiert (2014, p. 340) also believe that with natural mapping (which they call *mimetic play*), games shift from simulation to imitation, from "as if real" to "just like the real". By this, players could use their embodied competence (pp. 342-343) to play the game intuitively. I do not share this perspective, but before I explain my reservations, let me describe the current literature's assumptions of how natural mapping and game enjoyment relate.

Current Explanations for Game Enjoyment With Natural Mapping

Spatial Presence

The concept of spatial presence refers to the false impression of being *directly* involved in an in fact *mediated* experience (Lombard & Ditton, 1997), e.g. when a person watching a movie forgets that the events he or she experiences are in fact projected on a cinema screen. Spatial presence can be a source for game enjoyment (Lombard & Ditton, 1997).

Skalski et al. (2010) have picked up the concept of spatial presence as a link between natural mapping and game enjoyment: They assume that with natural mapping, players need less active focus on the controls. This, in turn, is supposed to facilitate spatial presence, which finally contributes to game enjoyment. In two studies, Skalski et al. found evidence that natural mapping in fact could predict spatial presence. But, spatial presence did not have a significant effect on game enjoyment. However, the authors (Skalski et al., 2010, p. 16) found an unexpectedly strong direct effect of controller naturalness on game enjoyment that they could not explain theoretically. They concluded that natural mapping is not necessarily a requirement for game enjoyment.

Need Satisfaction

Tamborini et al. (2010) conceptualize game enjoyment as need satisfaction. They criticize that past research focuses mainly on hedonism and that the few existing approaches taking aspects of need satisfaction into account lack an organizing framework to understand these needs. With self-determination theory by Deci and Ryan (2000), Tamborini et al. seek to solve these issues. Self-determination theory mentions several needs whose prospect of satisfaction motivates human behavior. Autonomy (the desire to organise one's behaviour independently and in consistence with one's self-perceiption) and competence (the wish for having control over one's environment) have already been investigated as antecedents of game enjoyment by Ryan, Rigby, and Przybylski (2006). Tamborini et al. hypothesized that naturally mapped game controllers provide intuitive handling. Since such intuitive controls were assumed to provoke stronger feelings of freedom and control (Ryan et al., 2006, p. 350), naturally mapped controllers were expected to facilitate satisfaction of competence and autonomy needs, which in turn should predict game enjoyment. In a study comparing enjoyment with a regular controller to a simulated bowling ball, Tamborini et al. found empirical proof for their assumptions in a bowling game.

Critique

As outlined above, most current approaches linking controller naturalness and game enjoyment follow a simple scheme such as that in Figure 1. They first imply that

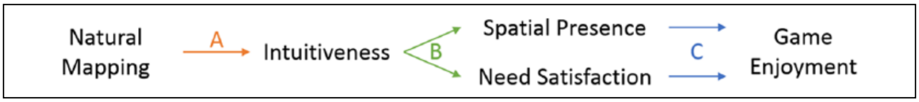

Figure 1. Current literature's linking of natural mapping and game enjoyment.

naturally mapped controllers are more intuitive and easier to handle (A). They then conclude that this intuitiveness facilitates *need satisfaction* and/or *spatial presence* (B), which in turn they assume to create *enjoyment* (C).

Empirical proof of these relations varies between studies. Nevertheless, the approach of Skalski et al. (2010) has been adopted by several authors. For example, McGloin, Farrar, and Krcmar (2011) used a similar theoretical framework and found empirical proof that controller naturalness could predict both spatial presence and game enjoyment. Schmierbach, Limperos, and Woolley (2012) also found a positive relation of controller naturalness and game enjoyment which they explained by the balance of skills and challenge. However, they did not find a direct connection between presence and game enjoyment. McEwan, Johnson, Wyeth, and Blackler (2012) also investigated the effects of controller naturalness. They found that, contrary to Skalski et al. (2010) as well as Tamborini et al. (2010), a regular controller led to more perceived competence and was rated less challenging than a more naturally mapped racing wheel, although natural mapping was related to presence. To sum up, the supposed relation of natural mapping and game enjoyment as visualised in Figure 1 lacks consistent empirical proof.

Natural Mapping Does Not Imply Intuitiveness

The causal relation of natural mapping and game enjoyment seems disputable, declaring a naturally mapped controller as being more intuitive than other forms of controllers is also debatable. For example, in a study comparing performance, frustration and game rating between a conventional controller and natural mapping, Rogers, Bowman, and Oliver (2015) found that not the naturally mapped, but the conventional controller led to better performance than natural mapping. The authors concluded that imitating real world actions with virtual counterparts can be less natural, especially when players do not have a strong mental model of the action. For example, a player might not have a strong mental model of the gesture by which the avatar within the game world casts a spell, because there is no magic in the real world. As a result, it would feel more natural for the player to just push the *cast spell* button on the gamepad than to wave his or her hands in the air as a magician.

The same might account for music games, which I will illustrate with the music game Frets on Fire (Frets on Fire, 2006), an open-source clone of the popular Guitar Hero series (Guitar Hero, 2005-2010). An episode of Frets on Fire consists of a song the player plays along to. As seen in Figure 2, the user interface shows a guitar's fingerboard. From the back, symbolized musical notes (A) appear on top of the strings and move towards the player. As the notes reach a row of keys, representing guitar

Figure 2. Frets on Fire's user interface.

Figure 3. A Guitar Hero controller.

strings, at the bottom of the screen (B), the player must press these keys and a pick button. If successful, a tone or chord is played and points (C) are granted. Missing a note results in a prerecorded, scratchy *screw up sound*. When the player misses too many notes in a row, he or she loses the game. Once the player hits ten notes without making any mistake, the score multiplier (D) increases by one, extending the amount of points he or she gets. The goal of the game is to score as many points as possible.

The game can be played with a regular keyboard, which would, if any, resemble the lowest form of natural mapping – directional natural mapping. But it could also be played with a Guitar Hero controller which imitates a real guitar in its shape a presented in Figure 3. In Skalski's et al. taxonomy, this controller could be regarded to as incomplete tangible natural mapping. It emulates some, but not all actions in the virtual world as shown below.

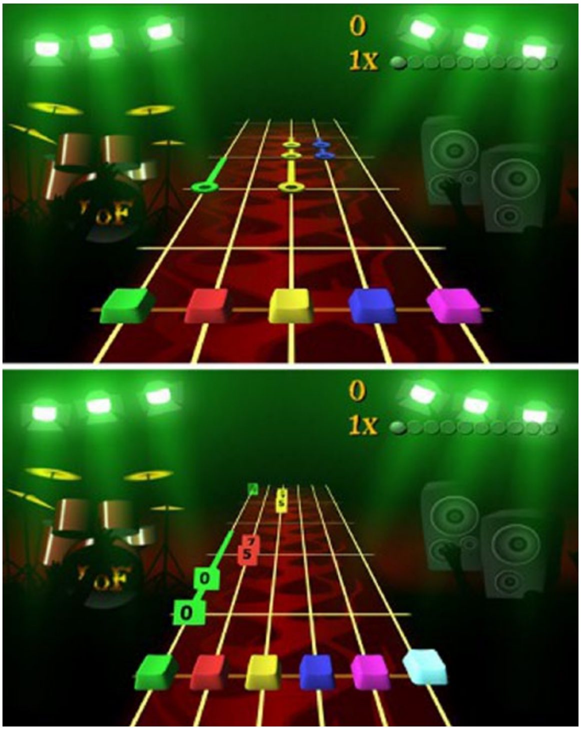

Figure 4. Frets on Fire's interface—Guitar Hero controller on top, a real guitar on bottom.

The highest form of natural mapping, realistic tangible mapping, could be achieved by using a real guitar as an input device. Frets on Fire supports this option by its MIDI module which allows to trigger game events by real instruments via MIDI interface.

In terms of complexity, the handling of a real guitar exceeds the one of a Guitar Hero controller in several ways. First, there is the *physical handling of the controller*. A Guitar Hero game controller only consists of five buttons, representing five frets of a guitar. These five buttons can trigger a wide range of different musical notes. During the whole song, the player's left hand rests on these buttons. An electric guitar, on the other hand, features up to 24 frets and six strings, each of which produces a distinct musical tone on each corresponding fret. This forces the guitar player to perform a lot more different fingerings in order to cover a musical scale and constantly change the position of his left hand (Arsenault, 2008). In addition, a Guitar Hero controller only has 3/4th the size of the guitar model it resembles, which makes it easier to switch between different fingerings. Second, there is the *complexity of the interface*. Since a controller button represents a fret and can trigger different musical notes, with a controller it is sufficient to display which button ("fret") to press at which time in order to play along to the song. However, with a real guitar, the user interface must provide information not only on which fret, but also on which string has to be pressed. As a result, the user interface gets more complex with realistic tangible mapping. See Figure 4.

In short, a Guitar Hero game controller waives a significant amount of realism in favor of playability. Thus, a real guitar representing realistic tangible mapping is less intuitive and its handling is more complex than a Guitar Hero controller (incomplete tangible mapping) – not although, but *because* it is more authentically and naturally *mapped* to the events within the game. This means that natural mapping does not necessarily imply intuitiveness. As Karppi and Sotamaa (2012, pp. 420-421) point out, this does not only apply to music games such as Guitar Hero, but also the game DJ Hero (DJ Hero, 2009) which features a controller that resembles a turntable.

The Importance of Challenge

Skalski's et al. (2010) as well as Tamborini's et al. (2010) approaches imply that psychomotor challenge indirectly harms game enjoyment, as it reduces the change of need satisfaction or spatial presence. However, this perspective is contradictory to many game enjoyment models that see challenge as a source for game enjoyment. For example, there is Csikszentmihályi's concept of flow, "the holistic experience that people feel when they act with total involvement" (Csíkszentmihályi, 1975, p. 36). According to Csíkszentmihályi (Csíkszentmihályi, 1975, pp. 49-54), experience of flow requires a balance of the skills a task requires and the abilities of a person. When the former exceed the latter, anxiety arises, decreasing (game) enjoyment and motivation. But also a lack of requirements is considered fatal for enjoyment, as if facilitates boredom.

Cox, Cairns, Shah, and Carroll (2012) found that physical and cognitive challenge in video games could increase immersion and by that the game experience. As the concept of immersion is related to the concept of spatial presence, their findings are even contrary to Skalski's et al. (2010) assumption that intuitive, psychometrically unchallenging tasks per se lead to presence and enjoyment.

Klimmt (2003) as well as Klimmt, Rizzo, Vorderer, Koch, and Fischer (2009) posited that game episodes contain a necessity and particular possibilities to act, which together form the impression of an episode's difficulty. A game's difficulty is related to the concept of *suspense*: Facing the necessity to act, a player is uncertain if he or she could overcome the challenge, yet hopes for a positive outcome of the situation. As a result, suspense, the "condition of negatively valenced emotion" (Klimmt et al., 2009, p. 29), emerges. Once the player has successfully taken actions within the given possibilities and produced a positive outcome, suspense that has built up is transformed into relief. As a result, affects are amplified by the sustained physiological arousal the suspense created, leading to strong, positive feelings of euphoria. Higher levels of suspense (resulting from higher difficulty) lead to greater game enjoyment (Klimmt et al., 2009).

Klimmt's (2003) model helps to understand the distinct relation of game play and enjoyment in music games such as Frets on Fire. The player desires to succeed in the game and to achieve a high score. *Necessities to act* consist of the continuously appearing musical notes the player has to hit. Suspense arises not only from the risk of missing too many notes and thereby losing the game, but also from a score multiplier which resets when a streak of correctly played notes gets interrupted. The end of an episode is clearly indicated by the end of the song, abruptly transforming suspense into relief.

Playing the game with a real guitar (as the highest form of natural mapping) presumably generates more enjoyment than lower forms of natural mapping. Due to the real guitar's more difficult physical handling, higher demands on the player's timing and a more complex user interface (cf. above), actions required are much more demanding than with less naturally mapped controllers. This leads to higher uncertainty about the desired success, which in turn results in higher levels of suspense. The same holds true for game episodes with increasing and more challenging necessities to act (that is songs with more musical notes and more complex fingerings). Theoretically, as long as the game does not get too difficult to handle and the player is successful, higher suspense should lead to stronger relief. In summary, psychomotor challenges resulting from more complex controller does not necessarily hinder game enjoyment. In contrast, it could even contribute to it.

Empirical Study

Hypotheses

Previous research suggested that natural mapping generally leads to more intuitive controls and therefore to higher levels of enjoyment. This article questions this perspective, and instead, states a positive relation between both natural mapping and challenge as well as challenge and enjoyment. When comparing the most natural form of mapping using a real guitar as an input device in music games with lower forms of natural mapping using a Guitar Hero controller, the following hypotheses were tested.

H1: A realistically mapped real guitar will be perceived to be more challenging than a less naturally mapped Guitar Hero controller.
H2: Later game episodes with more musical notes and more complex fingerings will be perceived to be more challenging.
H3: A realistically mapped real guitar will be more entertaining than a less naturally mapped Guitar Hero controller.
H4: More challenging episodes will be more entertaining than easier episodes.

Method

Participants

Participants were mostly computer science students and graduates from a German university as well as some senior high-school pupils. The sample group consisted of 20 participants (40 percent female) between the ages of 18 and 28 years ($M = 22.7$; $SD = 3.28$).

Material

This study used the music game Frets on Fire (Frets on Fire, 2006). Frets on Fire is an open source music game and provides a gameplay experience much like the commercial videogame Guitar Hero. For the purpose of this study, a modified version of Frets on Fire was created that could be played with a real guitar. Signals from an electric guitar were transmitted via a guitar-to-MIDI system and an USB-MIDI- Interface. A MIDI module, offered by the Frets on Fire development community, processed the guitar MIDI signals and transformed them into game controls. This way, audio latency was reduced beyond perceivable level. A virtual guitar rack amplified and played back the original acoustic guitar signals. For further technical details see Merz (2011).

Procedure

The study was conducted in a computer lab at a German university. Participants were recruited among students and acquaintances. Based on previously collected control variables (see below), participants were assigned to one of two parallelized groups. On a descriptive level, effect sizes of control variable differences were not significant, with the exception of smaller differences in dummy-coded sex (p = .39, d = .4) and interest in music games (p = .46, d = .33). A t-Test (α = .05) revealed no significant difference of control variables between both groups. Members of the both groups played the same three episodes, with each episode featuring a different song that was approximately 3 to 4 minutes in duration. Necessities to act increased and got more demanding with each episode, as more musical notes had to be hit in shorter intervals. After each episode, game enjoyment and perceived difficulty were measured using a questionnaire. Participants assigned to the control group used a naturally mapped game controller from the music game Guitar Hero. Participants of the treatment group played the game with a genuine electric guitar.

Measures

Control variables were interest in music, interest in computer games in general, interest in music games and experience in playing the guitar. All of these variables were measured in advance using single self-report items. On a Likert scale ranging from 1 to 4, higher values represented more interest/experience. Furthermore, frequency of playing games in general was assessed by one single self-report item asking for the average number of game sessions per week. A similar self-report item measured how often participants have played music videogames before.

The first dependent variable was *perceived challenge*. Challenge of each game version was assessed using two self-report items. One item addressed the game's overall difficulty and the other item the handling of the input device using such questions as "How easy/difficult did you perceive the game as a whole?", "How easy/difficult was the handling of the input device?". On a Likert scale ranging from 0 to 10, lower values reflected too low and higher values to high demand. Value 5 indicated optimal balance. Internal consistency was high (α_{EP1} = .9, α_{EP2} = .86, α_{EP3} = .82), so a mean score calculated from both items served as an index variable measuring challenge.

The second dependent variable was general *game enjoyment*. It was measured by a rating scale adopted from Klimmt (2006). It featured a 4-point Likert response format, with higher values representing higher levels of enjoyment. During item analysis, some items were removed due to suboptimal item difficulty or poor factor loadings, leading to a total of six items. The final scale was expected to be one-dimensional, which was confirmed by separate confirmatory principal component analyses for each episode, and demonstrated good internal consistency ($\alpha_{EP1} = \alpha_{EP2} = \alpha_{EP3} = .86$). Factor loadings of items varied from .58 (with one exception of .37) and .92, and explained variance ranged from 58.7 to 61.4 percent.

Statistical Procedures

For H1, H2, H3 and H4, a 2x3 mixed-design ANOVA was conducted with independent measures on input device (realistic tangible mapping with a real guitar vs. incomplete tangible mapping with a Guitar Hero controller) and repeated measures on game episodes ($\alpha = .05$). Post-hoc multiple comparisons of game episodes were conducted using Bonferroni correction. Due to violation of sphericity, Greenhouse-Geisser corrected values were used for both game enjoyment scales.

In addition to hypothesis testing, a multiple linear regression analysis was conducted. Both perceived difficulty and mapping type were dummy-coded (0 = incomplete tangible mapping and 1 = realistic tangible mapping) as predictor variables and game enjoyment served as a dependent variable ($\alpha = .05$).

All statistical tests were conducted with SPSS 19. Effect sizes within a priori test of differences in control variables were conducted with G*Power 3 (Faul, Erdfelder, Buchner, & Lang, 2009).

Results

Effects of Mapping on Challenge

Descriptive values are shown in Table 1 and results of omnibus significance testing and can be observed in Table 2. As expected, participants who played the guitar-supporting version of Frets on Fire rated the game more difficult than the ones who played the game controller version (H1). This main effect, induced by the *type of mapping*, was statistically significant, and effect size was large. Additionally, omnibus testing showed that more difficult gameplay conditions in later *episodes* had a significant and large main effect on perceived challenge, supporting H2. Post-hoc testing revealed significant differences between both episode 1 and 2 ($p < .001$), 1 and 3 ($p < .001$) as well as episode 2 and 3 ($p = .001$). However, participants who played the Guitar Hero controller condition reported a steeper challenge slope from episode to episode than participants who played with the real guitar in Figure 5. This large interaction effect was found to be statistically significant.

Effects of Mapping on Game Enjoyment

As for H3 and H4, Table 1 shows descriptive values and Table 2 shows results of omnibus significance testing. As hypothesized, participants who used a real guitar reported higher levels of game enjoyment than participants who used the game

Table 1. Mean Scores and Standard Deviations for Dependent Variables.

		Episode 1		Episode 2		Episode 3	
		M	*SD*	*M*	*SD*	*M*	*SD*
Guitar Hero controller	Challenge	2.85	1.36	3.95	1.17	5.1	1.35
	Game enjoyment	2.17	.34	2.33	.29	2.52	.36
Real guitar	Challenge	5	1.51	5.6	1.17	6	1.18
	Game enjoyment	2.98	.55	3.32	.41	3.45	.46
Total	Challenge	3.93	1.78	4.78	1.42	5.55	1.32
	Game enjoyment	2.58	.61	2.83	.61	2.98	.62

Table 2. ANOVA Table of Two-Way Repeated Measures With Type of Input Device as Between Factor, Episode as Repeated Factor.

Source of variance	*df*	Error	*F*	*p*	η_p^2
Challenge					
Type of mapping	1	18	8.12**	.01	.31
Episode	2	36	53.15**	< .001	.75
Episode * type of mapping	2	36	7.96**	.001	.31
Game enjoyment					
Type of mapping	1	18	32.3**	< .001	.64
Episode	1.28	23.06	13.91**	.001	.44
Episode * type of mapping	1.28	23.06	.6	.49[a]	.03

Note. $^*p \leq .05$, $^{**} \leq .01$; observed power within SPSS (α = .05): .12.

controller presented in Figure 6 for Hypothesis 3. ANOVA revealed these main effects to be large and statistically significant. As hypothesized, game enjoyment also significantly increased with each episode (H4). However, post-hoc analysis revealed significant differences only between first and second ($p < .001$) as well as between first and third ($p = .002$) game episode. No statistically significant *interaction effects* between type of mapping and episodes were found.

A Posteriori Analysis: Comparing the Impact of Challenge and Mapping Type

Table 2 has shown that compared to game episodes, mapping type had a weaker effect on challenge, but a stronger effect on game enjoyment. This led to the question whether natural mapping could have an additional effect on enjoyment out of reasons not considered a priori, beyond increased challenge. To explore this issue, a multiple linear regression analysis was conducted that clears out each predictor's influence out of the other predictor's effect. Perceived difficulty and mapping served as predictor variables and game enjoyment served as dependent variable.

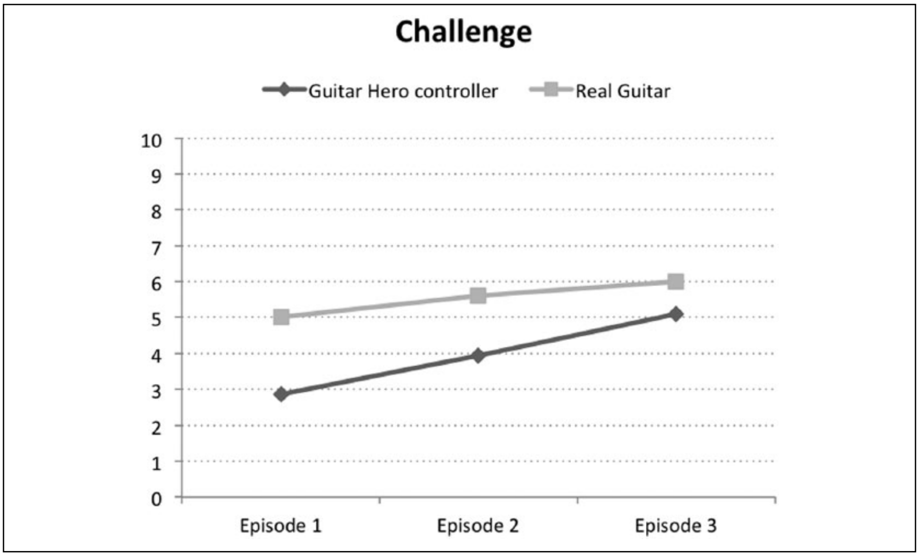

Figure 5. Challenge differences between Guitar Hero controller vs. a real guitar by episode.
Note. Main and interaction effects are statistically significant. A value of 5 represents an optimal challenge balance.

Table 3 presents the results of this analysis. Mapping type had a significant and the strongest effect on game enjoyment. Challenge, on the other hand, had much weaker and, except for episode 3, no significant influence on enjoyment.

Discussion

Natural Mapping, Challenge and Enjoyment in Music Games

Results confirm that, at least when it comes to music games, natural mapping is not necessarily more intuitive. Complex actions, such as guitar play, are perceived as more difficult when executed with lifelike devices than with artificially reduced and therefore less naturally mapped controllers. In the music game used in this study, a real instrument can be both more natural and authentic and more challenging: while the less naturally mapped controller stayed under the score of optimal challenge, the naturally mapped real guitar was always above optimal challenge as in Figure 5. Thus, the simple scheme *more naturally mapped means more intuitive*, underlying many current approaches to the relation of natural mapping, is not a valid premise for all scenarios.

Challenge and Game Enjoyment

Many theories pose a positive relation of challenge and game enjoyment. However, this study provided some contradictory data on this relationship. On the one hand,

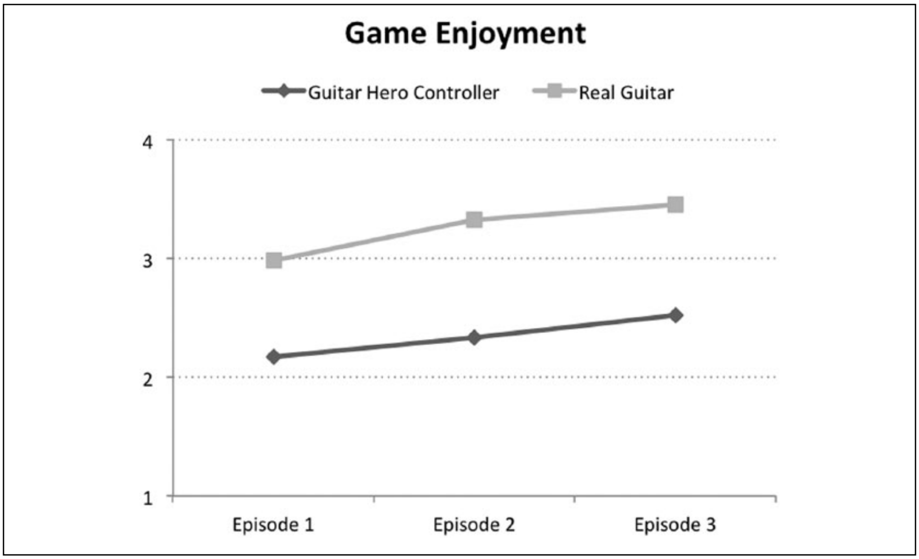

Figure 6. Enjoyment differences between a Guitar Hero controller vs. a real guitar by episode.
Note. Each had a statistically significant main effect.

regardless from the mapping type, later episodes were perceived as both more challenging and more entertaining than previous ones. Also, contrary to Skalski's et al. (2010) as well as Tamborini's et al. (2010) approaches, in this study, the most difficult condition was Episode 3 that was played with a real guitar and produced the most enjoyment as presented in Figure 5 and 6. But multiple linear regression analysis revealed that challenge had no or even a negative effect on game enjoyment if the influence of the controller was partialed out.

Natural Mapping and Game Enjoyment

The real electric guitar exceeded the less naturally mapped game controller by far in terms of enjoyment. Approaches such as the ones described in the theory section of this article have attributed similar effects to more intuitive controls of naturally mapped controllers and the higher degrees of spatial presence and need satisfaction previously presented in Figure 1. But this study argued, and demonstrated empirically, that neither does a high degree of natural mapping imply intuitive and easy handling, nor does challenge necessarily impact game enjoyment negatively.

Although of an exploratory nature, and therefore its finding have to be taken into account with care, multiple regression analysis revealed a guitar's impact on game enjoyment that could not be explained by its more challenging nature. What could have been responsible for this effect? It could be fruitful to take a look back to the older theories of play that put a strong emphasis on the role of simulation, fantasy, and

Table 3. Multiple Linear Regression Analysis of Game Enjoyment on Difficulty and Mapping Type.

	Challenge		Mapping type	
	β	*p*	β	*p*
Game enjoyment in episode 1	.31	.16	.49*	.03
Game enjoyment in episode 2	.11	.66	.76**	<.001
Game enjoyment in episode 3	−.31*	.05	.88**	<.001

Note: $^{*}p \leq .05$, $^{**} \leq .01$; Challenge represents values of respective game episode.

make-believe. For example, Huizinga (1949, p. 13) noted that during play, players temporarily discard their real-world identity. According to Huizinga, the "disguised or masked individual 'plays' another part, another being. He is another being." For Caillois (2001, p. 10), play is make-believe in the sense that it is "accompanied by a special awareness of a second reality or of a free unreality, as against real life." This quality of play is regarded to as a source of enjoyment.

In a newer approach, Klimmt (2003) sees the video game player involved in a complex narrative structure. Here, the key to game enjoyment lies in the combination of *identification, narrative and interactivity.* According to Klimmt, computer games provide experiences that cannot be made in real life. Players are able to take on new exciting roles, be part of world-shaking adventures and try out new appealing actions such as doing reckless stunts or use powerful weapons. Furthermore, Hefner, Klimmt, and Vorderer (2007) suggested that a player gets entertained by identifying themselves with the game's character. While playing, attractive attributes of the videogame character are transferred to the player. As a result, a courage-lacking player can feel courageous, reducing self-discrepancy and leading to positive perceptions (Hefner et al., 2007, p. 42). The concept of self-discrepancy has been picked up by Birk and Mandryk (2013) who investigated the impact of controller types on ingame personality and enjoyment. They found that the game self was strongly influenced by the controller type and that it had a larger impact on positive affects than need satisfaction. Also Castell et al. (2014, p. 344) consider the imitation of a creative identity to have an affective impact on the player. Here, the player's physical performance (e.g. moving like a real guitar player during a solo) could be the key that makes taking over the ingame role more lifelike and enjoyable.

In conclusion, the effect of higher degrees of natural mapping on game enjoyment found in this study could also be based on the identification of the player with the attractive role of a musician. A real guitar, the highest form of natural mapping, might facilitate this identification better than lower forms of natural mapping, e.g. Guitar Hero controllers. After all, an authentic electric guitar offers far more authenticity and therefore more identification and simulation mechanisms than any artificial game controller.

Methodological Implications

The impact of challenge and mapping type was compared a posteriori, making it an exploratory analysis instead. Thus, its results should be handled with care and they should be evaluated with a study design that takes this causal connection into account a priori in the form of hypothesis testing.

Also, this study featured only a small sample group, which may reduce generalizability. Therefore, the results should not be regarded as the foundation of a new theory, but an illustration of an idea: the conclusion that the relation of natural mapping and game enjoyment is too complex and multifaceted to be reduced to simple concepts like intuitiveness. However, this study may serve as an inspiration for subsequent, sophisticated research with larger sample groups.

Furthermore, operationalizing game enjoyment resulted in certain complications. Klimmt (2006, p. 143) reported that the scale adopted in this study produced different factorial structures in two separate surveys. The same problem was encountered in this study within the three measuring points. Problematic items mostly aimed to measure aspects that seemed theoretically questionable for operationalization of game enjoyment and were withdrawn from the scale. Furthermore, several items were removed due to difficulty and low homogeneity. Eventually, the revised scale was deemed reliable; however, it included only 6 out of Klimmt's 15 original items. It cannot be ruled out that these operations reduced comparability to Klimmt's findings.

Finally, the impact of perceived difficulty on game enjoyment could have been investigated more precisely if testing conditions generated a broader scope of difficulty. Table 1 has shown that, on a scale from 0 to 10, means of perceived difficulty only ranged from slightly below 3 to 6. Therefore, it is still unclear if very demanding gameplay conditions would have caused displeasure even an entertaining, genuine guitar could not compensate.

Implications for Learning and Teaching

The study described in this article raises some implications for learning and teaching. Since a genuine electric guitar like the one used in this study exceeds a naturally mapped game controller in both enjoyment and realism, real life tangible mapping in music games could provide both authentic and intrinsically motivating guitar exercise. For example, otherwise unexciting, but important *technical exercises* may become far more attractive when integrated into a music game. As the game urges the player to play as accurately as possible and keeps track of the user's high scores, the player can easily track his or her improvement. One would not even need to modify Frets on Fire to play a music game with an authentic guitar for that. Rock Band 3 (Rock Band 3, 2010) features a *ProMode* where the songs are played note-for-note (instead of the usual simplified tracks) with either an authentic game controller or even a real guitar, exclusively built for this game. With the game Rocksmith (Rocksmith, 2011/2012) it is even possible to use a regular electronic guitar. Castell et al. (2014, pp. 343–344) argue, and I tend to agree, that any mimetic performance, including music games playes with Guitar Hero controllers (i.e. incomplete natural mapping), could train technical skills required for guitar play. As explained above, using a regular Guitar Hero controller does not at all imitate guitar play in technical detail. It just simulates it on a very abstract layer. Thus, for technical exercise, only real life tangible mapping such as with real instruments seem to do the job. On the other hand, as Castell et al. and Peppler, Downtown, Lindsay, and Hay (2011, p. 27) point out, music games in general could increase the players' *interest in music* and *improve their understanding of more basic musical concepts* such as the notational system, rhythm, pitch, and others. This learning outcome would be independent from the mapping type.

However, Crookall (2014, pp. 418-419) argued that strong feelings (e.g. high levels of game enjoyment) might hinder the processing of game experience and thus learning. Here, debriefing comes into play. According to Crookall, debriefing allows us to reflect on concepts and techniques learned in the game that can be used outside, in the real world. The debriefing also consists of *de-rolling*, which means re-finding oneself after stepping into a different role during the game (e.g. the role of a guitar player). In addition, individuals tend to organise their experiences according to social and cognitive schemata about their environment. Experiences made in games worlds are processed by different schemata than those made in the real world, which could hinder their transfer into the players' real life (Wechselberger, 2013). Thus, debriefing and reflecting the game world experience's implications for the reald world is key to successful learning. However, debriefing aims at cognitive learning outcomes at a higher level, e.g. conceptual understanding or analysing a problem. It would therefore not so much benefit psychomotoric skills such as fingerings during guitar play, but the transferability of abstract concepts such as musical notation and harmonics between the game world and the real world.

One important questions remains: considering all the other games that can be played with naturally mapped controllers (e.g. driving simulations with force feedback wheels, sport games played with WiiMote controllers), what results can be applied to them by this study? This question cannot be answered for all games at once. First, it seems plausible that more realistic controllers are more difficult to handle and that to a certain degree, this difficulty might produce game enjoyment. However, it depends on the individual game and controller a) how realistic and difficult the controller is and b) if the game is challenging enough. Second, more realistic controllers might facilitate identification with the roles the player takes over. If and to what degree this increases enyoyment is probably a matter of the respective role's attractiveness to the individual player. Some might prefer the role of a tennis player over the role of a farmer steering a combine harvester, some might prefer it the other way around. As such, one would have to investigate for each scenario the unique level of naturalness, its implication on optimal challenge and simulation potential, and the preferences of the audience in combination.

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