SIGRAD 2015
L. Kjelldahl and C. Peters (Editors)

The Effects of Peripheral Use on Video Game Play

K. Stinson and N. Bohman

Södertörns högskola, Institutionen för naturvetenskap, miljö och teknik

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.

Categories and Subject Descriptors (according to ACM CCS): I.3.1 [Computer Graphics]: Hardware Architecture—Input Devices, K.8.0 [Personal Computing]: General—Games, H.5.2 [Information Interfaces and Presentation (e.g., HCI)]: User Interfaces—Interaction Styles

1. Introduction

From the NES Zapper for *Duck Hunt* to the Konami Dance Mat for *Dance Dance Revolution Universe*, 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* and *Rock Band*, 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, there are still gamers finding new uses for their aging plastic guitars until then.

1.1. Related Work

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 [AT11] 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. 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. 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. This study had a strong influence on our own experimental design.

In another study, 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 [NCM09]. The experiment focused on determining the technical performance of these devices in conjunction with a Fitts' point-select task, which involves target acquisition. 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. 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 also be useful sources of inspiration.

1.2. Research Question

The goal of our study is to determine: 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.

2. Method

2.1. Experimental Design

Our goal was to implement a mixed-methods design approach to our experiment, where we gather not only quantitative data, but also qualitative. We executed an experiment with a 2 x 3 within-subject design. 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.

2.2. Experimental Procedure Outline

First, the sections of the questionnaire pertaining to background information were answered by the participant. Next, 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.

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.

After the first half of testing, 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.

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), with feedback and observations transcribed.

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. The participant then completed the post-experimental evaluation section of the questionnaire.

2.3. 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, and an integrated laptop keyboard.

2.4. Prototype Description and Mechanics

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 player can move the car in between these lanes using three different control schemes, dependent on which peripheral is being used.

We wanted a no-fail state in our test level, so collision with obstacles would only result in a decrease in accuracy scoring. The accuracy score is calculated by taking the percentage of orbs collected with deductions taken for every obstacle that was not successfully avoided.

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. 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. Furthermore, this scheme was a viable equivalent to the row-oriented button layouts of the keyboard and guitar controllers. 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. Participants that have never played those games would need to learn how to use this specialized peripheral, which is why the tutorial phase of testing was allotted.

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, so all four keys must be employed to play.

We anticipated a learning effect, 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.

2.5. Participant Profile and Experiment Questionnaire

We had fourteen volunteers for experimental testing (N = 14), between the ages of 18 and 39. 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".

2.6. 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 [Rub94]. 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. 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 [DR99].

3. Results

3.1. Prototype Accuracy Score Analysis: ANOVA

The ANOVA analysis in R showed that there was no statistically significant difference between the accuracy scores based on which peripheral was being used ($p = 0.509$) nor 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 themselves based on the attempt block ($p < 0.001$). 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.

3.2. Prototype Accuracy Score Analysis: Pearson's Product-Moment Correlation

The analysis of accuracy scores using Pearson's product-moment correlation in R showed highly statistically significant results ($p < 0.001$, $r = 0.4901$), where the play order had a positive correlation to the variation in scoring. Summarily, we can verify that 24 percent ($r2 = 0.2401$) 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. This can be visualized further using a scatterplot graph, where the trend lines show that accuracy scores increased over the course of the six test runs, with all three peripherals.

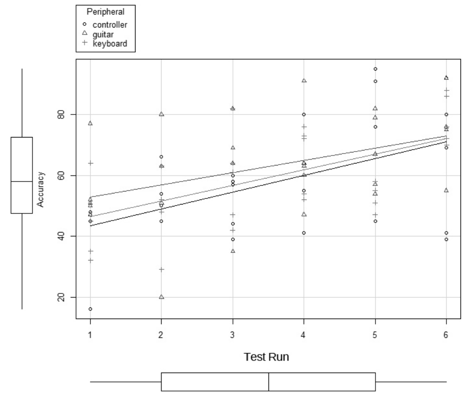

Figure 1: *Scatterplot of Accuracy Scores Based on Test Run.*

3.3. 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.

3.4. Participant Observation and Feedback

No participants were "corrected" if they were using the device a certain way, even if it can be assumed that there is an intended method by design, and were allowed to use them in whatever manner felt the most comfortable. As a result, there were several instances where unique interaction methods were utilized during testing, as it was felt to be easier to manipulate the input device with a specific, unexpected technique.

The prototype's keyboard control scheme made use of the A, S, D, F keys, which can be done with the four fingers of the left hand, from pinky to index. However, we found that

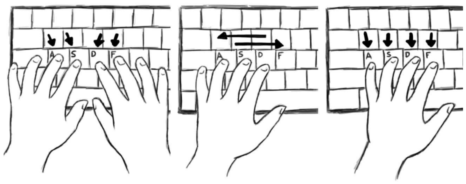

Figure 2: *Observed Keyboard Interaction Methods.*

certain participants felt more comfortable using their right hand. Another employed a two-handed approach, using two fingers from each hand to press the keys, resulting in relatively high scores on that device. Finally, one participant chose to only use three fingers, resting them on the standard movement keys of A, S, and D, found in many games, and shifting to the right when the F key is needed. Unsurprisingly, this participant felt that this was a very difficult way to play.

Figure 3: *Observed XBox Controller Interaction Methods.*

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. Interestingly, we found that one participant had initially tried using this peripheral with only two fingers, interacting with both the shoulder and trigger buttons by shifting finger position when needed. 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.

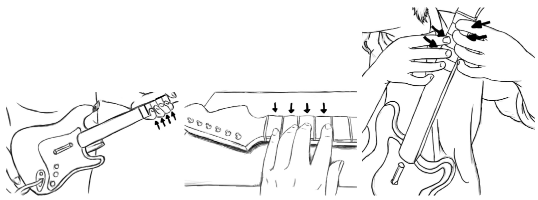

Figure 4: *Observed Guitar Controller Interaction Methods.*

The guitar peripheral has the most distinctive of interaction and construction designs, as it is intended to mimic an actual musical instrument. However, one participant specifically avoided holding the device like a guitar, rather opting to lay it flat on the table so that they could interact with it like a keyboard. Another participant initially tried using the peripheral the intended way, then chose to reposition the device, interacting with the neck buttons while using two hands. 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.

4. 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. Finally and most interestingly, we found that the intended use and design of a peripheral has no bearing at times with how it actually shall be used by the player. 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.

References

[AT11] A. THORPE MINHUA MA A. O.: History and alternative game input method. In *Computer Games (CGAMES), 2011 16th International Conference on. IEEE* (2011), pp. 76–93. 1

[DR99] DUMAS J. S., REDISH J.: *A practical guide to usability testing*. Intellect Books, 1999. 3

[NCM09] NATAPOV D., CASTELLUCCI S., MACKENZIE I. S.: Iso 9241-9 evaluation of video game controllers. In *Proceedings of Graphics Interface 2009* (2009). 1

[Rub94] RUBIN J.: *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*. John Wiley and Sons, Inc., 1994. 3