Project Number: DXF 0789

Analysis of Game Interface Performance

An Interactive Qualifying Project Report

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Abstract

This study tested the effects of different interfaces on players' performance in racing games. Participants raced each other on three different configurations, a PC with a keyboard, a PC with a gamepad, and a PlayStation2 with a gamepad. Participants switched setups after each race. We found a slight advantage in performance, as measured by lap time, mean speed, and place, when using a gamepad over a keyboard. Learning, experience, and skill had a much larger effect than the interface.

1. Introduction

Our goal for this project was to determine the effectiveness of various control schemes on players' performance in games. An answer to this question would be useful for people who play games as well as the people who develop them. Answering this question may help consumers to choose gamesthat are well suited to the particular platform they own. Players enjoy games that they can do well at, and where using the controls is not the primary challenge. Knowing how the interface affects player performance may also help developers by providing them with information on how to make their games more enjoyable to their customers.

As most games are controlled by either a gamepad or a keyboard, thoroughly testing these two interfaces would be useful to study. Similarly, most games are played on a personal computer or a home console, and we wished to compare these different platforms as well. We were able to separate the effects of platform from those of the physical interface by hooking up a console's gamepad to a personal computer using a specialized adaptor. This allowed us to have three configurations: one with a home console, one with a personal computer, and one with a personal computer with a console's gamepad.

We wanted to use a popular genre to have the most applicable results, and so we settled on racing games. This had additional benefits, as it gave us performance statistics for both personal performance, such as lap time, as well as relative performance, such as the place in which the participants finished. In order to get a fair view of player performance among these setups, we determined that we would need a racing game where a player on a console could race against a player on a personal computer. Having this feature allows for a much more accurate comparison of the data between the two platforms. To accomplish this, we bought several copies of the game *Need for Speed Underground*, a popular racing game on many platforms published by Electronic Arts. This allowed us to have a PlayStation 2 race against two personal computers simultaneously.

To collect participants, we sent out a basic survey to many WPI students asking them about their game-playing habits and whether they would be willing to participate in our study. We used the results from this survey to arrange participants into groups of three so that the skill and experience levels of the members of each group would be as similar as possible.

In order to minimize the effects of variations in individuals' skill levels, every participant raced on each of the configurations. Each race consisted of three laps around a basic track with all of the participants using the same model car. At the conclusion of each race, we recorded the statistical information about each player's performance, such as average speed, each lap time, and their place relative to each other. We had the participants rotate through all three testing setups, recording statistics after each race. Once a group had rotated through all of the testing setups, we had them fill out a post-survey to obtain more demographic information as well as participants' impressions of the interfaces they had been using.

From the analysis described in Section 4 of this document, we found several interesting trends. On average, participants were able to drive faster when using a gamepad as opposed to a keyboard. Similarly, participants' lap times were, on average, lower on the gamepad than the keyboard, but this could not be proven to be statistically significant. The platform, whether the participants were using the PlayStation 2 or the PC, did not have a significant effect on player performance. The interface had more of an effect. While other factors, such as previous experience, had a larger effect, the interface does have an effect on player performance. The results suggest that the gamepad is a superior controller for racing games.

In Section 2, we discuss some previous research done in the area of game interface performance, and give some background on *Need for Speed Underground*. In Section 3, we explain our experimental procedure in detail. In Section 4, we report and analyze the results of the study. In Section 5, we discuss possible future areas of research to explore that come out the study. In Section 6, we present our overall conclusions on the project.

Appendix A contains the forms and surveys used in conducting the experiment. Appendix B contains the participants' responses to the pre and post surveys. Appendix C contains a table of the racing results.

2. Background

2.1 Research

There has not been much research explicitly comparing the performance of users playing on different platforms, but there has been some research comparing the performance of various input devices for games. Of particular interest is Kavakli and Thorne's "Usability Study of Input Devices on Measuring User Performance in Computer Games." They compared the performance of two experts and two novices playing with keyboard, mouse, and joystick. The games played were *Need for Speed II*, an arcade racing game, and *Racer*, a realistic driving simulator. They found that the users performed better with the keyboard on the fast-paced *Need for Speed II*, whereas the joystick was more effective for the slower paced, precision *Racer*. They concluded that the best type of input device varies greatly with each game. They also found that the novices made fewer errors with the discrete keyboard input, which was easier to pick up, while the experts benefited from the extra control that the analog input devices could provide. This research is useful, as it provides some background for comparing input device performance, although the experimental procedure is quite different. The fact that racing games were tested makes the study even more relevant (Kavakli and Thorne).

Another study (Klochek and MacKenzie) looks at the game input performance from a more explicitly HCI perspective. The study compared the performance of a computer mouse with that of an Xbox gamepad in performing tasks associated with first-person action games, such as tracking a target or moving at a constant velocity. In general, the mouse performed better at the tasks, since the first-order control and small range of motion of the gamepad analog stick limits its speed and precision. While the experiment is quite different from ours, its direct comparison of PC and console input devices is of some value.

2.2 Previous Work

The previous year's IQP in this vein studied the degree to which tutorials helped players. Participants played a level of *Thief: Deadly Shadows*, a first-person stealth game. Half of the participants took a tutorial before playing, and half did not. Their playing was recorded on video, and later analyzed. They found that the tutorial helped a great deal, increasing the stealthiness of the players, and reducing the number of lives required to complete the level. They also found that the players who used the tutorial tended to use the same basic playing style, whereas those who did not use the tutorial were more diverse in their playing styles.

2.3 Need for Speed Underground: Game Background

Need for Speed Underground, developed and published by EA (Electronic Arts), pits players against each other or the AI in a high speed racing game. EA has released 14 different games in the Need for Speed series for the PC. The first game was *The Need for Speed*, which was released for the 3DO in 1994, and was later ported to the PC in 1995. Many of these titles have been released for other systems including PlayStation, PlayStation 2, PlayStation 3, Gamecube, Nintendo Wii, Xbox, Xbox 360, and several others. *Need for Speed Underground* is the first game in the Need for Speed Underground series. There are versions of the game for PlayStation 2, Xbox, PC, Gamecube, and Nintendo DS.

The biggest portion of the game is Career Mode, which was not used in our testing. Career Mode allows the player take on the role of an underground race driver. The player can win races to earn money and then uses the money to buy faster cars, which can then be used to win tougher races. Players can also race against computer controlled players in several different race modes such as circuit race and drag race, where a variety of cars are already unlocked for the player to choose from. The racing mode we used for our experiments was the circuit race, where players race a preset number of laps around a map.

We used the multiplayer feature where up to four players can race against each other in a game where the map, number of laps, and the car being used by each player can be chosen before the start of the race. The driver must finish the preset number of laps before the other drivers in order to win the race. The driver has access to all the basic controls of driving a car including acceleration, braking, steering, emergency brake, and reverse. In addition, the player can control several different camera views including two different first person views, one which looks out the front window and the other which looks out the rear window, and two different third person views, both following the car at different distances.

We chose *Need for Speed Underground* because we wanted to test player performance by having players race against one another. *Need for Speed Underground* is one of the few games that allows players using different platforms to compete. Competition helps drive the test subjects to perform their best on each test input. This should increase the accuracy of the data collected, and hopefully clearly indicate which interface is the best for racing performance. The online circuit race feature of *Need for Speed Underground* also allows for a completely fair racing environment. All players may choose the same vehicle and there is no oncoming traffic so a player's performance is based entirely on his or her skill level. The use of competition in a fair environment led us to choose *Need for Speed Underground* as our testing game for analyzing player performance on different interfaces.

3. Experimental Approach

3.1 Overview

In order to evaluate the effectiveness of the control interfaces on player performance in the game *Need for Speed Underground*, we used a survey to evaluate and group participants. We did not reject any participants who were willing to participate, but we did realize that the results could be influenced by participants with different levels of ability playing each other. Thus, participants were grouped with those of similar rated skill. In order to test the effectiveness of the different interfaces, we determined that three setups were required. We also determined that an additional survey after the study would help us to capture player impressions of the different information as well as gaining demographic information that would help us to organize the data and isolate any outside factors.

3.2 Pre-Screening

We selected participants through the use of questionnaires. The primary goal of these questionnaires was to get volunteers for the experiment. Other questions were designed to get a sense of the person's experience with different types of games and platforms. We used this information to place participants in groups with others with roughly similar experience. For example, we tried to put participants who rated their skill in racing games as being low in the same groups whenever possible. This helped to prevent the difference in abilities from completely overwhelming any effect the interface may have had. The surveys were distributed solely among students at WPI in several ways. They were given out at meetings of the Game Development Club and several IMGD (Interactive Media and Game Development) and Psychology classes that were in session. As we collected the surveys, we screened out the people who did not want to participate, and grouped the rest by their self-rated skill. Each group was then e-mailed a list of times they could choose from to take part in the experiment. When three participants filled a slot, we scheduled the time and performed the experiment.

3.3 Experiment Setup

In order to test the effectiveness of multiple control schemes in a realistic environment, we divided participants into groups of three. When possible, we formed groups of similar experience levels, as closer races show clearer results between control interfaces. Due to space requirements, we set up all three systems in the same room according to the layout below. On the left, we placed a TV that had a PlayStation 2 console hooked up to it. On top, we used a laptop that had an adapter to connect a second PlayStation controller. On the bottom, we had a desktop PC with a standard keyboard interface.

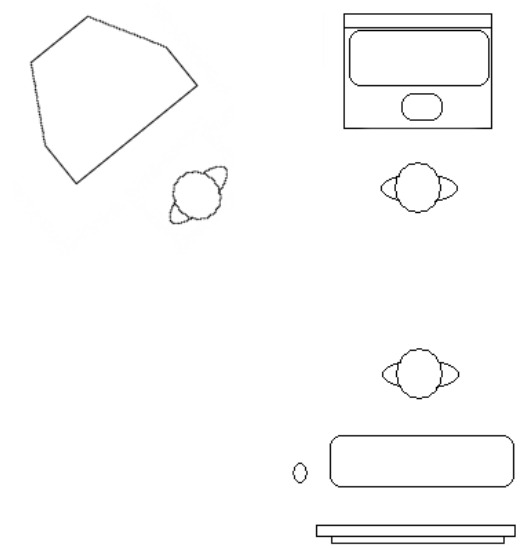

Figure 4-1: Experimental Setup

In order to get the best results, we tried to recreate conditions under which consumers would play each platform and keep all other factors equal as much as possible. To this end, the PlayStation 2 was hooked up to a traditional CRT television screen, while the laptop and desktop relied on LCD. The two computers were roughly equivalent in specification, and did not have noticeable problems running the game. Due to the nature of the game, all of the systems had to connect to Electronic Arts' (EA) servers via the internet, so no station was at an advantage or disadvantage for being the “host” machine.

3.4 Conducting the Experiment

Upon arriving at the testing site, participants were randomly assigned to each station. Participants were then informed that they would be playing the game *Need for Speed Underground* against one another, and asked to do their best. Each participant was given a sheet with the controls for each console and given as much time as they wished to review their controls. When all participants were ready, we began the race. Each race was a timed challenge consisting of three laps around the 'downtown' track, with all participants using a basic Mazda RX-7 car. This made sure that no participant was at an inherent advantage. The car is relatively slow but had good control, to make it easier on the participants. At the end of each race, we recorded all of the in-game stats for each player on our results sheets (see Appendix A.2), before asking the participants to rotate clockwise to the next setup. We would ask them to review their new controls, giving them as much time as they desired before starting the new race. During each session we ran three races to ensure that all participants had a chance to race with all three control interfaces.

After the third race, we asked participants to fill out a post-survey about their experiences (see Appendix A.3). This was in order to capture their opinions of the different interfaces and their impact on the game, as well as data on how their experience might affect their behavior in the future when it comes to purchasing video games. Before any of the participants left the room, we asked them not to talk about the specifics of the testing (such as what game we used) to their peers to ensure that future participants did not have a chance to practice the game. As compensation for their time, participants were invited to take some candy as they left and thanked for their time. The psychology students were given a bonus on their course grade for their participation.

3.5 Post Survey

While we had the statistical data, we also wanted to compare the participants' preferences and overall impressions of the different platforms after playing. We created a post-survey for the participants to complete immediately after the last round of testing. Participants were asked to rate each of the platforms on the interface's effectiveness, the ease of learning the controls, and the participant's experience with the controls. Interface effectiveness and ease of learning the controls directly measures their experience in testing. The survey also asked what factors were most important to buying a game, how many hours per week are spent playing games, and how many different racing games have been played. Finally, it asked which platform the participants would play it on and why. This would give us feedback that could not be acquired statistically, or that could have been missed.

We also wanted to compare their actual performance on each interface to how well they thought they performed on each interface. It is possible to prefer one interface over another while still performing better on the less preferred interface. For example, a person may prefer to play a first person shooter on a console as they can usually relax on a couch or a more comfortable chair and use a bigger screen as compared to a PC where they are in a chair using a smaller screen. If this was the case for most people, it would be in the developers' interest to make the game for the console even though performance was generally better on a PC. A post survey allows us to compare performance and preference in case they did not match up.

4. Data Analysis

4.1 Analysis Techniques

To analyze the data from the experiment, we used R, an open source software package for statistical computing and graphics (R Foundation). The main technique used for measuring effects was analysis of variance (ANOVA), which is a specialization of linear regression which uses discrete categories as independent variables (Field and Hole, chapter 6). Since the same subjects raced with different interfaces, repeated measures ANOVA was used, which takes this into account. The results of the ANOVA are reported as follows: *F*(degrees of freedom of effect, degrees of freedom of error) = mean square of effect/mean square of error. The *p*-value, or the probability that the variance observed happened by random chance, is also given. A *p*-value of less than 0.05 is generally considered to be statistically significant. Pearson's correlation was also used to find effect sizes. Mean and standard error are abbreviated as *M* and *SE* respectively.

Some of the graphs in this section are box and whisker diagrams, which may bear some explanation. The boundaries of the box represent the first and third quartiles of the data. The bar in the middle of the box is the median. The whiskers extend to the 5^{th} and 95^{th} percentiles. Any individual points are outside of the 5^{th} and 95^{th} percentiles and are possible outliers.

In the lap times and mean speed, there were a few outliers that differed considerably from the rest of the data, and greatly skewed much of the calculations. Since the distributions of lap times and mean speeds are skewed, outlier techniques based on a normal distribution could not be used. Instead, values were considered outliers if they were more than three times the interquartile range away from the first and third quartiles (NIST Information Technology Laboratory). Using this technique, one outlier from the mean speeds and two outliers from the lap times were removed.

4.2 Demographics

There were 9 females and 27 males who participated in our experiment (Figure 4-1). This high ratio of males to females is due to a number of factors. Participants were students at WPI, which has a population of 23% females and 77% percent males. The surveys were also distributed at IMGD (Interactive Media and Game Development) classes and meetings of the GDC (Game Development Club), which are mostly male.

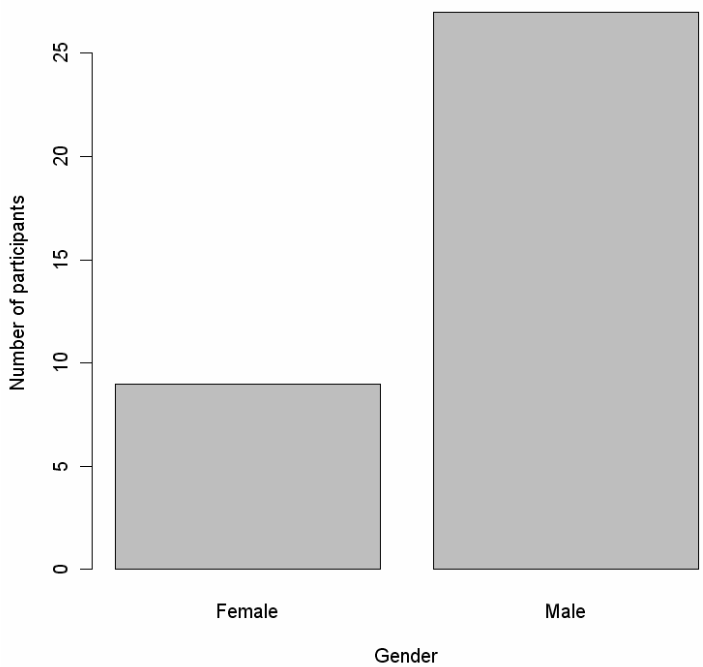

Figure 4-1: Gender of Participants

As shown in Figure 4-2, the participants had a wide range of majors. The majors with the most people were IMGD and CS (Computer Science). Since many of the participants were gathered at IMGD classes and GDC meetings, this concentration is not surprising.

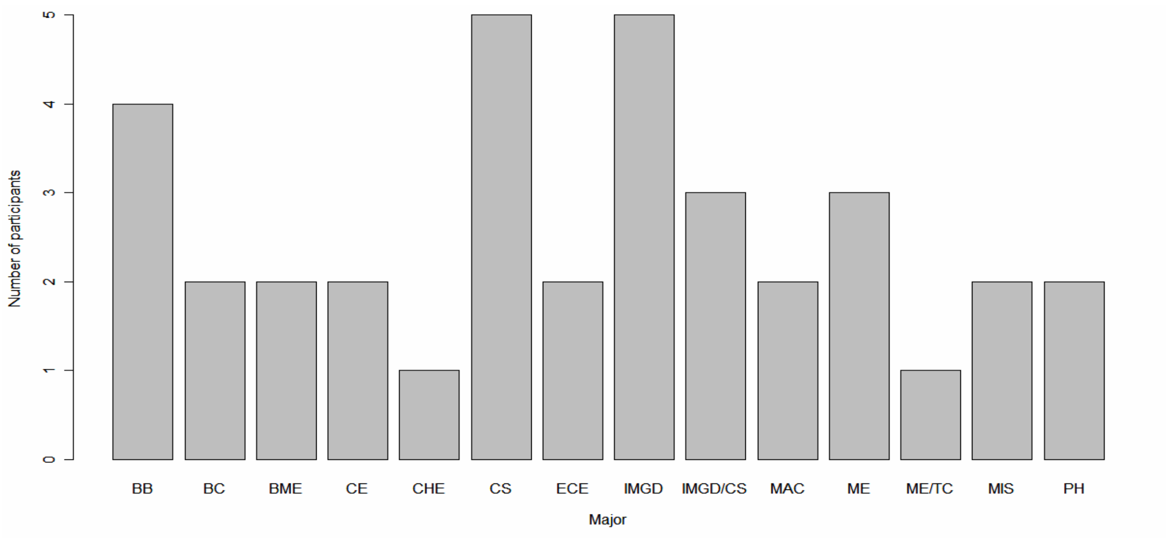

Figure 4-2: Major of Participants

The participants were all of typical college age, ranging from 18 to 28. 20 years old was the most common age, and there is a skewed right bell shaped curve as seen in Figure 4-3. This is highly representative of the college population our participants were drawn from.

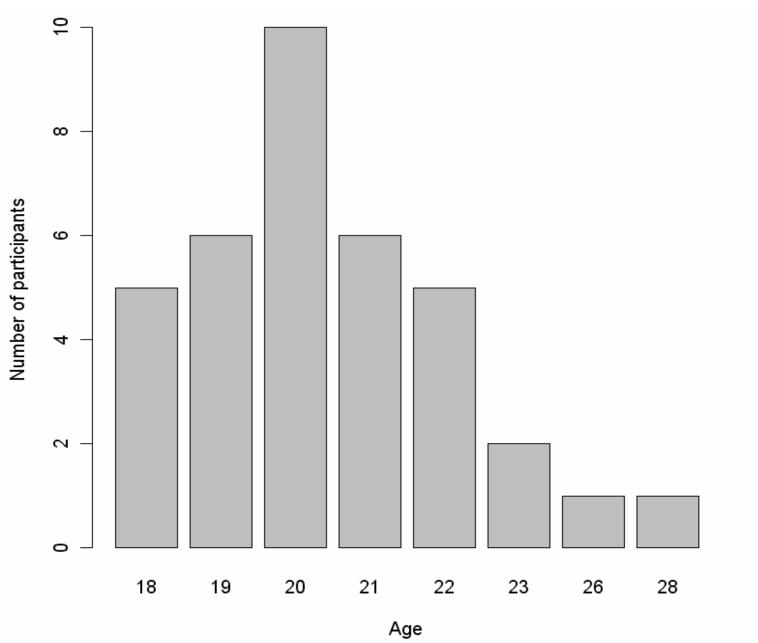

Figure 4-3: Age of Participants

4.3 Performance by Interface

The purpose of this study has been to determine the effects of the interface on players' performance in racing games. Participants each used three different set-ups: a PlayStation 2 with a gamepad, a PC with a gamepad, and a PC with a keyboard. Analysis of variance for all of our measures of performance has shown that the actual machine that ran the game did not have any significant influence on the players' performance, nor has there been any interaction between the effects of the machine and the controller used. Thus, examinations of the effect of the interface shall concentrate solely upon which controller was used. Performance is measured with three different metrics: finishing place, lap time, and mean speed.

Initial tests suggested that players tended to perform better on the gamepad. As testing progressed, this trend became clearer.

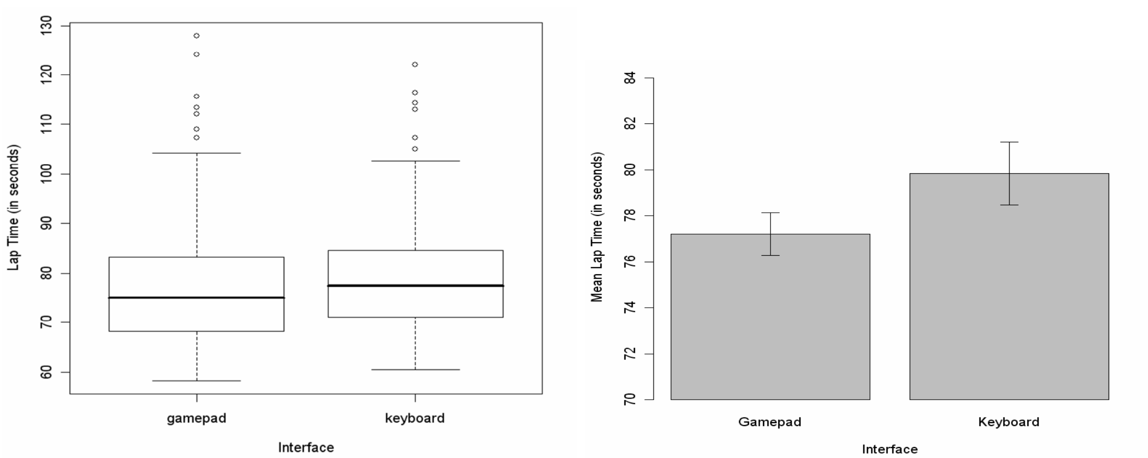

Figure 4-4: Lap Time versus Interface

Lap time, which measures the number of seconds it takes to complete a lap, is a useful absolute measure of performance. A race consists of 3 laps, so there are up to three lap times per player in a given race. Of course, not everyone finished all three laps, so some participants have less than three lap times for a race. Figure 4-4 shows a boxplot of the lap times for each interface and a bar chart showing the mean lap time for each platform with error bars showing the standard error. An analysis of variance of the lap times reveals that the difference between the lap times when the players are using a gamepad, (M = 76.94, SE = 0.90) and when players were using a keyboard, (M = 79.48, SE = 1.34) is not quite significant, $F(1, 279) = 3.19$, $p < 0.1$. Although this measure was not significantly affected, others suggest that there may be an influence.

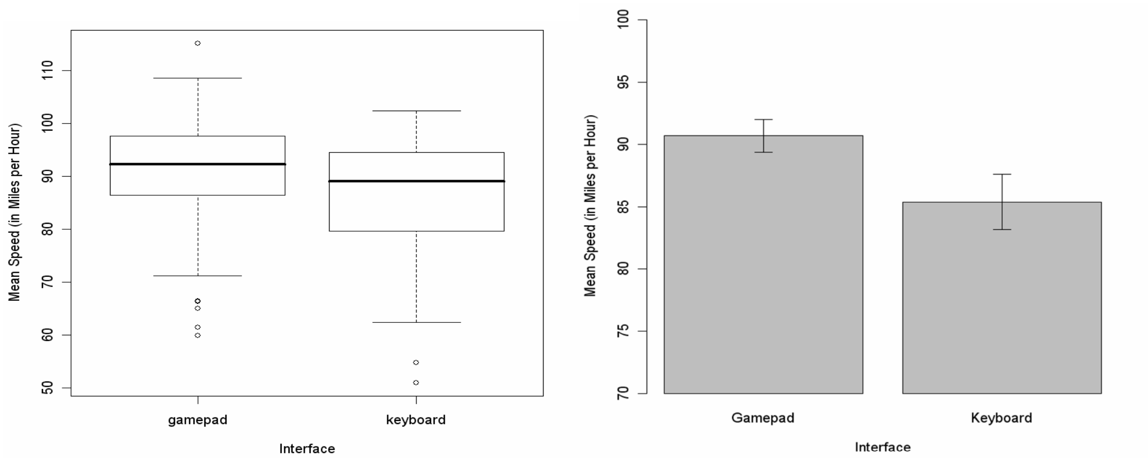

Figure 4-5: Mean Speed versus Interface

The mean speed is the mean speed traveled at by a player in a given race. It approximates performance, as players who can sustain high speeds tend to finish better. However, it is not perfect, as players can make more efficient turns or take shortcuts while maintaining the same velocity as someone who traveled farther. It is still a good absolute measure of performance, and can give an idea of how many crashes and other errors the player makes, as errors will slow down the player. Figure 4-5 shows a boxplot of the mean speeds for each interface and a bar chart showing the average mean speed for each platform with error bars showing the standard error. An analysis of the mean speed with the gamepad (M = 90.68, SE = 1.34) versus that with keyboard (M = 85.38, SE = 2.22) differed significantly, $F(1, 85) = 4.39$, $p < 0.05$.

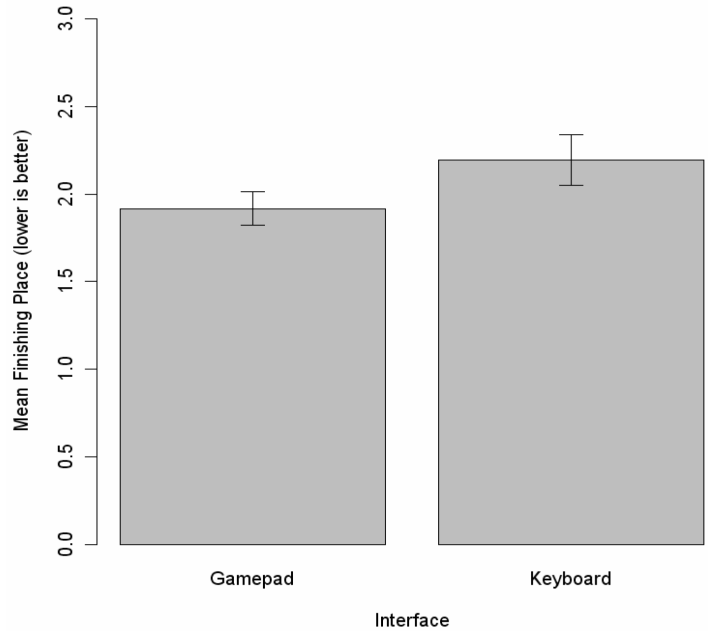

Figure 4-6: Place versus Interface

The finishing place of the race, which measures whether a person came in first, second, or third in a given race, provides a useful measure of a player's performance relative to the other players in a given race. Analysis of the finishing place shows that that the place when using a gamepad (M = 1.92, SE = 0.09) was significantly less than when using a keyboard (M = 2.19, SE = 0.14), $F(1, 104) = 4.80$, $p < 0.05$. This suggests that participants performed better when using a gamepad than when using a keyboard.

Interestingly, other factors, which had significantly influenced the more absolute measures of performance, did not have a significant effect upon the relative measure of place when calculating analysis of variance. This may partially be due to the coarse, discrete nature of the place measure, which may hide the variation caused by the statistics.

4.4 Learning Effects

During each testing session, each participant raced three times, once for each platform. Naturally, participants performed better the more they played because of familiarity with both the controls of the game and the race track that was used. With each iteration of racing, their performance improved. This is clearly visible when looking at each participant's lap time.

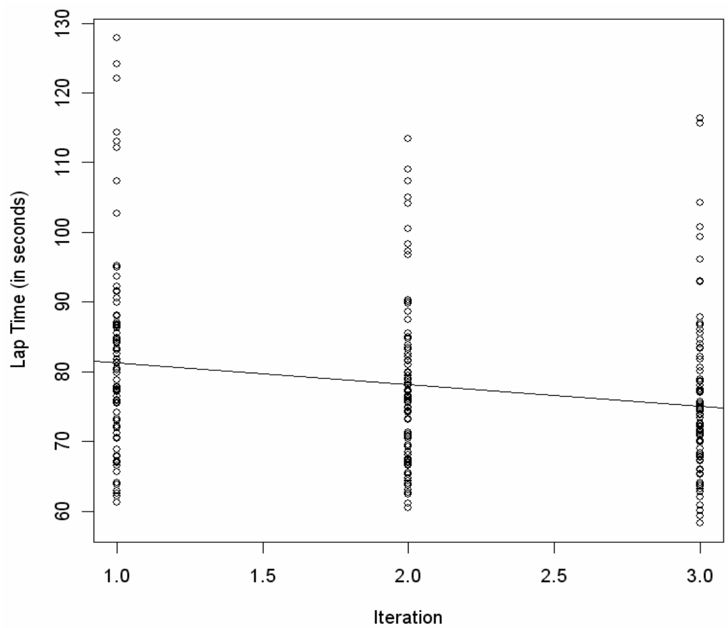

Figure 4-7: Learning Effect for Lap Time

Figure 4-7 clearly shows how the lap time decreases with each iteration. The line on the graph shows a linear regression of the lap times based on the iteration. Analysis of this regression shows it to be statistically significant, $F(1, 281) = 11.81$, $p < 0.001$. A similar improvement can be seen with the lap times within a race, from the first, to the second, to the third. However, since not every participant completes all three laps, there is a fairly considerable survivor bias, in that those that make it to the third lap tend to be have shorter lap times than those who do not. The same trend can be seen when looking at mean speed for each iteration.

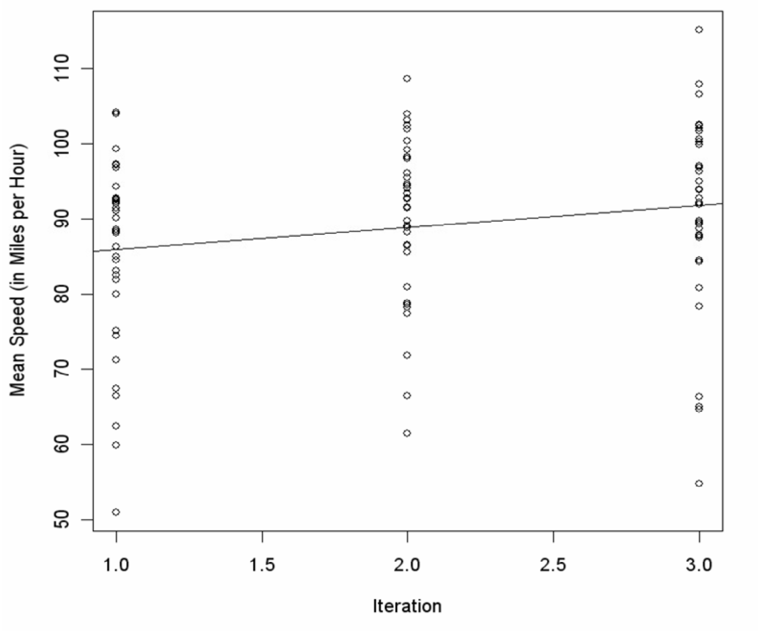

Figure 4-8: Learning Effect for Mean Speed

Figure 4-8 shows that as participants adjusted to the game, they were able to complete the race with a higher mean speed. The line on the graph shows a linear regression of this trend, which analysis shows to be statistically significant, $F(1, 106) = 5.837$, $p < 0.05$. This improvement in mean speed suggests that with each iteration, participants made fewer errors that would slow them down.

This effect is not as visible when looking at discrete measures, such as place. This is most likely because place is a relative measure. Since all participants improved more or less uniformly, their relative place would not be affected. Because this improvement is symmetric, the analysis of the effect of the interface should not be affected.

4.5 Order Effects

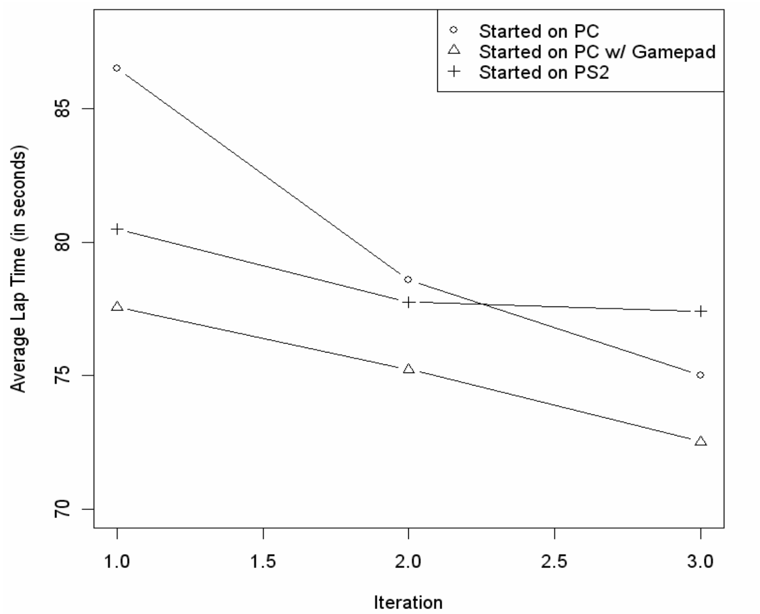

Figure 4-9: Order Effects

In addition to learning effects, there is the possibility for order effects, which are caused by different orders in which the participants play on the three platforms. Figure 4-9 shows a plot of average lap times for the three orders that participants could have: PC to PS2 to PC with gamepad, PC with gamepad to PC to PS2, and PS2 to PC with gamepad to PC. Surprisingly, there does appear to be some sort of order effect. Participants who started on the PC with the gamepad had lower lap times on average for all three races. Those who start on the PS2 start out with lower lap times than those on the PC, although this is reversed on the third race. This swap can be explained by the higher average performance of the gamepad over the keyboard, but the consistently low lap times of those who started on the PC with the gamepad is more difficult. One would think that participants who played with the gamepad twice in a row would have better performance, but the opposite is true. This phenomenon could possibly be the result of some experimental error.

4.6 Previous Experience

As shown in Figure 4-10, 24 of the participants had not played *Need for Speed Underground* before participating in the testing session while 12 had, as reported by the pre-survey. This had a significant impact on the observed lap times throughout the testing sessions. Participants experienced with the game *Need for Speed Underground* showed a significant decrease in lap time, as shown below, $F(1, 281) = 14.303$, $p < 0.001$. Similarly, participants who had played the game before had a significantly higher mean speed, $F(1, 105) = 4.715$, $p < 0.05$.

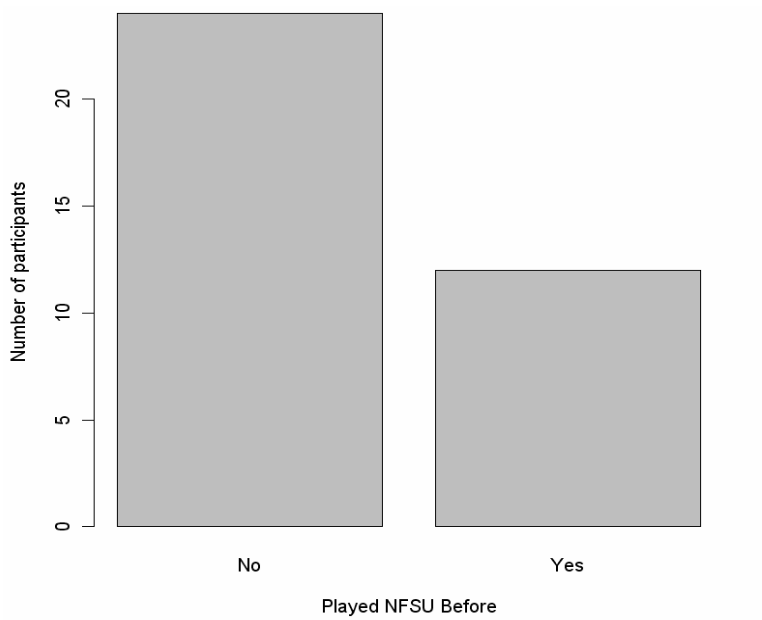

Figure 4-10: Previous Experience with NFSU

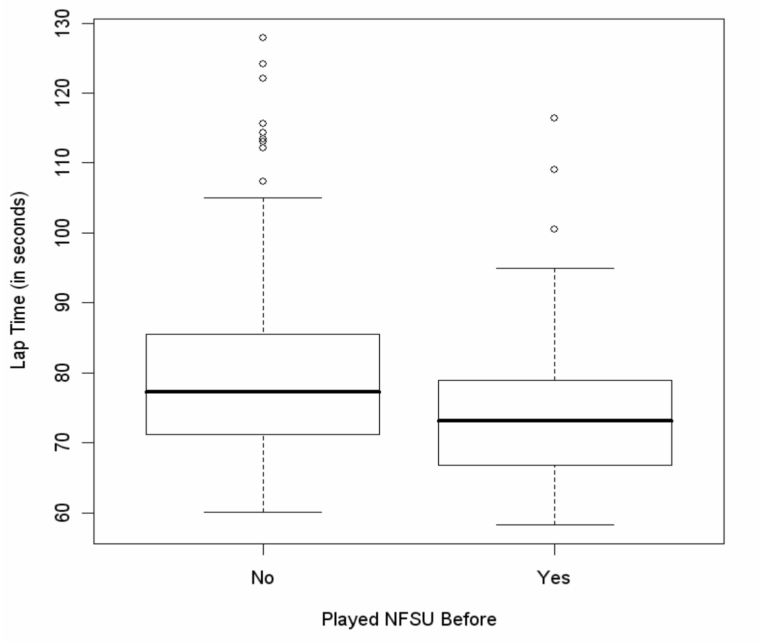

Figure 4-11: Lap Time by Experience with NFSU

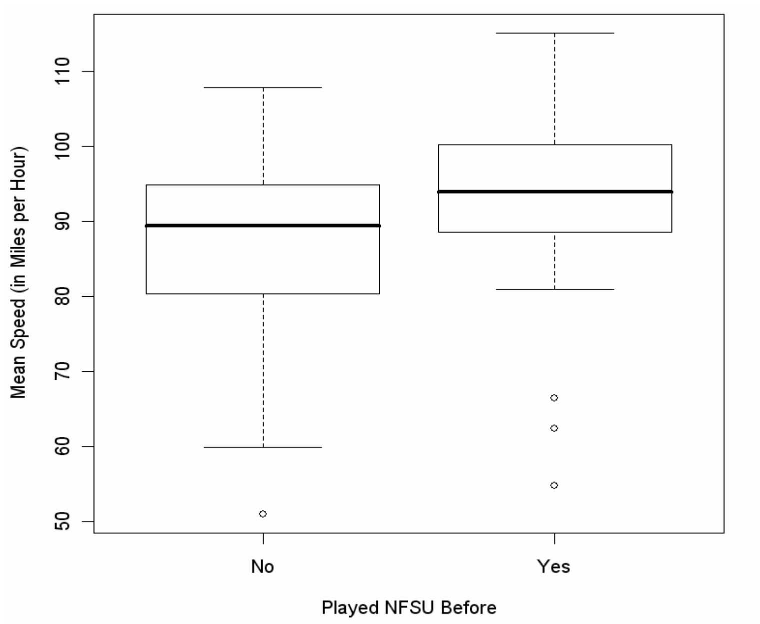

Figure 4-12: Mean Speed by Experience with NFSU

4.7 Self-Rated Skill

Of course, the biggest factor in the players' performance is their skill and experience. In the pre-survey, participants rated their skill with racing games. These ratings are not expected to be completely accurate, as people may not be able toaccurately estimate their own skill, and may have different views of what the different ratings represent. Figure 4-13 and 4-14 compare a participant’s self-rated skill with their actual performance.

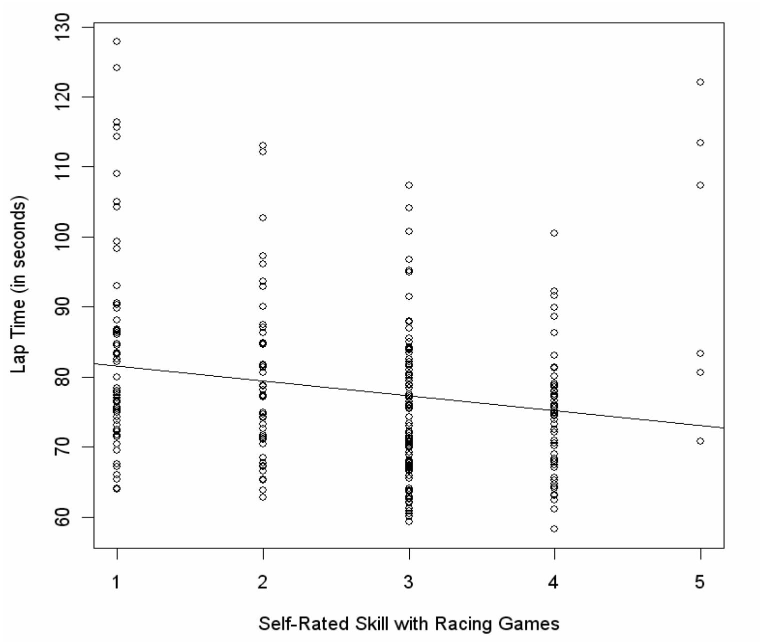

Figure 4-13: Lap Time versus Self-Rated Skill with Racing Games

While the lap times for each level of rated skill are quite varied, there is still a definite downward trend in the lap times (Figure 4-13). Indeed, linear regression shows that lap times decrease significantly as self-rated skill with racing games increases, $F(1, 281) = 12.988$, $p < 0.001$, $r = -0.19$. This supports the suggestion that players who gave themselves a higher skill rating tended to perform better. The same trend can be seen when looking at mean speed.

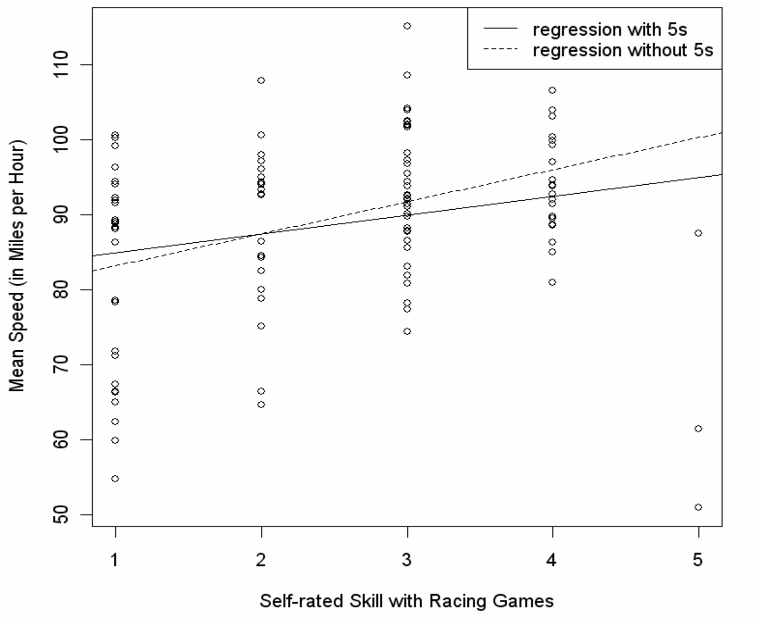

Figure 4-14: Mean Speed versus Self-Rated Skill with Racing Games

Figure 4-14 shows a definite upward trend of mean speed as self rated skill increases, $F(1, 105) = 6.12$, $p < 0.05$, $r = 0.23$.

It is interesting to note that the only participant who rated himself as a five performed quite poorly in terms of both lap time and mean speed. In fact, he had the worst mean speed for one of his races. It seems likely that he grossly overrated his abilities. These poor results at the highest level of skill reduce the correlations between performance and self-rated skill considerably. Indeed, when the fives are removed from the calculations, the correlation between mean speed and self-rated skill jumps to 0.40, and the correlation between lap time and self-rated skill rises to -0.26.

4.8 Self-Rated Experience with Interface

The post-survey asked participants to rate their experience with the gamepad and keyboard on a scale of one to five. Figure 4-15 compares a player's lap time to the player's experience with the interface being used.

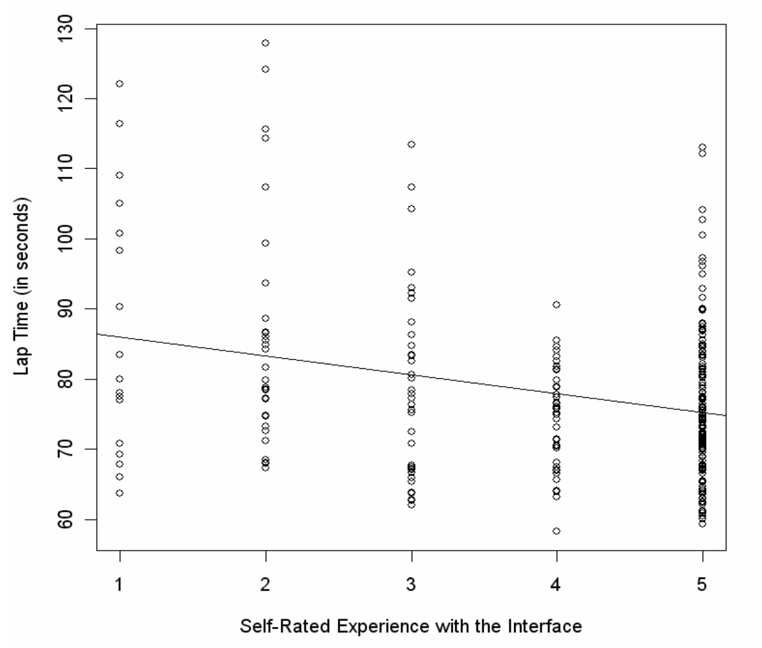

Figure 4-15: Lap Time versus Experience with Interface

A linear regression of the lap times versus experience with the interface suggests that players performed significantly better on interfaces they had more experience with, $F(1, 272) = 23.41$, $p < 0.001$, $r = -0.32$. There is a similar trend for mean speed. A linear regression (see Figure 4-16) shows that players maintained higher speeds on interfaces that they had more experience with, $F(1, 105) = 21.14$, $p < 0.001$, $r = 0.41$. In both graphs, the variance among the performances decreases as the experience increases. This suggests that participants performed more consistently with interfaces they were more experienced with. These fairly strong correlations in both measures of performance suggest that a considerable portion of players' performance is due to their experience with the controls.

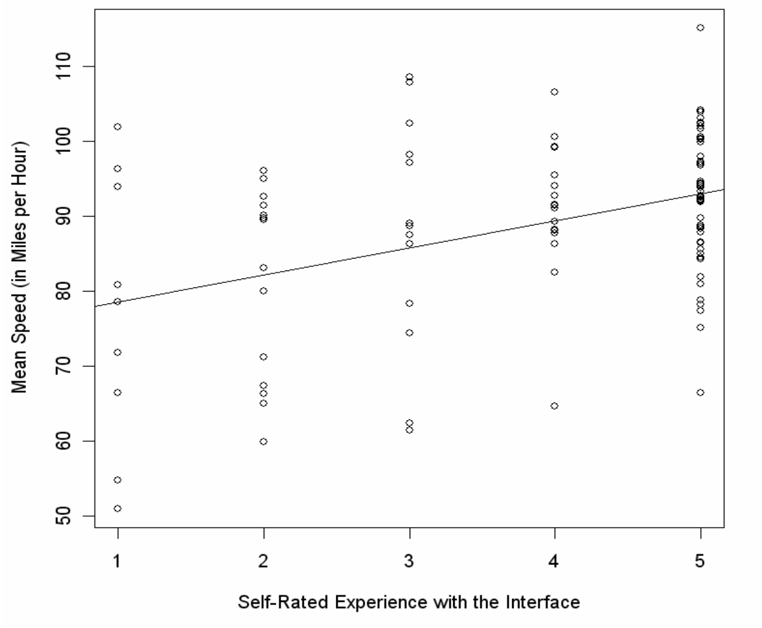

Figure 4-16: Mean Speed versus Experience with Interface

The overall level of rated experience with the interfaces was actually quite high, with 34 out the 72 responses being fives. This is a rather large difference from self-rated skill in racing games, where only one person rated himself as a five. Figure 4-17 shows a boxplot of the participants experience with each interface. The level of experience with the gamepad (M = 4.14, SE = 0.27) was significantly higher than that with the keyboard (M = 3.25, SE = 0.27), $t(63)$ = 2.64, $p < 0.01$, r = 0.31. Given the rather high correlations between the experience with the interface and both the lap times and the mean speeds, this difference in interface experience suggests that any benefits seen from using the gamepad over a keyboard may not be a result of any inherent advantages in the control device, but rather simply a reflection of the participants' previous experience with the interfaces. Indeed, when calculating the analysis of variance for the effects of the interface on performance, the significance of the effect of the interface tended to be lower when the experience with the interface was included in the calculations. If this is the case, the question is whether the results have much meaning. If the biases in interface experience among those tested are representative of a general population, then it is of some use.

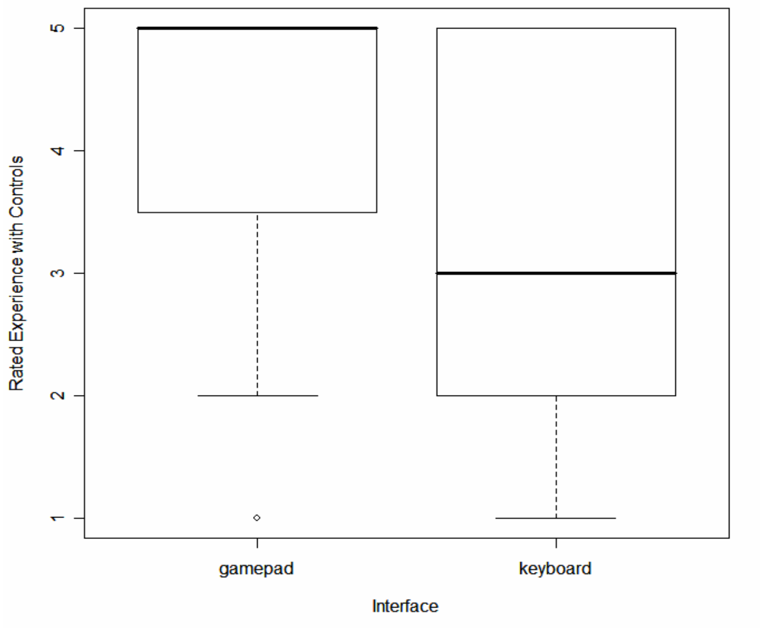

Figure 4-17: Previous Experience with Interfaces

4.9 Effects of gender

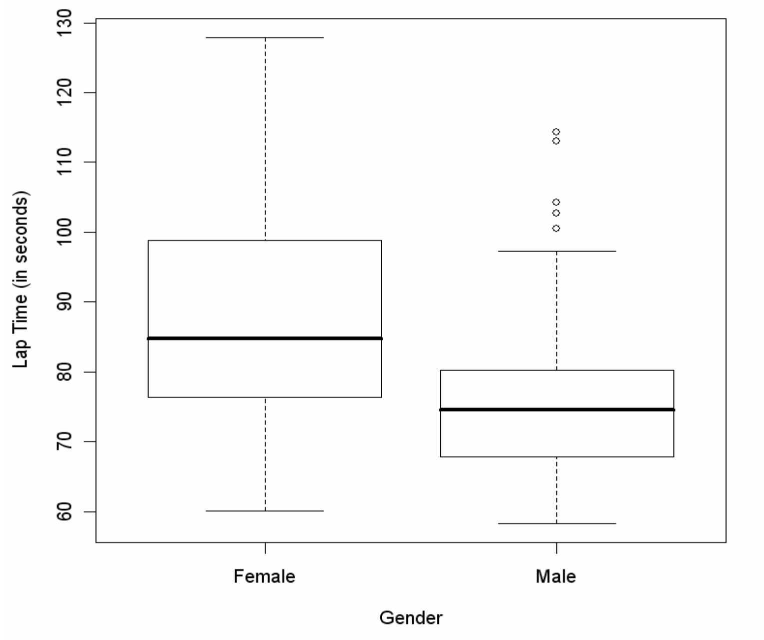

Figure 4-18: Lap Time versus Gender

As shown in Figure 4-18, there is a significant difference in the lap times between the males and females who participated in the experiment, $F(1, 260) = 49.37$, $p < 0.001$. The males had three times the number of participants as the females, so there was more statistical stability in the males demographic. This difference in lap time is most likely attributed to factors other than gender, such as experience. The male participants had significantly more experience with racing games. Of the 12 participants who had played *Need for Speed Underground* before the experiment, 10 of them were males and 2 were females. This is a 1:5 ratio of females to males among those who had played the game before, which is more pronounced than the 1:3 ratio of females to males among all of the participants.

These differences in experience may be a result of the populations from which the participants were taken. All of the female participants were from psychology classes, whereas a large proportion of the male participants were taken from IMGD classes and Game Development

Club meetings. Thus, the prevalence of male gamers in the study may have positively skewed the gaming experience of the male participants.

4.11 Post-survey responses

Analysis of the post-surveys shows that there was no significant difference between the perceived ease with which the participants learned the three interfaces (Figure 4-19). However, as can be seen in Figure 4-20, participants did note a significant difference in control effectiveness between the platforms, $F(2, 102) = 4.47$, $p < 0.05$. The survey also shows that participants as a whole had more experience with a gamepad than a keyboard as a control scheme, which could have an impact on the perceived ease of use and effectiveness.

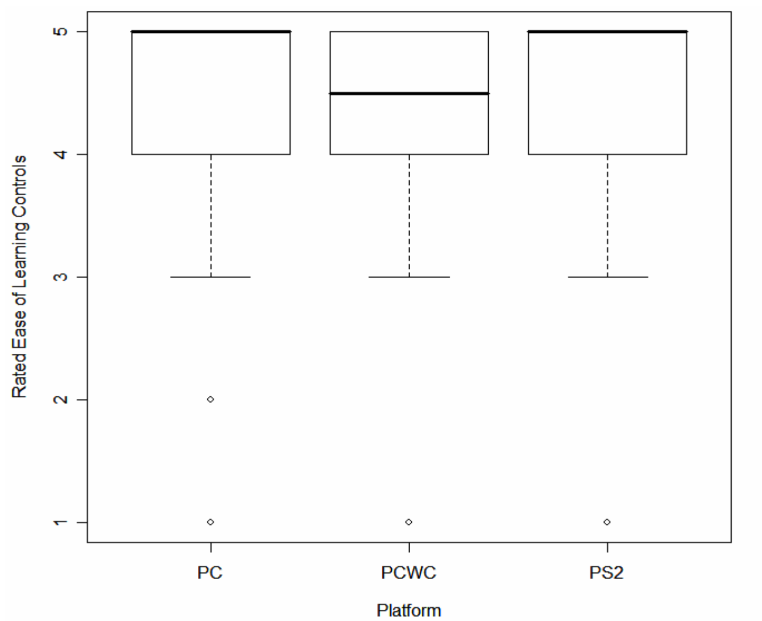

Figure 4-19: Rated Ease of Learning by Platform

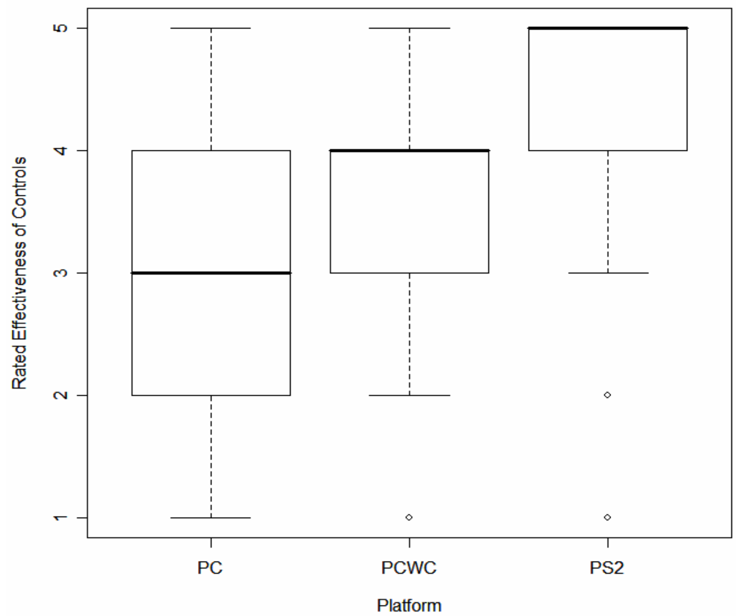

Figure 4-20: Rated Control Effectiveness

The results of our post-survey indicate that most participants are more likely to buy games for a home console than a PC (Figure 4-21), and this effect was more pronounced for racing games (Figure 4-22). This is not surprising given the distribution of video game sales being so heavily weighted to the home console market (Entertainment Software Association). Since the question was in the post-survey, the experiment may have also influenced their responses.

One question in the post-survey was, "If you were to buy this game (*Need for Speed Underground*), what platform would you buy it for and why (it is available on PC, PlayStation 2, and Xbox)?" The majority opinion was that the PlayStation 2 is the platform of choice when buying*Need for Speed Underground*. Twenty-two of the participants favored the PlayStation 2 with the majority of them citing superior controls or superior graphics. Seven participants favored the Xbox with a few stating that they preferred the controller. Six participants preferred the PC, but only two of them cited controller preference as their reason, and this was only because they were more familiar with the controls. One person stated they would not buy the game for any of the platforms.

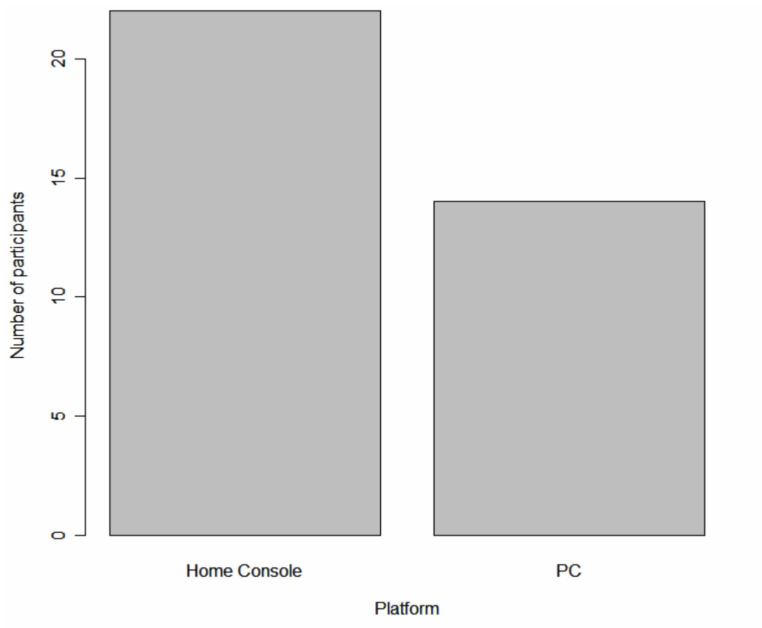

Figure 4-21: Most Likely Platform to Buy Games For

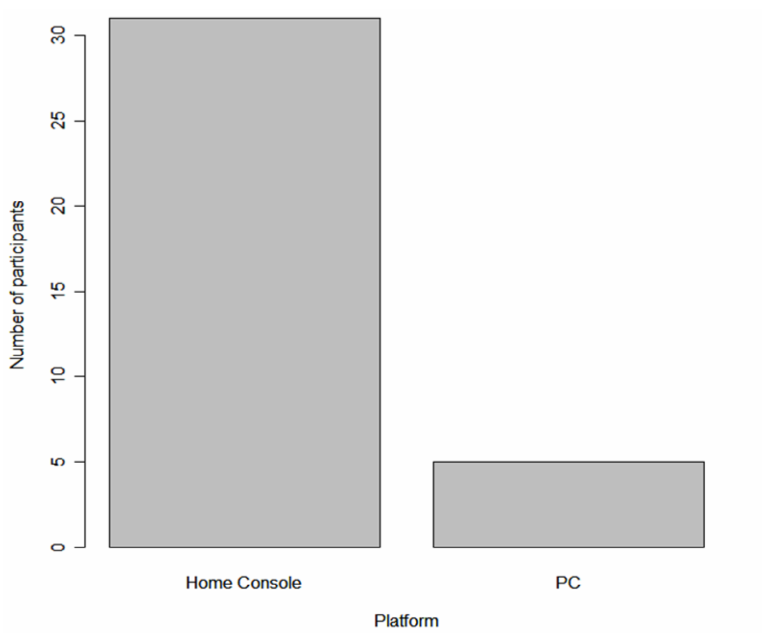

Figure 4-22: Most Likely Platform to Buy Racing Games For

4.12 Conclusions

The purpose of this study has been to test the effect of different interfaces on players' performance in racing games. The effect depends on how one measures performance. Measuring performance by place suggests that using a gamepad is significantly more effective than using a keyboard, and the same is true for mean speed. However, performance by lap time only shows a slight advantage for the gamepad and does not give a p-value low enough for the results to be considered statistically significant. Learning, or the improvement in performance from race to race, proved to be one of the biggest factors in player performance. It is logical that one would perform better with each race, as long as the trials themselves are not tiring. Self-rated experience with the interface was a major factor in how well the participants performed. Those who rated their experience higher with a given interface tended to perform better with it. Self-rated skill was also a factor in performance. Those that rated themselves as having a higher skill level with racing games had a tendency to perform better, although self-rated skill did not have nearly as big of an effect as previous experience with controls and the learning effect. There was one participant that rated himself as having a skill level of five with racing games and turned out to have one of the worst performances of all participants. Had this player been eliminated from the results, we would be likely to see self-rated skill as having a much larger effect on performance.

4.13 Possible Sources of Error

Throughout the course of testing, some factors came up that may have had an undesirable effect on the results. At the beginning of each testing session, we asked participants to take a seat, but we did not randomly assign them which platform to sit at. Because of this, participants may have chosen to sit at a platform that they were familiar with first. This is most likely not very significant as participants at the time did not know what the study was about, but it could have skewed our results slightly due to adding to the order effect described above.

While efforts were made to ensure that all equipment was functioning properly at the time of testing, a few problems did occur. The PC with the keyboard interface would on occasion show some signs of lag during the early parts of the race. Also, the controller that was hooked up to the laptop was not able to be fully calibrated and occasionally exhibited some signs of drift. Sound also was not always consistent, as the volume levels of the three systems were not equalized before beginning the race. While these factors are often noticed in real-world situations, they are not qualities of the control interface, and thus could have introduced unwanted effects on participants' performance.

Finally, the participants overall have had more experience with using a game controller than a keyboard. This would imply an inherent bias towards the effectiveness of the gamepad. While this is not based off of inherent advantages or disadvantages of the interfaces themselves, it is not necessarily a bad influence. This is because these kinds of games are more popular on the consoles than on the PC, meaning that some bias in this manner is likely to occur with a representative sample of the population.

5. Future Work

The results of this study bring up several possible areas where future research could be useful. While racing games are interesting to study, similar methods could be applied to other genres. This could allow future researchers to see whether there were inherent advantages in the controls themselves, or if the advantages noticed are specific to the genre. Similarly, this study focused on comparing the PlayStation gamepad to the PC keyboard, when there are a wealth of other control schemes and platforms whose interfaces could easily be compared. For example, video games can be controlled not only by a gamepad or keyboard, but also by a steering wheel controller, a joystick, mouse, a trackball, and many others.

With developing technologies come more and more varied options for platforms that often experiment with new and interesting controls, such as the Nintendo Wii and its inertial controllers. Similarly, many different games are being produced in the racing genre, each with different levels of realism, and styles of gameplay. Each of these could have an effect on player performance, and would only be able to be tested by studies comparing multiple games.

While this study focused on the effects of input, there is also the question of the effects of output devices for games. With increasing support for high-definition displays in the home console market, the study of effects of screen resolution on player performance is becoming an increasingly important area of research.

The gamepad has both analog and digital input for steering and acceleration. We did not give any instructions on which to use, or record which method participants used. In future studies, it would be interesting to at least record whether participants used analog or digital input on the gamepad, or even explicitly create separate groups for the two options.

6. Conclusions

In order to determine the effect that interface had on player performance in racing games, this study used the game *Need for Speed Underground*. By testing each participant on both the PlayStation 2 and the PC versions, any inherent advantage or disadvantage could be determined. In order to separate the differences between the platform and the interface, participants were also tested on a PC with a PlayStation controller.

Using the statistics provided by *NFSU* and the demographic data provided by the pre- and post- surveys, several interesting patterns emerged. While performance can be determined either by lap time or mean speed, most of these patterns held true regardless which measure was used. Not surprisingly, a participant's individual level of experience with the game and the interface had a significant impact on their performance. A considerable proportion of participants had more experience with the gamepad than the keyboard before the study, and thus these participants performed better when using the gamepad. Our data also showed that there was not a significant difference in performance between the PlayStation 2 and the PC with the PlayStation controller, meaning that the control interface was the primary difference between the three game setups. Naturally, participants performed better the more they played the game. However, the study was set up symmetrically so that the learning effects would balance themselves out.

Overall, we found that participants were able to drive at a faster mean speed when using the gamepad. There was also a trend for participants to have faster lap times when using the gamepad, but this was not statistically significant. We believe that this effect along with the initial preferences led to the majority of participants stating that they would purchase *Need for Speed Underground* for the PlayStation 2 over other platforms.

While some participants prefer using a keyboard due to their previous experience, our study indicates that gamers and developers should prefer games with a gamepad-based interface for the genre of racing games. While the reasons for the potential performance benefits of a gamepad are not clear, the increased demand for console-based games give game developers good reason to continue to develop for home console systems.

Appendix A. Forms and Surveys

A.1 Pre-survey

Games IQP Survey

Name: E-mail:

Have you ever played the following games? (mark all that apply)

Halo	☐	Project Gotham Racing	☐
Morrowind	☐	Final Fantasy 7	☐
Need for Speed: Underground	☐	Legend of Zelda: Ocarina of Time	☐
Fable	☐	Eternal Darkness: Sanity's Requium	☐
Starcraft	☐	Super Mario 64	☐
No One Lives Forever 2	☐	Star Fox	☐

Which platform do you play games on?

PC Console I have no platform preference

How would you rate your gaming abilities for each of these genres?
(1 being little skill, 10 very skilled, circle the most appropriate choice)

Role Playing Games examples: Morrowind, Final Fantasy 7, Fable	1	2	3	4	5
Strategy Games examples: Starcraft, Age of Empires	1	2	3	4	5
Racing Games examples: Project Gotham Racing, Need for Speed Underground	1	2	3	4	5
Shooter Games examples: Halo, Counter-Strike, No One Lives Forever	1	2	3	4	5
Adventure Games examples: Zelda, Mario, Myst	1	2	3	4	5

Our study includes human subjects playing video games. Should you choose to participate, we will contact you via email to arrange a date and time (no more than one hour) that is convenient for you to come to our testing site, which will be within walking distance from WPI's campus.

Would you be willing to participate in a study in video games? (circle one)

Yes No

A.2 Result Sheet

Games IQP – Results

Number	**Platform**	**Lap 1**		**Lap 2**		**Lap 3**		**Total Time**	**Time Behind**	**Best Lap Time**	**Top Speed**	**Mean Speed**	**Distance**	**Laps Led**
		Time	**Place**	**Time**	**Place**	**Time**	**Place**							

A.3 Post Survey

ID:	

Please briefly answer the following questions:

Age:______________ **Gender (circle one) M F**

Major:____________ **Year of Graduation:____________**

Rate each interface on effectiveness for this game :

1 being very ineffective even after learning the interface,

5 being very effective to use after learning the interface

(circle one number for each interface)

Playstation 2	1	2	3	4	5
PC	1	2	3	4	5
PC with Playstation 2 controller	1	2	3	4	5

Rate each interface on how easy it was to learn the controls for this game:

1 being very difficult to learn the controls

5 being very easy to learn the controls

(circle one number for each interface)

Playstation 2	1	2	3	4	5
PC	1	2	3	4	5
PC with Playstation 2 controller	1	2	3	4	5

Rate each interface based on how much experience you have with it for the purpose of gaming:

1 being no experience using the interface for gaming

5 being many hours of experience using the interface for gaming

Keyboard	1	2	3	4	5
Gamepad (Such as PS2 or Xbox controller)	1	2	3	4	5

On which type of platform are you more likely to buy games in general? (circle one)

PC	Home Console

Which type of platform are you more likely to buy racing games? (circle one)

PC	Home Console

Please indicate the top four factors you consider when purchasing a game. Mark each with the order of importance – put a 1 by the most important factor, a 2 by the second most important factor, etc.

Factor	Importance
Platform	
Genre	
Price	
Playtime (Length of game)	
Graphics	
Controls	
3rd party ratings	
Friend's / Peer's opinions	
Publisher / Developer	
Storyline	

How many hours a week (on average) do you spend playing video games? ____________

How many different racing games have you played? ____________

If you were to buy this game (Need for Speed: Underground), what platform would you buy it for and why?

Appendix B. Survey Responses

B.1 Pre-survey results:

Subject	Age	Gender	Major	Year of graduation	Played NFSU	Self-rated skill with racing games
1	18	M	IMGD/CS	2010	no	3
2	21	M	CS	2007	no	3
3	28	M	IMGD	Graduated	no	2
4	23	M	CS	2005	no	2
5	20	M	ECE	2008	no	2
6	26	M	CS	2003	no	1
7	23	M	IMGD	2008	yes	3
8	18	M	CS	2010	no	2
9	20	M	IMGD	2008	yes	2
10	20	M	IMGD/CS	2008	no	1
11	21	M	MAC	2008	yes	3
12	19	M	IMGD	2009	no	3
13	21	F	BME	2008	yes	1
14	22	M	CE	2007	no	1
15	19	F	BC	2009	yes	1
16	22	M	ME	2007	no	4
17	22	M	MIS	2007	yes	4
18	18	M	CHE	2010	yes	3
19	19	F	BB	2009	no	3
20	20	M	IMGD/CS	2008	yes	4
21	22	M	ME/TC	2007	yes	4
22	20	F	PH	2008	no	2
23	19	M	ECE	2010	no	3
24	20	M	ME	2008	no	3
25	22	M	ME	2007	no	4
26	20	F	BB	2009	no	5
27	19	F	BB	2009	no	1
28	18	M	IMGD	2010	yes	4
29	21	M	MAC	2007	yes	4
30	19	F	BC	2010	no	1
31	21	M	CS	2008	no	2
32	21	F	MIS	2008	no	3
33	18	M	CE	2011	yes	3
34	20	M	BME	2008	no	3
35	20	F	BB	2008	no	1
36	20	M	PH	2008	no	1

B.2 Post-survey results

subject	Mostly likely platform to buy		Rated Effectiveness			Rated ease of learning			Experience with interface	
	games	racing games	pc	pc w/ g	ps2	pc	pc w/ g	ps2	gamepad	keyboard
1	PC	HC	4	3	2	5	4	4	4	5
2	HC	HC	4	5	5	4	4	4	5	5
3	HC	HC	2	4	5	5	5	5	5	5
4	PC	PC	4	3	3	4	3	3	2	5
5	PC	HC	3	5	5	4	5	5	3	5
6	PC	HC	2	4	5	5	5	5	4	2
7	HC	HC	3	4	5	5	5	5	5	5
8	HC	HC	2	4	5	5	4	4	5	5
9	PC	PC	4	4	4	3	3	3	2	4
10	PC	HC	2	3	4	5	5	5	4	5
11	HC	HC	2	4	4	5	5	5	5	5
12	HC	HC	4	5	5	5	5	5	5	3
13	PC	PC	1	1	1	4	4	4	1	1
14	PC	HC	5	4	2	5	5	5	4	4
15	HC	HC	2	4	4	5	5	5	5	3
16	HC	HC	2	3	4	2	4	5	5	2
17	HC	HC	2	4	5	3	5	5	5	2
18	PC	HC	2	4	5	4	3	3	3	2
19	HC	HC	2	4	4	4	4	4	5	2
20	PC	HC	2	5	4	1	1	1	4	5
21	HC	HC	2	4	4	3	5	5	4	1
22	HC	HC	5	4	5	5	4	5	5	4
23	HC	HC	4	3	5	4	5	5	5	3
24	PC	HC	4	2	4	3	4	4	4	5
25	HC	HC	2	4	5	5	5	5	5	5
26	HC	HC	3	5	5	5	5	5	3	1
27	PC	PC	3	4	5	5	3	3	2	1
28	HC	HC	3	2	5	5	5	5	5	3
29	HC	HC	4	4	5	4	5	5	5	3
30	HC	HC	4	3	3	5	4	4	2	1
31	PC	HC	2	4	4	3	4	4	5	5
32	HC	HC	2	4	5	3	5	5	5	1
33	HC	HC	3	5	5	5	5	5	5	1
34	HC	HC	5	3	4	5	4	4	5	2
35	HC	HC	3	2	4	4	3	4	5	1
36	PC	PC	4	2	5	5	3	3	3	5

B.3 Post-Survey Written Responses

If you were to buy this game (Need for Speed Underground), what platform would you buy it for and why (it is available on PC, Playstation 2, and Xbox)?

1. PC, because I am more familiar with the keyboard, I'd prefer using a computer screen, and online play isn't as costly.

2. Playstation 2, since I am most familiar with its controls for a racing game.

3. PS2, since I own one, and because of improved game control and graphics.

4. PC, as I don't have any consoles.

5. Xbox, racing games are better on consoles. I prefer the Xbox controller to the PS2 controller.

6. PS2, because I hate playing games that require quick reflexes on a PC, though I would have to play in my friend's PC.

7. PS2, I have that at home.

8. PS2, best controller.

9. PC, I have one.

10. PS2, it's a PS2 game, runs more smoothly, more natural with a controller and usually looks better.

11. PS2, because of the controls.

12. PS2

13. (no response)

14. Xbox

15. PS2, mostly because I am most used to those controls.

16. Xbox, the configuration seems to be the best.

17. PS2, because I don't like playing racing games or sports game on the PC.

18. PS2, my brother owns a PS2 and I wouldn't buy a whole other Xbox for the game. Plus, playing this game is less fun on the PC than a system like PS2.

19. Xbox, because I won an Xbox and I like using the analog stick (It's better for control) more than the keyboard.

20. PS2, better controls.

21. PS2, I don't play many, if any, PC games and I don't own an Xbox/Wii/etc console.

22. PS2, I usually play consoles and don't have an Xbox.

23. Playstation 2

24. PS2

25. Any console

26. Playstaion 2, I like the controls better.

27. PC

28. Playstation 2, because that's the system I already have. I prefer using the gamepad, and a gamepad plugged into a PC via a USB port is less responsive than plugged directly into a PS2.

29. PS2, because most of my friends and I have it.

30. PS2, because I have a PS2 and once I got used to the controller, it was easier than the keyboard for PC.

31. PC, because I don't have a tv for my Xbox/free *wink*/better graphics.

32. Xbox, because I have one and my computer sucks.

33. Xbox

34. PS2, I don't play racing games on PC and I don't have an Xbox.

35. I probably wouldn't buy it unless Nintendo made it because it's the only platform I will use.

36. PC, I don't own or use consoles.

Appendix C. Race Results

ID	Platform	Lap 1		Lap 2		Lap 3		Total Time	Time Behind	best lap time	top speed	mean speed	distance	laps led	avg. lap time	iter-ation
		time	rank	time	ran k	time	rank									
1	PS2	84.06	2	66.91	2	78.79	2	230.76	18.73	66.91	136.65	91.05	5.89	0	76.59	1
1	PCWC	82.51	2	71.36	2	67	2	220.87	24.09	67	136.31	95.46	5.86	0	73.62	2
1	PC	87.90	2	81.77	2	71.25	2	240.92	17.89	71.25	129.27	87.81	5.84	0	80.31	3
2	PS2	82.11	1	77.06	1	63.86	1	223.03	-	63.86	130.35	92.17	5.75	3	74.34	3
2	PCWC	80.27	1	68.89	1	62.87	1	212.03	-	62.87	135.04	97.21	5.76	3	70.68	1
2	PC	70.70	1	65.56	1	60.52	1	196.78	-	60.52	133.54	102.44	5.64	3	65.59	2
3	PS2	90.07	3	97.22	3	NA	3	226.8	timeup	90.07	132.97	78.74	5.02	0	93.65	2
3	PCWC	96.09	3	77.23	3	74.27	3	247.61	24.56	74.27	135.73	84.56	5.85	0	82.53	3
3	PC	102.73	3	112.9	3	NA	3	242.05	timeup	102.73	126.51	66.42	4.48	0	107.86	1
4	PS2	84.82	2	93.64	2	NA	2	245.71	timeup	84.52	127.63	79.93	5.47	0	89.23	1
4	PCWC	81.61	3	67.37	3	70.68	1	219.66	-	67.37	130.29	96.12	5.87	1	73.22	2
4	PC	78.74	3	65.23	2	63.73	2	207.75	11.9	63.73	132.55	100.64	5.85	0	69.23	3
5	PS2	67.69	1	65.35	1	62.81	1	195.85	-	62.81	137.44	107.83	5.93	3	65.28	3
5	PCWC	84.69	1	67.16	1	63.85	1	215.7	-	63.85	135.75	97.17	5.84	3	71.90	1
5	PC	71.11	1	77.10	2	77.37	3	225.58	5.92	71.11	134.51	94.09	5.9	1	75.19	2
6	PS2	74.96	2	73.16	1	76.51	2	224.63	4.97	73.16	129.48	94.02	5.91	1	74.88	2
6	PCWC	71.45	2	75.20	3	64.06	3	210.71	14.86	64.06	136.97	100.61	5.88	0	70.24	3
6	PC	114.26	3	86.67	3	NA	3	245.73	-	86.67	124.49	67.35	4.6	0	100.47	1
7	PS2	70.95	1	75.39	2	64.14	1	210.48	-	64.14	136.71	96.83	5.71	2	70.16	3
7	PCWC	64.10	1	94.91	3	68.29	2	227.3	7.34	64.1	129.95	92.06	5.85	1	75.77	1
7	PC	83.48	3	75.90	3	NA	3	239.88	timeup	75.92	133.12	85.61	5.69	0	79.69	2
8	PS2	74.10	2	77.19	2	NA	1	219.96	-	68.67	137.5	94.34	5.82	1	75.65	1
8	PCWC	71.07	1	74.18	1	64.62	1	209.87	-	64.62	137.34	97.95	5.71	3	69.96	2
8	PC	80.56	3	71.75	3	69.1	3	221.41	10.93	69.1	131.36	92.75	5.74	0	73.80	3
9	PS2	78.76	2	68.42	2	73.27	2	220.47	10.6	68.42	128.88	92.67	5.74	0	73.48	2
9	PCWC	71.25	2	72.65	1	74.63	2	218.53	8.05	71.25	137.58	94.99	5.8	1	72.84	3
9	PC	81.79	3	66.49	1	NA	3	249.96	timeup	66.49	135.07	82.48	5.75	1	74.14	1
10	PS2	90.62	3	77.41	2	NA	2	226.83	timeup	77.41	130.28	88.07	5.63	0	84.02	1
10	PCWC	83.25	2	74.31	2	70.14	2	227.7	13.12	70.14	137.89	91.56	5.8	0	75.90	2
10	PC	74.91	2	71.67	2	76.24	2	222.84	24.31	71.69	132.22	91.84	5.73	0	74.27	3

ID	Platform	Lap 1		Lap 2		Lap 3		Total Time	Time Behind	best lap time	top speed	mean speed	distance	laps led	avg. lap time	iter-ation
		time	rank	time	ran k	time	rank									
11	PS2	67.76	1	69.91	1	60.86	1	198.56	-	60.86	138.07	102.52	5.72	3	66.18	3
11	PCWC	73.06	1	62.56	1	61.19	1	196.81	-	61.19	138.19	103.94	5.66	3	65.60	1
11	PC	81.01	1	66.60	1	66.97	1	214.52	-	66.6	139.6	94.39	5.66	3	71.53	2
12	PS2	96.71	3	83.87	3	NA	3	244.6	timeup	83.87	130.34	78.19	5.35	0	90.29	2
12	PCWC	86.97	3	67.28	3	73.32	3	228.51	29.54	67.78	134.37	89.79	5.72	0	75.86	3
12	PC	91.50	3	95.24	3	NA	3	226.83	timeup	91.5	133.96	74.36	4.69	0	93.37	1
13	PS2	223.73	3	NA	3	NA	3	273.45	timeup	223.73	91.2	35.65	2.74	0	223.73	1
13	PCWC	109.08	3	103.7	3	NA	3	240.97	timeup	103.68	126.71	66.41	4.46	0	106.38	2
13	PC	116.33	3	NA	3	NA	3	241.7	timeup	116.33	129.56	54.71	3.7	0	116.33	3
14	PS2	75.72	2	70.16	2	88.93	2	234.81	23.14	70.16	134.91	89.25	5.81	0	78.27	3
14	PCWC	77.81	1	76.46	1	89.74	1	243.55	-	76.4	130.18	86.28	5.86	3	81.34	1
14	PC	76.59	1	70.36	1	64.02	1	210.97	-	64.02	136.99	99.17	5.85	3	70.32	2
15	PS2	82.11	2	74.29	2	67.63	2	224.03	13.06	67.63	130.15	94.43	5.94	0	74.68	2
15	PCWC	73.79	1	65.34	1	72.54	1	211.67	-	65.34	138.2	100.19	5.93	3	70.56	3
15	PC	82.52	2	88.08	2	86.29	2	256.45	13.34	82.52	130.78	62.35	5.9	0	85.63	1
16	PS2	86.28	2	75.83	1	67	1	229.11	-	67	129.1	92.07	5.91	2	76.37	1
16	PCWC	74.91	2	64.78	2	64.34	2	204.03	11.03	64.34	137.21	103.9	5.91	0	68.01	2
16	PC	78.52	3	77.10	3	NA	3	232.22	timeup	77.1	136.16	89.46	5.72	0	77.81	3
17	PS2	73.88	2	73.89	2	70.17	2	217.94	15.75	70.17	129.99	93.81	5.73	0	72.65	3
17	PCWC	91.58	3	73.24	3	71.19	3	236.01	6.9	71.19	132.16	88.55	5.6	0	78.67	1
17	PC	88.63	3	74.82	3	NA	3	223.03	timeup	74.82	134.34	89.74	5.6	0	81.73	2
18	PS2	66.68	1	62.68	1	63.64	1	193	-	62.68	137.26	108.56	5.89	3	64.33	2
18	PCWC	65.87	1	62.08	1	74.24	1	202.19	-	62.06	137.55	102.4	5.79	3	67.40	3
18	PC	79.87	1	84.23	2	67.98	2	232.06	2.97	67.98	134.92	90.13	5.83	1	77.36	1
19	PS2	79.39	3	75.61	2	85	3	240	24.52	75.61	136.76	86.51	5.78	0	80.00	2
19	PCWC	71.55	2	74.26	3	60.14	2	205.95	16.34	60.14	137.09	101.99	5.85	0	68.65	3
19	PC	77.30	2	107.3	3	NA	3	234.16	timeup	77.3	132.61	83.12	5.43	0	92.30	1
20	PS2	68.10	1	58.32	1	63.19	1	189.61	-	58.32	136.95	106.57	5.67	3	63.20	3
20	PCWC	70.57	1	67.04	1	66.54	1	204.15	-	66.54	135.88	99.26	5.6	3	68.05	1
20	PC	77.99	2	63.05	1	74.44	1	215.48	-	63.05	135.87	94.59	5.7	2	71.83	2
21	PS2	81.24	3	65.69	2	81.41	2	228.34	24.19	65.69	130.83	91.45	5.85	0	76.11	1
21	PCWC	76.55	1	78.87	3	67.38	2	223.8	8.32	67.38	135.91	92.68	5.8	1	74.27	2

ID	Platform	Lap 1		Lap 2		Lap 3		Total Time	Time Behind	best lap time	top speed	mean speed	distance	laps led	avg. lap time	iter-ation
		time	rank	time	ran k	time	rank									
21	PC	77.53	3	67.77	2	NA	3	219.61	timeup	67.77	136.16	93.97	5.77	0	72.65	3
22	PS2	112.18	3	81.39	3	NA	3	245.58	timeup	81.39	117.75	75.14	5.21	0	96.79	1
22	PCWC	87.50	3	78.15	3	NA	3	241.81	timeup	78.15	127.3	86.44	5.84	0	82.83	2
22	PC	84.67	3	132.9	3	NA	3	241.81	timeup	84.67	129.2	64.61	4.45	0	108.80	3
23	PS2	72.17	1	83.91	2	63.28	1	219.36	-	63.28	136.16	93.82	5.77	2	73.12	3
23	PCWC	70.44	1	71.97	1	84.97	2	226.8	11.22	70.44	138.1	92.5	5.86	2	75.79	1
23	PC	77.31	2	67.47	1	67.03	1	211.81	-	67.03	131.56	98.27	5.8	2	70.60	2
24	PS2	76.11	1	79.80	2	75.87	2	231.78	19.97	75.87	129.26	88.22	5.71	1	77.26	2
24	PCWC	78.89	2	70.11	1	85.58	2	234.58	15.22	70.11	132.17	87.78	5.76	1	78.19	3
24	PC	76.54	2	71.25	2	67.79	1	215.58	-	67.79	130.1	96.84	5.84	1	71.86	1
25	PS2	83.06	1	64.14	1	77.2	1	224.4	-	64.14	134.15	92.77	5.82	3	74.80	1
25	PCWC	74.79	1	61.12	1	62.36	1	198.27	-	61.12	136.51	103.13	5.68	3	66.09	2
25	PC	70.88	2	73.94	1	72.07	1	216.89	-	70.88	136.01	97.08	5.87	2	72.30	3
26	PS2	113.38	3	107.3	3	NA	3	228.27	timeup	113.38	128.68	61.35	3.89	0	110.37	2
26	PCWC	70.82	1	83.37	2	80.65	2	234.84	23.95	70.82	133.62	87.49	5.95	1	78.28	3
26	PC	122.01	2	NA	3	NA	3	254.4	timeup	122.01	127.08	50.94	3.63	0	122.01	1
27	PS2	99.31	3	115.5	3	NA	3	246.89	timeup	99.31	133.87	66.29	4.61	0	107.45	3
27	PCWC	127.83	3	101.4	2	NA	3	254.4	timeup	101.43	108.97	59.85	4.22	0	114.63	1
27	PC	105.04	2	90.27	2	NA	2	228.27	timeup	105.04	122.17	71.75	4.55	0	97.66	2
28	PS2	89.87	1	91.65	2	66.6	2	248.12	2.91	66.6	130.33	85.03	5.91	1	82.71	1
28	PCWC	100.49	3	76.12	2	NA	3	238.21	timeup	76.12	131.37	80.96	5.37	0	88.31	2
28	PC	72.45	2	75.14	2	80.06	2	227.65	15.76	72.45	134.84	88.66	5.64	0	75.88	3
29	PS2	79.07	1	65.23	1	63.89	1	208.19	-	63.89	137.79	100.33	5.85	3	69.40	2
29	PCWC	68.41	1	68.97	1	74.49	1	211.87	-	68.41	137.66	99.88	5.89	3	70.62	3
29	PC	92.25	2	75.56	1	77.9	1	245.21	-	75.56	131.63	86.26	5.9	2	81.90	1
30	PS2	86.73	3	86.05	3	NA	3	241.89	timeup	86.05	128.36	65.01	5.81	0	86.39	3
30	PCWC	124.11	3	86.49	3	NA	3	275.21	timeup	86.49	130.01	71.17	5.46	0	105.30	1
30	PC	79.96	2	98.30	3	NA	2	238.19	timeup	79.96	135.77	78.51	5.18	0	89.13	2
31	PS2	70.46	1	74.96	2	NA	2	223.76	20	70.46	131.91	93.27	5.83	1	72.71	2
31	PCWC	92.84	2	71.44	2	NA	2	210.29	timeup	71.44	130.39	84.29	4.94	0	82.14	3
31	PC	86.26	3	87.04	2	NA	3	231.08	timeup	86.26	131.6	84.48	5.44	0	86.65	1
32	PS2	85.52	2	87.95	3	NA	2	231.06	timeup	85.52	133.04	81.92	5.3	0	86.74	1

ID	Platform	Lap 1		Lap 2		Lap 3		Total Time	Time Behind	best lap time	top speed	mean speed	distance	laps led	avg. lap time	iter-ation
		time	rank	time	rank	time	rank									
32	PCWC	104.10	3	81.48	3	NA	3	233.77	timeup	81.48	136.54	77.41	5.03	0	92.79	2
32	PC	100.79	3	83.47	3	NA	3	210.31	timeup	83.47	134.52	80.81	4.74	0	92.13	3
33	PS2	63.60	1	59.29	1	57.4	1	180.29	-	57.4	142.1	115.1	5.83	3	60.10	3
33	PCWC	77.52	1	62.17	1	61.36	1	201.05	-	61.36	138.44	104.23	5.86	3	67.02	1
33	PC	70.79	2	69.30	1	63.67	1	203.76	-	63.67	135.44	101.86	5.79	2	67.92	2
34	PS2	70.79	1	67.19	1	70.08	1	208.06	-	67.19	136.39	101.68	5.92	3	69.35	3
34	PCWC	80.51	2	75.98	2	75.82	2	232.31	2.87	75.82	134.88	92.59	5.98	0	77.44	1
34	PC	85.46	2	68.14	1	78.47	1	232.07	-	68.14	132.14	91.48	5.84	2	77.36	2
35	PS2	75.49	1	86.75	3	67.2	1	229.44	-	67.2	133.44	92.21	5.94	2	76.48	1
35	PCWC	89.79	3	84.73	3	69.53	3	244.05	11.98	69.53	142.9	88.8	6.04	0	81.35	2
35	PC	78.08	2	76.97	2	65.99	2	221.04	12.98	65.99	133.05	96.27	5.93	0	73.68	3
36	PS2	83.51	1	76.33	2	78.45	2	238.29	6.22	76.33	131.25	89.01	5.92	1	79.43	2
36	PCWC	92.99	3	104.3	3	NA	3	238.09	timeup	92.99	137.05	78.26	5.21	0	98.65	3
36	PC	83.32	3	72.24	1	84.52	3	240.08	10.64	72.24	131.13	88.36	5.9	1	80.03	1

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