The Effects of Peripheral Use on Video Game Play

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Abstract

Fourteen volunteers were asked to participate in an experiment, along with answering a survey, to evaluate the performance of three peripherals: the Xbox 360 Wired Controller, a keyboard, and the Rock Band Fender Stratocaster Wired Guitar Controller. The participants played a prototype made in Unity, and their accuracy scores were analyzed in R using ANOVA. However, no significant quantifiable difference was found based on which peripheral was being used. The scores were also analyzed using Pearson's Product-Moment correlation, and we were able to determine that the variation in accuracy scores was directly linked to the participant's specific test run in the experiment. Taking this into consideration along with results of our observational data and participant feedback, we found that there were more factors at play, in regards to playability and accuracy, than just the input device itself. The learning effect of repetitive play of the prototype and input devices, the control input scheme, and the participant's chosen peripheral manipulation method all had an impact.

Keywords:

Human-Computer Interaction, Video Games, User Interface, Input Devices
Abstrakt

I syfte att utvärdera prestandan av de tre kringutrustningarna handkontroll till Xbox 360, ett vanligt tangentbord samt Rock Bands gitarrkontroll Fender Stratocaster deltog fjorton frivilliga personer i ett experiment samt svarade på en enkät. Deltagarna spelade en prototyp gjord i spelmotorn Unity som samlade in deras precisionspoäng som senare kunde analyseras i programmet R med metoden ANOVA. Dock hittades ingen signifikant mätbar skillnad mellan de olika kringutrustningarnas prestanda. Precisionspoängen analyserades även med hjälp av Pearsons produkt-moment korrelation där vi kunde konstatera att variationen i precisionspoängen var direkt kopplade till deltagarens specifika testrunda i experimentet. Med hänsyn till detta tillsammans med resultaten från våra observationer samt feedback från deltagarna fann vi att det fanns fler faktorer än inmatningsenheten som påverkade spelbarheten och precisionen: deltagarnas val vid hanteringen av kringutrustningen, de olika kontrollschemana samt inlärningseffekten som uppstod vid upprepade spelande av prototypens testbana och användandet av kringutrustningen.

Nyckelord:
Människa-datorinteraktion, Tv-spel, Användargränssnitt, Spelkontroller
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1. Introduction

From the NES Zapper for *Duck Hunt* (Nintendo R&D1, 1984) to the Konami Dance Mat for *Dance Dance Revolution Universe* (Konami, 2007), game and interaction designers have been innovating new and creative ways for people to enjoy playing games. With the popularity of rhythm music games such as *Guitar Hero* (Harmonix, 2005) and *Rock Band* (Harmonix, 2007), new specialized peripherals made for use with these games have been finding their way into living rooms all over the world.

While talk of Harmonix reviving the *Rock Band* franchise for the next generations of consoles has recently been circulating gaming news outlets and conventions (Makuch, 2014), there are still gamers finding new uses for their aging plastic guitars until then. A subculture of gaming has emerged where these input devices have been repurposed or modded so that they could be used to play games belonging to a totally different genre than the one that they were originally designed for. This practice has been done for fun, but more importantly, for the challenge of successfully playing games using unexpected, unintended methods.

1.1. Guitar Gaming

Gamers looking for a greater sense of challenge or heightened entertainment value from the games they play have taken to experimenting with the use of nonconventional peripherals. For many players, the device deemed the most iconically difficult for this task is the guitar controller, as it is specifically designed for the use in rhythm and music games, and not for other genres like first person shooters or action role playing. In order to play these games effectively, it has been found that the Rock Band Stratocaster controller is the best choice, as the additional neck buttons and effects switch give more potential control mapping options than most other guitar peripherals available. However, even with the Stratocaster, it is difficult emulating larger complicated control schemes, and often certain controls or button mappings must be omitted completely.

One popular example of experimental guitar gaming is playing *Call of Duty* (Treyarch, 2010) with a guitar controller, a practice once nicknamed by YouTube user Fractured Studios as “Rock Band Black Ops” (Fractured Studios, 2011). The disclaimer “(Funny)” is added to the title of the stream recording highlighting this playstyle, indicating that this was done for fun and entertainment purposes, and is not presented as serious or competitive play. As the video progresses, with the
player shown in a webcam view overlaid on top of the in-game recording (as seen in Figure 1), it becomes obvious that he is having difficulty playing with the guitar, however it clearly makes the online match humorous and amusing for him, along with the spectators in the room with him. For comedic effect, his friends attempt to help by pressing the whammy bar while he struggles to move forward, and the room erupts in cheers when he successfully kills an opponent.

Figure 1: Guitar Gaming: Fractured Studios Playing Rock Band Black Ops (screen capture from Fractured Studios’s YouTube channel)

A better known example is Twitch.tv user Bearzly, whose channel description reads “Hi! I like to play a lot of Dark Souls 1 and 2, especially challenge runs. Here is where I'll be attempting to beat dark souls using the dumbest control methods I can imagine (Bearzly, n.d.).” Bearzly’s Dark Souls (From Software, 2011) and Dark Souls 2 (From Software, 2014) videos and streams have been featured on gaming sites such as Polygon, Kotaku, Eurogamer, The Verge and many more. Michael McWhertor’s article on Polygon summarizes this here: “The act of simply completing Dark Souls, the notoriously difficult action role-playing game by From Software, is for many players an impressive accomplishment in and of itself. But player Benjamin "Bearzly" Gwin took the Dark Souls challenge to another level: He beat the game using nothing but a Rock Band guitar controller (2014).”

Similar to Fractured Studios and their Call of Duty videos, Gwin has a webcam view showing him as he plays with the guitar, to assuage doubts that he is actually using it. He supplements this with an additional overlay of an Xbox controller image (as seen in Figure 2), with real-time indicators showing when he is performing device input and its corresponding console controller button equivalent.
Gwin presents this method of unorthodox play, nicknamed “Guitar Souls”, as a purposely imposed play handicap and subsequently, a new, suitable challenge to his gaming skills. He had already completed the *Dark Souls* games while playing with the intended controller, and wanted to test himself with even harsher trials, such as previously with playing one-handed and now with the limited control scheme of a guitar peripheral. Excerpts from his Twitch.tv channel FAQ refer to the “stupid control method” and the ensuing “silly control runs”, where his goal with these videos is “Mostly just to challenge myself and say that I can (Bearzly, n.d.).” He strives to make it clear that his methods are unconventional. As a result, beating these demanding games while using a guitar controller has summarily earned him internet acclaim and respect from other gamers for these feats of skill.

1.2. Research Goal

We want to explore the effect that input devices have on human-computer interaction. This can be examined both in the physical manipulation of the peripherals themselves by the player, and also in the input control scheme. We especially want to examine how different peripherals compare to each other.

We, the researchers as programmers, manipulate and manage the input from the player via the code we write, in order to make that information have a perceptible, understandable effect on the game. We hope that through a deeper understanding of interaction and its design, we can work together
with designers to create more enjoyable, well-crafted games, where the choice of peripheral has a meaningful influence on their design. We also hope to gain a better understanding of the subculture that seeks out the challenges that certain peripherals have on video game play.

1.3. Disposition

This study will present previous research related to game peripherals and the game Rock Band, as we have chosen to include a guitar peripheral in our experiment. Next the method will be outlined, describing the experimental design, the experimental procedure, the prototype design and the peripherals being tested. Next, details about the participant questionnaire will be presented.

The results of prototype testing will then be explained and analyzed, along with the results of the participant questionnaires. These results will be broken down further and evaluated in the discussion section. Critique on our methods will then be discussed. Finally, our conclusions will be summarized.
2. Background

In order to have a better understanding about this subject, we gathered as much pertinent information as we could. We focused on research pertaining to peripherals, but also on those related to Rock Band and the guitar controller, so that we could better design our study and experiment.

2.1. Previous Research

There is extensive research evaluating the effects that peripherals can have on gameplay. We examined several studies, not only to gain more understanding about this field of study, but also to use as inspiration for our own experimental design. Thorpe, Ma, and Oikonomou (2011) developed a prototype that accepted eight different types of peripheral input, focusing specifically on certain types of devices that can be deemed alternative, or non-conventional, including a Konami Dance Pad and a Nintendo Wii Remote.

Their choices in peripherals had a distinct influence on how their prototype and the desired control scheme were designed, as play with each of these devices needed to work as equally well as possible. This was shown to be an especially difficult task with peripherals such as the webcam or the Phantom Omni haptic device. Both quantitative and qualitative data was collected and analyzed, evaluating the participants’ performance and their subsequent opinions on the peripherals based on their ease of use, intuitiveness and how they suited the prototype’s game design. The participants were also asked to evaluate if they felt that certain peripherals gave them a disadvantage or advantage in comparison to others. The results of the study showed that the participants felt that certain alternative input methods can have advantages when paired with the right type of game, however unsuitable peripherals can discourage their use overall, especially in other games played in the future.

This study had a strong influence on our experimental design. We thought that adapting a mixed method approach like the one in this study would net us rich and interesting data, more than a purely quantitative one. We also used the survey questions found in this study as a starting point for the design of our own participant questionnaire. While their study focused on examining the unconventional peripherals implemented for use with their prototype, the guitar controller nor the Xbox controller were not included. We want to expand research in this area by using these devices in our experimental design.
Researchers Natapov, Castellucci and MacKenzie created a prototype to be used to evaluate the performance of two peripherals: the Nintendo Classic Controller and the Nintendo Wii Remote, with a mouse as a baseline condition (2009). The experiment focused on determining the technical performance of these devices in conjunction with a Fitts’ point-select task, which involves target acquisition (Natapov, Castellucci, and MacKenzie, 2009). Afterward, the participants answered a questionnaire rating the peripherals’ ease of use, perceived accuracy and smoothness of operation, along with other questions gauging the comfort involved in interacting with the devices. The results of this study showed that the analog stick found on the Nintendo Classic Controller did not perform well with point-select tasks. Additionally, the results of the participant survey show that fourteen out of fifteen prefer the Wii Remote over the Classic Controller. While we found the prototype in this study to be more of a technical test compared to the more game-like prototype design we wished to implement, we found the research methods and the survey wording to be useful sources of inspiration. We want to create a similar type of experiment where participants would evaluate their performance along with how it felt to interact with these peripherals, but we want the prototype to still retain a game-like feel. With this in mind, we want to examine not only the devices themselves, but also their impact on game design.

Other studies had similar experimental designs to the aforementioned others, but involved a racing wheel in their peripheral testing (McEwan et al., 2012; Schmierbach, Limperos, and Woolley, 2012). This specific research was topical as we had initially had plans to make use of racing wheel in our own prototype, however we did not due to time and technical constraints. While we did not look deeper into these studies for direction as to how we would design our experiment, they still had interesting results in regards to immersion and performance, where their quantitative testing score data was supplemented with survey data.

Researcher Rory McGloin has done extensive work examining violence and aggression in games, and how it can be influenced by which peripheral is being used. We examined two of his studies (McGloin, Farrar, and Krcmar, 2013; McGloin, 2011) where the Wii Remote and Nunchuk were placed inside boxing gloves and tested in conjunction with boxing games. The results of that testing showed that the participants felt that the game felt more immersive and realistic when played with the glove peripheral, and as a consequence of that, there was an increase in cognitive aggression after such play. We found these studies focused on too specific a subject, namely boxing games and aggression, to be directly useful as inspiration for our own study, however there were similar, useful experimental design methodologies being employed as those in the previous research. While the
examination of immersion in tandem with peripheral interaction was fascinating, we want to expand on existing research without focusing on one specific device.

Finally, Tanenbaum and Bizzocchi (2009) have performed a *Rock Band* case study, focusing on evaluating the kinesthetic and ludic properties of the peripherals designed for use with this particular game. While we chose to perform an experiment rather than a case study, the results of this research were useful in evaluating the interaction design and functionality of the guitar controller, along with its effect on immersion. Despite the fact that this study focuses on its use in conjunction specifically with the game *Rock Band*, we still found the data interesting as a base of knowledge, as we were planning including a guitar controller in our experimental design. If we had more time to design and test our game prototype, we would take a stronger focus on the kinesthetic and ludic elements in the game design in conjunction with the peripherals. Also, for this study, we want to examine the interaction between the player and the input device both on a quantitative and qualitative level.
3. Research Question

While the peripheral itself may or may not have an effect on general game play, they are also directly linked to a control scheme design. So, with that in mind, that scheme could have an effect on playability along with the device. Furthermore, when games are played repeatedly or regularly, there may be a learning effect at play, where memorization of the level can have an impact on accuracy specifically. Finally, the relationship between the peripheral and the specific manner in which the game was played, to determine its effect on playability and accuracy. Taking all this into consideration, our research questions asks: is there a quantifiable impact on playability and accuracy due to the use of certain controllers or peripherals during video game play?

We hypothesize that accuracy scores will be affected by the choice of peripheral. We also expect a learning effect through repetitive play that will also affect accuracy. However, this learning curve will be different dependent on which peripheral is being used. We also want to examine how controller mapping and other factors may have had an impact on these results.
4. Method

Our goal was to implement a mixed-methods design approach to our experiment, where we gather not only quantitative data, but also qualitative. This section of the study will describe and give an outline of the experimental design, procedures and materials.

4.1. Experimental Design

Our design was inspired and heavily influenced by Thorpe, Ma, and Oikonomou's peripheral research (2011), as described in the Background section. We implemented an experiment with a 2 x 3 within-subject design, where participants were tested individually. To counter the learning factor of repetitive prototype play, we introduced counterbalancing methods focusing on the testing order of each peripheral per participant. Permutations of each potential peripheral play order were found and assigned to the participants as equally as possible, and as were as follows:

- Order Permutation 1: Keyboard, Controller, Guitar
- Order Permutation 2: Keyboard, Guitar, Controller
- Order Permutation 3: Controller, Keyboard, Guitar
- Order Permutation 4: Controller, Guitar, Keyboard
- Order Permutation 5: Guitar, Keyboard, Controller
- Order Permutation 6: Guitar, Controller, Keyboard

4.2. Experimental Procedure Outline

- The sections of the questionnaire pertaining to background information were answered by the participant.
- Instructions were given describing the peripherals, their input control schemes, and the prototype gameplay mechanics.
- The participant was then allotted time to practice with each peripheral in a tutorial level. He or she could practice with all of the devices, or only certain ones of their choosing, for as long as they required. Any pertinent feedback or comments were written down, along with observations of the participant's behavior.
- The participant was asked if they were ready for the first block of testing.
- First Attempt Block: The participant then played the prototype level with each peripheral in the predetermined order, resulting in the first three runs (Test Runs 1-3), where accuracy scores were recorded automatically in the prototype and/or transcribed by hand. Any pertinent feedback or comments were written down, along with observations
of the participant's behavior.

- The participant was asked if he or she would like to make use of the tutorial level again before proceeding to the next attempt block.
- The participant, once it was confirmed that no more practicing was required, was then asked if they were ready to proceed with the second block of testing.
- **Second Attempt Block:** The participant then played the same prototype level again with each peripheral in the same order as the first attempt block, resulting in the second block of three runs (*Test Runs 4-6*), where accuracy scores were recorded automatically in the prototype and/or transcribed by hand. Any pertinent feedback or comments were written down, along with observations of the participant's behavior.
- After the prototype testing, the participant was then asked if there was any more feedback they would like to give, especially in regards to their performance with the peripherals. This feedback was also written down.
- The participant then completed the post-experimental evaluation section of the questionnaire.

### 4.3. Experimental Materials

For our experiment, the participants played the prototype on a laptop computer. The peripherals used for testing were a Xbox 360 Wired Controller, a Rock Band Stratocaster Wired Guitar Controller (the same as the one mentioned in section 1.1, Guitar Gaming), and an integrated laptop keyboard.
4.4. Prototype Description and Mechanics

Our aim was to make a game prototype with simple controls that would be easy to learn quickly. As we wanted a no-fail state in our test level, collision with obstacles would only result in a decrease in accuracy scoring. The prototype, made in Unity, features a car moving forward, bound to a four lane highway that is scattered with obstacles and colored, collectable orbs. The orb placement would match the tempo and beat of the accompanying music to add elements from the rhythm music game genre, while avoiding making an obvious Guitar Hero clone. The lane layout with horizontal navigation is similar to that found in the game Rock Band Blitz (Harmonix, 2012), and its predecessors Amplitude (Harmonix, 2003) and Frequency (Harmonix, 2001). The player can move the car in between these four lanes using three different control schemes, dependent on which peripheral is being used.

Keyboard input is bound to the A, S, D, and F keys. This scheme was chosen based on the typing home keys for a standard keyboard, in addition to mimicking a guitar peripheral with keys in a row. We chose this scheme as we felt it would be very familiar for people who regularly interact with a computer.

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1 http://www.asus.com/Notebooks_Ultrabooks/ASUS_ROG_G750JX/gallery/
Controller input is bound to the Left Trigger, Left Shoulder, Right Shoulder, and Right Trigger buttons. This scheme was chosen as it is the controller input scheme in Guitar Hero 3 for alternative non-guitar peripheral play. As we have incorporated rhythm gameplay elements, we felt it would be easiest to adapt an input scheme from an already established music game franchise, as it would have been heavily tested and proven to work by their developers. Furthermore, this scheme was a viable equivalent to the row-oriented button layouts of the keyboard and guitar controllers, as the four buttons could be manipulated simultaneously in an easier manner than the A, B, X, Y buttons.

Guitar input is bound to the Green, Red, Yellow, and Blue buttons. This is the standard guitar peripheral scheme found in Guitar Hero and Rock Band games, except for the fact that we do not make use of the strum bar. We chose this control scheme as we wanted to focus input on the buttons on the neck and observe how participants would interact with them. Those who had played the Guitar Hero games before would be instantly familiar with the layout on this device. On the other hand, those who had never played those games would have to learn how to use this specialized peripheral, which is why the tutorial phase of testing was allotted.

![Figure 6: Prototype Control Scheme](image)

Each of these four buttons or keys is assigned to a lane on the highway, going from left to right. Movement is forced to an incremental scheme. For example, if the player is in the first lane and wants to move to the fourth, he or she must pass through the second and third lanes first. This cannot be done by simply pressing the key or button assigned to the fourth lane.
We anticipated a learning effect, as mentioned in section 4.1, not only with the peripherals, but the prototype test level as well. However, the creation of individual levels for each input device would make it difficult to compare those results with each other. So with that in mind, we had one level for use throughout the entirety of testing, and our focus was to determine exactly how much the learning effect had an impact on the results.

4.5. Scoring

An accuracy score is calculated by taking the percentage of orbs collected (out of 68 total, in the case of our prototype level) with deductions taken for every obstacle (out of 36 total) that was not successfully avoided.

4.6. Experiment Questionnaire

Every participant filled out a survey in conjunction with experiment testing. Basic information such as age, gender and weekly gaming habits was gathered to help form a participant profile. The participants' experience with each of the test peripherals was also inquired. Finally, the participants were asked to rate each of the three input devices based on ease of use and intuitiveness, in conjunction with their use in the prototype testing. These were rated on a seven-point Likert scale, where 1 is “Strongly Agree” and 7 is “Strongly Disagree”.

4.7. Participant Feedback

Participants were encouraged to give feedback after the experiment in regards to their performance and how they felt while playing the game, if they had not already freely done so. Rubin describes “Think-Aloud” data, or verbal protocol, as the participant giving running commentary as they perform an usability test (1994). With that in mind, this type of feedback was strongly encouraged as our experiment had lots of similarities to and elements of an usability test.

The post-experiment interview questions were intentionally left very open ended, to avoid leading the responses given. However, if the participants needed guidance, we instructed them to discuss how interaction felt with each peripheral, in conjunction with the game's mechanics, and how they felt that it affected their performance. We also inquired about the difficulty of the test level and if they felt that it was balanced. Notes from this feedback were taken, in a manner as outlined in A Practical Guide to Usability Testing, focusing both on comments and observed behavior (Dumas and Redish, 1999).
5. Results

Once the participant prototype testing and questionnaires were completed, the collected data was then analyzed, utilizing several methods, all of which shall be outlined in this section of the study.

5.1. Participant Profile

We had fourteen volunteers for experimental testing (N = 14), between the ages of 18 and 39. The majority of these participants are students at Södertörns Högskola.

The participants were surveyed to determine what their current gaming habits were and if they regularly play games with the three peripherals being tested in the experiment. We were able to gather an interesting mix of people with gaming habits that ranged from very casual (less than 3 hours a week) to “hardcore”, where they spend the majority of their free time playing games (more than 20 hours weekly).
5.2. Prototype Accuracy Score Analysis: ANOVA

We tested our data for normality and homogeneity, and subsequently determined our sample to be of enough of a normal distribution. The accuracy data was then analyzed in R (R Development Core Team, 2014) using ANOVA, comparing the scores dependent on which peripheral was used. The ANOVA analysis showed that there was no statistically significant difference between the accuracy scores based on which peripheral was being used (p = 0.509). There was also no statistically significant difference between the accuracy scores based on which peripheral was used in conjunction with the two attempt blocks (p = 0.782) However, there was a highly statistically significant difference in scores based on the attempt block (p < 0.001*).

The accuracy scores were then plotted into a box-and-whiskers plot, where we noted again that there was a distinct difference between the first and second test attempt scores with all of the input devices. This was further verified by calculating the delta values between those two sets of scores. We decided to analyze these scores again, focusing more on the multiple test runs done rather than the peripherals, to determine if there was a correlation.

![Accuracy Scoring by Peripheral per Attempt Block](image-url)

*Figure 10: Accuracy Scoring by Peripheral per Attempt Block*

\[ p = 0.0000372 \]
5.3. Prototype Accuracy Score Analysis: Pearson's Product-Moment Correlation

We analyzed the series of accuracy scores using Pearson's product-moment correlation in R. Each participant tested the prototype level twice with each of three peripherals, resulting in six test run values to be evaluated and compared.

The analysis showed highly statistically significant results ($p < 0.001^*, r = 0.4901$), where the play order had a positive correlation to the variation in accuracy scores. Summarily, we can verify that 24% ($r^2 = 0.2401$) of the score variation is explained by the test run order (1-6), regardless of which peripheral was being used.

The results of the Pearson's analysis show that there is a strong learning effect of the test level, resulting in an independent increase of all accuracy scores towards the end of testing. While the peripheral itself may have an influence on those scores, its impact is not as consistent. This can be visualized further using a scatterplot graph (Figure 11), where the trend lines show that accuracy scores increased over the course of the six test runs, with all three peripherals.

![Figure 11: Accuracy Scoring Scatterplot based on Test Run and Peripheral](image)

$p = 0.0005039$
5.4. Participant Questionnaire

In regards to which peripheral was easiest to use, participants rated the guitar scored highest, followed by the keyboard, with the Xbox controller receiving the lowest scores (respective median values: 6, 5, 4; respective mean values: 5.5, 4.93, 3.79). Many of the participants reinforced this by remarking in the post-experiment feedback and interview that they believed they performed best with the guitar peripheral.

The guitar also scored highest when rated on intuitiveness by the participants (median value: 6, mean: 5.14), with the Xbox controller scores drastically lower in comparison (median value: 1.5, mean: 2.71). Upon use of the Xbox controller, the majority of participants immediately commented that it was the hardest to use out of the three peripherals or specifically that it had a very difficult control scheme.

The Likert scale scores were also analyzed in R with ANOVA, comparing by peripheral, which showed statistically significant results (Ease of Use: p = 0.0304, F = 3.824; Intuitiveness: p = 0.0123, F = 4.93). A post-hoc test was also performed on these ANOVA results, Tukey’s Honest Significant Difference. The results there showed that there was a significant difference specifically

![Figure 12: Questionnaire Results: Ease of Use by Peripheral](image1)

![Figure 13: Questionnaire Results: Intuitiveness by Peripheral](image2)
between the guitar and Xbox controller ease of use and intuitive mean scores (Ease of Use: p adj = 0.0259, Intuitiveness: p adj = 0.0104).

5.5. Participant Observation and Feedback

Examination of the observatory field notes and interview feedback show two distinct points of interest. The first being that several participants remarked on how the prototype test level reminded them of *Guitar Hero* in its appearance and/or mechanics. With this in mind, this often also resulted in the participant remarking that the guitar was the easiest to use. Secondly, no stipulations or requirements were made as to how the participants must interact with the peripherals, even if it can be assumed that there is an intended method by design. As a result, there were several instances where unique interaction methods were utilized during testing, as certain participants felt it was easier to manipulate the input device with a specific, unexpected technique. This will be described further in the following section.

5.6. Peripherals and Their “Intended” Use

A fascinating phenomena that we observed during testing was how certain participants chose to interact with the peripherals. No one was instructed on how they must use the input devices, as this was not a treatment that we intentionally planned on controlling during testing as a part of our experimental design. The control scheme was explained and the buttons on the device were pointed out, in case their positioning and placement was not clear or obvious. Upon interaction with the peripherals, no participants were “corrected” if they were using the device a certain way and were allowed to use them in whatever manner felt the most comfortable.

The prototype's keyboard control scheme made use of the A, S, D, F keys, also known as the left half of the home row in touch typing. Interaction with these keys could be potentially done with the four fingers of the left hand, from pinky to index, as seen in Figure 14. However, we found that certain participants felt more comfortable using their right hand, possibly due to being right-handed. Another employed a two-handed approach (depicted in Figure 16), using two fingers from each hand to press the keys, resulting in relatively high scores on that device. We found that this was because this specific participant routinely plays a game called *Flash Flash Revolution* (Synthetic Light Studios, 2002), while using a similar technique on the arrow keys. Finally, one participant chose to only use three fingers, resting them on the standard movement keys found in many games (A, S, D. W was not used), and shifting to the right when the F key is needed (see Figure 15). Unsurprisingly, this participant felt that this was a very difficult way to play.
The Xbox controller, as discussed in the previous section, was deemed the most difficult to use, according to the majority of the feedback we received, despite the fact that the button layout on the device is somewhat linear. Interestingly, we found that one participant had initially tried using this peripheral with only two fingers, the index fingers of each hand, to press both the shoulder and trigger buttons by shifting finger position when needed, as illustrated in Figure 18. They discovered through testing that this method was very difficult and slowed their reaction time. The participant then remarked that when they switched to using four fingers, with one on each of the controller buttons instead, their performance noticeably improved.
The guitar peripheral has the most distinctive of interaction and construction designs, as it is intended to mimic an actual musical instrument. It is designed to be held like a guitar, where one hand interacts with buttons on the neck, like frets, while the other hand manipulates the strum bar, whammy bar, and other buttons found on the body. However, we found that some of the participants choose not to interact with the device in that fashion. One participant specifically avoided holding the device like a guitar, rather opting to lay it flat on the table in front of them, so that they could interact with it in a manner reminiscent of a keyboard (as seen in Figure 20).

Another participant initially tried using the peripheral the intended way, holding it like a guitar. Surprisingly, they then chose to reposition the device, interacting with the neck buttons while using two hands, resulting in needing to rest the peripheral close to their chest, with the body in their lap, as shown in Figure 21. This closely resembled the guitar technique known as tapping, where the strings are tapped against the fretboard by the fingertips. This is also reminiscent of the two-handed keyboard technique, previously shown in Figure 16. The participant felt that this position was more comfortable, and subsequently felt that they had improved performance because of it.

We have found that the way in which the participants physically interacted with the peripheral had an impact on the participant's perceptions of the input device, potentially affecting their opinions on their playability. The sense of competitiveness in our participants resulted in a desire to perform to the best of their ability, even if they were only taking part in an experiment, and unexpected input techniques were the product of that drive. Furthermore, the experimentation with manipulation...
methods showed that, for some people, the intended method may not be the best method for them and this was supported by their subsequent improved performance after adapting a different technique.

Looking back on the guitar gaming subculture while taking these results into consideration, perhaps the difficulty in the usage of such peripherals is not as straightforward as believed. If the player is comfortable with the device’s manipulation method, or finds a technique that feels best for him or her, they could potentially perform well, even with nonconventional peripherals. We have found that this learning effect of the peripheral itself, in addition to the memorization of a game's levels or strategy, had an impact on our results and could potentially do so in other games as well.
6. Discussion

As detailed in the previous section, our experiment and participant questionnaire netted us very interesting and sometimes surprising results. This section examines those results further, to determine and evaluate the factors at play that may have had an impact on our results.

6.1. Quantitative Analysis Examination

Even though each participant tested our prototype using one of six potential order permutations, a notable amount of the accuracy scores increased over the course of testing, even with all three peripherals. Furthermore, while all participants had an allotted time for practicing and familiarization with the peripherals if needed, this was done in a separate, simplified tutorial level and not through premature exposure to the actual test level. Also, while some of the participants were familiar with the peripherals or certain input schemes prior to testing, they had not been familiar with their use in conjunction with our prototype or its specific gameplay mechanics. Finally, to avoid learning the test level through passive observation, we tested the participants individually rather than in a group setting. While we, at times, did test two participants simultaneously, they still were isolated from each other and had no interaction during testing or during the post-experiment interview.

The participants greatly improved their scores simply by playing the prototype level several times in succession, and this correlation was supported by Pearson's analysis in \( R \). Combining this with the ANOVA results, where there was no difference between accuracy scores based on the peripheral used, we have found that level repetition and memorization has a more quantifiable effect on accuracy than the input device. This potentially could be a factor in the guitar gaming subculture as well, where certain games have been mastered before attempting them with unorthodox peripheral usage.

6.2. Qualitative Participant Feedback Examination

Deeper analysis of the feedback and observational data revealed potential reasoning as to why our participants commented and replied as they did.

6.2.1. Prototype Design

Some participants were very vocal about how they had routinely played Guitar Hero in the past, but
no longer do so. This would come into play once testing began, and is connected to the reoccurring remark that the prototype was reminiscent of Guitar Hero.

The participants pointed out how the colors of the collectible orbs gave the prototype a very Guitar Hero feel. Those colors specifically matched those of the buttons of the guitar, and even if the highway lanes themselves were not color-coded, some participants felt that this made it easier to play using that peripheral. On the other hand, several participants, even those who felt the guitar was easiest to use, mentioned their prior Guitar Hero experience and how the learned habits and muscle memory from regular play of that game had had an effect on their testing performance. While some design elements in the prototype were similar to those found in that game, the actual gameplay mechanics in the test level were quite different. Consequently, participants that reflexively played the prototype like they played Guitar Hero performed poorly and summarily had difficulties acclimating themselves to the lane navigation mechanic and control scheme. Taking this into consideration, the orb coloring becomes less of a straightforward advantage during guitar peripheral testing.

6.2.2. Controller Mapping

Finding a control scheme that would work well on an Xbox controller was a difficult task for us, so we implemented the one found in the Guitar Hero franchise, which makes use of the shoulder and trigger buttons. Our reasoning behind this is that Harmonix would have had the time and resources to test this input scheme prior to the game's release, to evaluate its strengths and weaknesses. In the end, this was the scheme they had in several Guitar Hero games, until the controller was reserved for use in tandem with the microphone. Furthermore, we felt that this scheme was a viable equivalent to the ones on the other controllers, due to its layout on the device.

On the other hand, the majority of participants remarked negatively about the Xbox controller. At times, this was immediately after interacting with it in the tutorial level, but sometimes the participants strongly reacted simply during the explanation of the control scheme. The results of the survey show that the controller was ranked the least intuitive and had the lowest ease of use. However, taking that into consideration in conjunction with the feedback received, most participants remarked on the control scheme employed, rather than the peripheral itself, saying it was “weird”, “strange” or even simply “bad”.

Interestingly, some participants took the controller testing as a personal challenge, similar to Bearzly’s Guitar Souls, striving to improve their scores between attempts, and inquiring us
researchers if their scores were better than the other (anonymous) participants. Those who managed to perform extraordinarily well were visibly proud of the achievement, as while the participants were not actively competing with each other, they knew their scores were being tallied and compared.

6.3. Method Critique

The participant feedback we received was usually concise and straightforward, so it seemed that field note taking was a sufficient data recording method. The majority of participants spoke using key phrases that recurred in most of the feedback, such as remarking on the peripheral being used, the input scheme or the prototype gameplay mechanics. However, looking back on the results of the testing now, we should have utilized more situation-encompassing data gathering methods. As we did not video or voice record the testing sessions, we were limited to only the data that we felt, at the time, was pertinent to write down. While we managed to gather a large amount of observational and interview data, it might be possible that we focused our sights too much on the peripherals themselves. Seeing as the peripherals had no statistical significance to accuracy scoring, we should have taken greater care to observe all aspects of the entire testing experience. We also should have transcribed more of the scoring data than just the final accuracy score. Timestamped scores along with data pertaining to the number of orbs and crashes, which are the main factors of the accuracy scoring, would have allowed for a more nuanced analysis that could examine play-strategic behaviors that emerged during testing.

Additionally, we would have liked more concrete examples and information in regards to the unorthodox peripheral gaming subculture, so we could make better connections with this study and the input devices examined. While gamers like Bearzly have gained acclaim in gaming and streaming circles with his Guitar Souls playthroughs, this style of play is still a rather small niche in gaming as a whole. Perhaps it will gain more popularity if Harmonix succeeds in releasing a next-gen version of Rock Band, with newer more versatile guitar controllers, that can easily be modded or control remapped.

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7. Conclusions

The goal of our study was to determine if the choice of peripheral has an affect on accuracy and playability. We hypothesized that the peripheral would have an impact, but our results showed otherwise. We are unable to make a definitive conclusion in regards to accuracy based on which peripheral was used, as the results from our ANOVA analysis show no significant difference between those scores. On the other hand, we were able to show a positive correlation between accuracy scores based on which test run, out of six, the participant was playing, regardless of which peripheral was being used. Through this data, we have determined that the participants were able to improve their scores through repetitive play, even with counterbalancing measures imposed, and that practice with the peripheral and level memorization had a stronger impact on accuracy scoring.

The results of the post-experiment questionnaire showed that the participants felt that the guitar was the easiest to use and most intuitive, in comparison to the keyboard and the Xbox controller. According to the interview feedback, the Xbox controller was the most difficult to use mainly due to its input control scheme, and not because of the device itself. In regards to the prototype design, the feedback revealed that its similarities to Guitar Hero was a double-edged sword for some. Several participants remarked that the matching orb and button coloring made the guitar feel like it was the easiest to play. However, the actual gameplay mechanics were more difficult to learn, as they were not the same as Guitar Hero, and were in conflict with those remembered play habits and input schemes.

Most interestingly, the intended use and design of a peripheral has no bearing at times with how it actually shall be used by the player. We have examined this in the experimental gaming subculture, where unconventional peripherals are used to make gameplay more challenging or interesting, and also in unexpected input techniques used to make a device more comfortable to interact with. In conclusion, our results show that the entire interaction experience, consisting of peripherals, their input schemes, manipulation techniques, and how they’re all used in tandem with a game’s design, work together to influence how well a player performs and how playable it feels as a whole.
8. References


