Comparing Traditional Video Game Controls with Eye Tracking Controls

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Acknowledgements

I owe a big thank you to Dr. Katherine Robinson for the opportunity to work on such a fun and interesting project in the IMPACT Lab. Your advice, encouragement and patience made this paper possible. I would also like to thank Patrick Larsen for his excellent coding work with the eye trackers.
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Abstract

Videogame controllers have retained their general, two-handed shape for nearly 40 years. While this basic controller form works well for a lot of people, it is not inclusive or accessible for everyone. Those whose needs are not met by the standard two-hand controller are offered expensive alternatives that are simple adaptations of the current control scheme. A change in controller form, from the basic two-handed controller to a design that works on a different principle may open the door to a more accessible world of gaming. One such alternative is eye tracking, the use of eye movement to manipulate electronic devices. The present study examined whether those unfamiliar with eye trackers could use them to play a simple video game, and if it was enjoyable to do so. By having participants play through a videogame with both an eye tracker and an Xbox controller, this study determined that while participants are not as efficient at playing video games with an eye tracker over more traditional control methods, they can be successful and there is some evidence that this may be a more enjoyable way to play videogames.
Comparing Traditional Video Game Controls with Eye Tracking Controls

The current design of the standard videogame controller can be traced to Nintendo’s introduction of the Famicom videogame console in 1983 (Margel, 2015). This controller was a single piece of plastic, had buttons on its face and required players to hold it with and use both hands in unison to play a videogame. This controller layout has changed remarkably little since 1983, especially when compared with the development of software and other pieces of videogame hardware that has taken place since. Aside from minor differentiation in shape and ergonomics between brands, and minor tweaks like the addition of joysticks and more buttons, contemporary controllers would not feel out of place in the hands of a time traveler from 1983.

This stability in design may reflect a design choice that was effective for use by a large segment of the public. The current number of people who play video games can be taken as evidence for this. An industry study found that 23.6 million Canadians play some form of videogame (Entertainment Software Association of Canada, 2018). The economics of video gaming also bears this out; with videogame revenue in North America reaching 33.94 billion dollars in 2018 (Newzoo, 2019). This enthusiasm to play and pay for games that rely on the two-handed controller design shows that it works well enough for enough people to not force the video game industry to radically change its design. The only major videogame company to radically shift away from this two-handed design was Nintendo after its traditionally controlled GameCube console failed commercially, costing the company over a billion dollars (Kim et al., 2011).

Console manufacturers also retain their specific controller designs for less apparent reasons. Videogame scholar David Parisi (2015) notes that Microsoft spent approximately 100 million dollars to create a new controller for the Xbox One. Experimental designs for the
controller update included non-standard controller design features such as cameras, projectors, built-in displays, and even an olfactory module (Santos, 2013). Despite the huge investment Microsoft settled with a controller design nearly identical to that of its precursor the Xbox 360. The decision to retain the Xbox controller design was made not for performance reasons but based on “ergonomic branding” (Parisi, 2015). Ergonomic branding is the idea that users develop an association between the physical experience of using a specific device and its manufacturer much the way they would with a visual brand marker. Moving away from the Xbox version of the basic controller led testers to feel like they were having an experience that did not reflect what they thought playing an Xbox should feel like.

This “should” is important because of who it comes from. Microsoft chose to work with what it described as “core” players to test the experimental controller designs (Santos, 2013). These players were chosen because they were very proficient at what Microsoft consider its main game genre – first person shooters. Playing first person shooters competitively requires users who have the ability to use a two-handed controller very efficiently. Basing controller design on the feedback of people who are best served by an existing system is an excellent way to strengthen that system for that specific sample. However, not including input from people for whom the existing design does not work well guarantees that nothing will be done to change this.

There is no good estimate on the number of people for whom the two-handed controller does not work well. However, anyone with affected fine-motor control in at least one of their hands will have difficulty with a two-handed controller. Full or partial paralysis of one or both hands, a lack of fingers or hands, or conditions that effect smooth movement of the fingers or wrists could all impact the use of a two-handed controller. Conditions that make taking or
maintaining a sitting posture difficult may also make the use of a two-handed controller impractical.

There are commercially available alternatives to the basic controller. The most common of these is the keyboard and mouse, which is often associated with computer gaming but can also be used for some games on gaming consoles. Games on cellphones and tablets use touch screens instead of buttons and joysticks. There are also motion controlled videogames that function by having the player make bodily movements which are then translated into game controls. Each of these methods have their own strengths and drawbacks. The mouse and keyboard combination has flexibility in that games can often be configured to use a keymapping which is convenient for the user. However, keyboards still require at least some use of both hands. Touch screen devices can often be controlled with one hand; however, they provide less tactile feedback than controllers or keyboards do. Motion control offers some solution to a lack of fine motor control by trading it for gross motor control. This, however, is only practical for users with good gross motor control abilities.

These options provide some alternatives to the basic controller setup and may make video games generally more accessible. For those whose needs are not accommodated by these mainstream alternatives, there are some further options available. Custom setups can be created to augment or replace a controller. These can make use of whatever is convenient for the user, such as arm, head or even tongue movement to substitute for specific functions that would be carried out by a finger on a basic controller (Vickers, et al., 2013). Setups like this can be useful but have two main drawbacks. The first is that they are often expensive and can require professional installation. The second problem is that, while they may account for the physical problems that controllers may create for players, they often create secondary problems with the
user interface of games. Users of these setups report that they often have trouble navigating menus to configure the game they are trying to play (Bates et al., 2010).

The difficulty of making videogames accessible stems from the fixation on the basic two-handed controller design. Modifications to increase videogame accessibility are built around finding ways for players to control videogames using proxies of this design. What may be necessary to make videogames truly universally accessible is to not focus on more and more differentiated adaptations of this one design and look at all the other options available for controlling videogames. This study will look at eye trackers as one possible option for video game control.

Eye trackers are devices that measure the movement of a subject’s irises and historically they have taken a variety of forms. Lupu and Ungureanu’s (2013) survey of eye tracking methods argues that the first eye tracking experiment took place in 1879 and used mirrors that allowed the experimenter to observe the eye movements of participants as they were reading. This method was followed by a century of invasive eye tracking techniques that often involved contact lens-like apparatuses, and heavy, head-mounted setups. The availability of personal computers in the 1980s led to less invasive systems based around the use of cameras to track iris movement. Modern eye trackers use infrared cameras paired with sophisticated algorithms to follow and log eye movement in real time. This has been very useful for studying where and for how long users look at text, photos, or three-dimensional objects.

Camera-based eye tracking offers a feature that its predecessors did not. Because modern eye tracker data is processed in real time it allows for users to interact with a computer using eye movement (Lupu & Ungureanu, 2013). This is promising because it offers a way to directly interact with a computer that is completely independent of fine and gross motor skills in the
hands, arms, and torso. The obstacle to using eye tracking as a videogame control method until now has been two-fold. Camera-based eye trackers have only had the benefit of high-quality eye detection algorithms for the past decade (Lupu & Ungureanu, 2013). Prior to this, the use of an eye tracker required specialized training in its setup and use. Older eye trackers also allowed the user very little movement because devices relied on the user’s head remaining stationary to properly track eye movement. Modern software allows eye trackers to keep a lock on a user’s eyes despite reasonable head movement. This makes eye trackers comfortable to use and means they do not need specialized training to properly set up. The other barrier to eye tracker use was cost. However, circa 2010 eye tracking devices began to enter the market at a price point that gaming enthusiasts were willing to pay (Corcoran et al., 2012). Initially these were used as supplementary controls to mouse and keyboard setups and provided extra utility to players who were not served well by a keyboard and mouse alone (Vickers et al., 2013). This study will move beyond using eye trackers as supplementary videogame controls and explore the possibility of using eye trackers as standalone controllers.

There are two hypotheses that need to be tested to determine if eye tracking is viable as a sole video game control method. The first hypothesis is that users will perform less effectively while using eye trackers than they will when using a traditional style controller, but that eye tracker usability will still be rated reasonably by participants. This difference in performance at this stage of research in the field is justified because traditional video game controllers are very common, and many participants will have developed significant expertise with them, while having little to no experience with an eye tracker.

The second hypothesis is that participants will have more fun playing the game with an eye tracker than they will with a traditional controller. Following from the previous hypothesis
this may seem counterintuitive. The simplest assumption to make is that the easier controller to use will be the most fun to play with. However, this assumption ignores the main motive behind playing videogames. Birk and Mandryk (2013) explain that videogames differ from other software in that obstacles are intentionally placed between users and their goal. In a good videogame this addition of a challenge is what attracts and then engages players.

Methods

Participants

This study consisted of 81 psychology students recruited via the University of Regina Department of Psychology participant pool. Participants scheduled themselves to be tested by selecting a one-hour block of their choice on the participant pool website. Participants who attended their appointment and signed a consent form (Appendix A) received a bonus credit as per the participant pool policies (https://www.uregina.ca/arts/psychology/research-participants.html). Participants were excluded from this study if they did not have natural or corrected to average eyesight. There were no other exclusion criteria for this study.

All procedures in this study were approved by the University of Regina’s Research Ethics Board. The testing took place at Innovation Place at the University of Regina in the IMPACT lab (University of Regina, Saskatchewan). For the purposes of this study each participant made one visit to the IMPACT lab.

Materials

A videogame was developed for the purpose of this study. The videogame consisted of the participant guiding a character through a two-dimensional level from a starting point to an end point (see Figure 1). The player must traverse vertical obstacles by jumping over them, and avoid hazards such as stationary spikes, and monsters that move from side to side. A single
contact with the spikes or three contacts with a monster ends the player’s current attempt of that level and begins a new attempt of the same level. For the purposes of this study the videogame was composed of three levels, each with varied obstacles and hazards. Players were also given a tutorial level to familiarize themselves with the controls.

**Figure 1**

*The videogame used in the present study*

The videogame can be controlled by two methods. One method has the player use a videogame controller. In this study an Xbox controller was used (see Figure 2), but any videogame controller or even a keyboard can be used as a controller. The horizontal movement of the videogame character is determined by the player manipulating the controller’s joystick in the horizontal plane. Vertical movement (jumping) is initiated when the player presses a button. Pressing the button on its own will initiate a purely vertical jump. Pressing the button in conjunction with horizontal movement will cause the videogame character to move in a diagonal arc. Jumping into a wall, and then pressing the jump button while making contact with the wall will cause the character to jump upwards and away from the wall.

**Figure 2**

*An Xbox controller*
The other control method for the videogame is via eye tracking. For this study a Tobii 4c eye tracker was used (see Figure 3). This device sat on the laptop used in the study directly below the laptop’s screen. The eye tracker functions by using infrared light to track the motion of the player’s irises to gauge where the player is looking. In the videogame a small yellow dot appears on the screen where the player looks. The videogame character is controlled by the player directing their sight. Horizontal movement of the character is controlled by the player looking left or right of the character on the screen. The character then moves toward the yellow dot. To make the character jump, the player simply raises the yellow dot above the character’s head by looking at a point above the character on the screen. As with the Xbox controller, the character can jump vertically, or diagonally when the vertical motion is combined with horizontal motion. The character will “stick” to a wall when it makes contact with one via jumping. The player can then cause the character to jump up and away from the wall by raising the yellow dot above the line of the character’s head.

Figure 3

A Tobii 4c eye tracker

In both control methods, players automatically began the first stage after having three minutes to familiarize themselves with the controls in the trial stage. Players progressed through the stages by reaching a clearly marked exit point for each stage. The videogame is designed to
log the amount of attempts a player takes on each stage, the time they take on each stage, and the player’s total time taken to complete all three stages. The three minutes the participants are given in the tutorial stage are not included in this total.

**Procedure**

This study consisted of participants taking part in two conditions. In condition A participants played the video game with an Xbox controller. In condition B participants played the video game using an eye tracker. Before participants began condition B, they were run through the brief calibration procedure for the eye tracker. To control for order effects, participants were randomly assigned to one of two groups. Group one participated in condition A first, and then B. Group two participated in condition B and then A. Both groups completed a consent form (Appendix A) before and the demographic survey (Appendix B) before beginning the first condition of their group. Participants then completed the first condition of their group. Between conditions participants in each group completed the System Usability Scale (SUS) (Appendix C) and an Enjoyability Scale (ES) (Appendix D) to gauge subjective participant impressions of enjoyability of the condition. Participants then completed the second condition of their group. After the second conditions participants completed a second set of the SUS and Enjoyability Scale, as well as an exit questionnaire (Appendix E).

**Measures**

This study collected objective data about participant performance. The attempts needed to complete each stage, and the time taken to complete each stage were logged. Each condition’s total duration was also logged. The mean of each of these scores was calculated for each condition. Participants completed the System Usability Scale (SUS) after completing each condition. The SUS is comprised of 10 Likert scale items and is used to rate the subjective
usability of a piece of software (Peres, Pham, & Philips 2013). To assess the subjective level of enjoyment each condition provided, participants were also be asked to answer five questions via Likert scales relating to fun, engagement, and perceived challenge afforded by each condition.

Participants were also asked to complete a demographic questionnaire. This detailed each participant’s age, gender, favourite video game genre, time spent per week playing video games, age when participant began playing video games, favourite gaming system, and whether the participant had used eye trackers or virtual reality headsets to play videogames with before. The questionnaire determined if the participant used any method of vision correction and if they had a physical or neurological condition. Participants also completed an exit questionnaire with questions asking if they preferred one condition over the other for aspects of gaming such as ease of use, naturalness, immersion and fun. Participants were also asked if the eye tracker added something to the game that the Xbox controller did not, if the participant felt practice would improve their ability with the eye tracker, and if they would like to use eye trackers to play videogames in the future.

Results

Participant Information

The sample in this study consisted of 52 women and 29 men aged 18 to 39 ($M = 21.75$, $SD = 4.36$). Only one participant had used an eye tracking device prior to the study. In addition to this, 26 participants had used a virtual reality headset to play a video game at least once. Most participants used some form of vision correction with 43 participants using glasses or contacts during the study and another 12 participants had their vision corrected by other means (i.e. surgery). No participants disclosed a serious physical or neurological disability. Study participants played between zero to 22.5 hours of video games per week ($M = 2.88$, $SD = 4.7$).
Comparison of Control Method Performance

It was hypothesized that participant performance would be significantly worse in the eye tracker condition relative to the XBox condition. Participants in the XBox condition ($N = 79$ due to one participant withdrawing, and one software issue causing data for one participant not to be logged) averaged 114.43 seconds over 9.43 attempts to complete the condition. Participants ($N = 76$ and 77 for total time and total attempts respectively due to one participant withdrawal and a software error omitting participant information) averaged 588.6 seconds over 34.64 attempts to complete the eye tracker condition.

An analysis of variance showed that the eye tracker condition took significantly more time than the XBox condition to complete, $F(1, 153) = 69.07$, $p = .01$, $\eta^2 = .31$. There was also a significant difference in the same direction between the number of attempts needed to complete each condition, $F(1, 154) = 59.38$, $p = .01$, $\eta^2 = .28$. However, this comes with a caveat. Neither tests variances can be assumed to be homogeneous ($p = .01$ in both cases). Additionally, as each test is skewed towards the lower end of the distribution (Welch tests for both time and attempts are significant, $p = .01$), a paired-samples t-test was also performed.

The paired-samples t-test indicated that significantly more time was needed to complete the condition ($M = 588.6, SD = 482.88$) than for the XBox condition ($M = 113.53, SD = 154.37$), $t(75) = 8.76$, $p < .01$, $d = 1.33$. The same test performed for the number of attempts needed to complete each condition also indicated that the eye tracker took significantly more attempts ($M = 34.64, SD = 26.93$) than for the XBox condition $M = 9.44, SD = 10.96$, $t(76) = 8.34$, $p < .01$, $d = .94$.

Eye tracker total attempts per condition and XBox total attempts per condition were correlated, Pearson’s $r(77) = .24$, $p < .034$. Eye tracker total time per condition was also
correlated with Xbox total attempts per conditions, Pearson’s $r(76) = .30, p < .009$. Being a male participant and Xbox total time per condition was correlated, Pearson’s $r(79) = -.236, p < .036$. Being male and Xbox total attempts per condition was also correlated, Pearson’s $r(79) = -.253, p < .025$. There were no correlations between gender and total time or total attempts for the eye tracker condition. Participant age did not correlate with total time or attempts in either condition. Wearing glasses was not correlated with either category of performance for the eye tracker, however total time in the Xbox condition and wearing glasses was correlated, Pearson’s $r(76) = - .239, p < .034$.

**Participant Perceptions of Usability**

A paired samples t-test of the SUS scores indicated Xbox usability scores ($M = 84.97, SD = 15.57$) were significantly higher than eye tracker usability scores ($M = 53.92, SD = 17.25$), $t(78) = 11.89, p < .001, d = 1.89$. Xbox SUS scores and Xbox total time per condition were correlated, Pearson’s $r(79) = -.64, p < .001$. Xbox SUS scores and Xbox total attempts per condition were also correlated, Pearson’s $r(79) = -.67, p < .001$. There were no significant correlations between eye tracker SUS scores and eye tracker total attempts per condition or eye tracker total time per condition. Experience with a virtual reality device and eye tracker SUS scores were correlated as well, Pearson’s $r(79) = .27, p < .016$.

**Relative Enjoyment of Control Methods**

A paired samples t-test was also performed on the ES scores which indicated that participants rated the eye tracker ($M = 13.51, SD = 2.17$) as significantly more enjoyable than the Xbox controller ($M = 12.87, SD = 2.08$), $t(78) = 2.00, p < .048, d = 0.30$. Eye tracker ES scores were positively correlated with hours per week of video games played, Pearson’s $r(79) = .23, p < .04$. Eye tracker ES scores were also correlated with participants being male, Pearson’s $r(79) =$
.22, \( p < .048 \). Note that hours per week of video game playing and male participants were also correlated, Pearson’s \( r(81) = .30, p < .007 \). There was also a correlation between eye tracker ES scores and Xbox SUS scores, Pearson’s \( r(79) = .325, p < .004 \).

**Discussion**

The first hypothesis, that participants would perform less aptly with the eye tracker than they would with an Xbox, but that the system would still be usable is supported quite strongly by the data. The two objective data points, *total time* and *total attempts*, show that players are much more efficient with the Xbox controller when compared to the eye tracker. The difference in *total time* was especially striking, with participants taking on average just under two minutes to complete the Xbox condition compared to an almost full ten minutes to complete the eye tracker condition. The subjective component of this gauged via the SUS concurred with these results. Participants ranked the usability of the Xbox condition much higher than the eye tracker. However, the mean SUS score given by participants to the eye tracker (\( M = 53.92 \)) ranks in the “OK” category of SUS scores (Bangor, Kortum, & Miller, 2009). This gives support to the second part of this hypothesis that despite a difference in performance the eye tracker would still meet a reasonable standard of usability. Another piece of support for this is the fact that no participants withdrew from the study out of frustration with the eye tracker. The fact that the use of virtual reality devices correlated with higher SUS scores also suggests that experience with non-traditional video game control methods may make eye tracking more accessible to video gamers.

It was interesting to see how performance was linked to the subjective usability of each condition. Specifically, that there were strong correlations between performance in the Xbox condition and SUS scores which was not seen in the eye tracker condition. The fact that wearing
glasses was also correlated with shorter times completing the Xbox condition, but had no relation to time taken to complete the eye tracker condition. On the one hand, it is encouraging to see that the eye tracker technology is not affected by eyeglasses, but on the other the relation between glasses and time in the Xbox condition is puzzling. The correlation between total time and total attempts in each condition was also interesting because it suggests some transferal of video gaming skill between controller methods.

The second hypothesis was that, despite a definite difference in usability between the two controllers, participants would still find the eye tracker the most enjoyable is also supported by the data. While the difference in ES scores between the eye tracker and the Xbox controller is modest it is statistically significant. What is especially striking, is that these scores were consistently higher even after participants took on average five times as long to complete the eye tracker condition. This is a very promising finding and aligns with self-determination theory in that challenge increases rather than decreases video game enjoyability.

The relationship between eye tracker ES scores and Xbox SUS scores may also provide some more support for this. Participants who rated the Xbox as more usable also tended to give the eye tracker higher marks on the ES. One interpretation of this is that as players experience less challenge with the Xbox, they perceive the heightened challenge of using the eye tracker as more fun. The correlation between ES scores and gender with the eye tracker is also interesting as it suggests male participants liked the eye tracker more than female participants. However, male participants also played more video games per week, and thus may have found the eye tracker comparatively more novel than the Xbox.

It is important to remember that these findings are very preliminary. This study consists of only a medium sized sample of university students playing three stages of a videogame
purpose-made for studying eye trackers. However, every area of study needs to begin somewhere, and this is a very encouraging first step in assessing a new modality for playing video games. This may seem like a frivolous pursuit, but it is important to remember that videogames are a very prominent form of entertainment. Furthermore, they have been a form of entertainment that until recently has been left inaccessible to a lot of people.

The Able Gamers charity recently posted an article (Casper, 2019) about how gamers with disabilities often feel left out by games that are intentionally made to be very challenging. These games assume that players can make full use of their controller and are very frustrating if not impossible for video gamers who cannot. As a further insult, when these video gamers take to social media to ask game developers to make game modes that are inclusive of them, they are often shouted down by others who suggest that they are simply not trying hard enough to be as good as the game demands. This is a double blow because, besides a reasonable challenge, video gamers also play video games to feel a sense of autonomy and competence (Ryan et al., 2006). Even needing to ask for a way to play a video game is counter to autonomy and having others question their skill as a video game player is a strike against competence.

Eye tracking may furnish a control method that not only eliminates a video gamer’s barriers to playing a video game, but also levels the field between them and other players. This would give players who have never been able to experience videogames in this way full autonomy in how they play, and also the ability to develop in-game competence to any level to which they are willing to take it. The prospect of people having the opportunity to experience the art form of video games in ways they have not been able to before is very exciting.

Beyond making video games more accessible, there may be some implications for neurological health. In a 2013 experiment, Anguera et al. demonstrated that having elderly adults
play a driving videogame dramatically increased their performance on multi-tasking tests. Another study (Kuhn, Reich, Lorenz, Lindenburger & Gallinat, 2014) found that playing Super Mario (a similar game to the one to be used in this study) induced changes in brain plasticity that could positively affect conditions that damage or diminish the prefrontal cortex and the hippocampus. Having a video game control method that does not rely on the user’s hands in situations where conditions commonly found in elderly populations may affect hand movement (arthritis for example) could possibly open up these benefits to groups who would otherwise miss out on them.

There is one further implication of being able to use an eye tracker to play video games. Videogames have a history of gently teaching users how to use new technology. Microsoft Solitaire and Minesweeper (Microsoft, 1990) were originally included with Windows 3.0 as simple and unassuming ways to ease users into having the skills to use a mouse, a new piece of hardware at the time (Garreau, 1994). Coupling eye trackers with similar low pressure, low key games could act as a method to train the public in using eye trackers for general computing tasks. This may not seem to offer too many advantages in a home or office setting, but in places where the hands are otherwise occupied (e.g. operating controls on heavy machinery), or in public places where physically touching an interface of a publicly accessible computer (e.g. an automated teller machine) may be less desirable than being able to use an eye tracker.

**Conclusion**

Finding a way around the problems that the basic video game controller causes for many people involves looking not just at modifying these controllers, but in finding altogether different modes of control. Eye tracking is a technology that shows a lot of promise in doing exactly this. By beginning to assess the usability of eye trackers as video game controllers and the enjoyment
video gamers have using them, a door to making video gaming a much more inclusive and accessible medium, may be opened
TRADITIONAL VIDEO GAME CONTROLS & EYE TRACKING

References


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Appendix A
Participant Consent Form

Project Title: Comparing Traditional Video Game Controls with Eyetracking Controls

Researchers:

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Christian Riegel, Professor of English, Campion College @ University of Regina, (306)359-1219, Christian.riegel@uregina.ca

Purpose(s) and Objective(s) of the Research:

- The goal of the study is to determine if commercially available eyetrackers are a viable alternative to traditional handheld controllers for the purpose of playing two-dimensional video games.
- The data will be used as part of an honours thesis for J. Woodcock and may be also used in conference presentations and publications.

Procedures:

- Participants will play a video game twice for 15 minutes each: once with an Xbox controller and once with an eyetracking device to control the game. The order for each type of controller will be determined randomly.
- After each of the two game playing periods, participants will be asked to fill out questionnaires about their player experience. Participants will also be given a demographics questionnaire right
after the first game period. Each set of questionnaires will take approximately 5 minutes to complete.
• Please feel free to ask any questions regarding the procedures and goals of the study or your role as a participant.

Potential Risks:
• There are no known risks associated with the methods used in this study.

Potential Benefits:
• This research may be useful in establishing alternative control methods for video games thereby making gaming more accessible for individuals who may have difficulties or limitations using more traditional control methods.

Compensation:
Participants will receive one (1) Psychology Participant Pool credit for their participation in this study.

Confidentiality:
• All data will be confidential and data will be stored by a randomly assigned participant number. No names will be collected for the study. Drs. K. Robinson and C. Riegel will not know who participated in this study.

Storage of Data:
The questionnaires and data sheets will be securely stored in a locked office in the IMPACT (University of Regina). Once the data have been transferred to electronic format, the questionnaires and data sheets will be shredded. Electronic files will be identified only by participant number and kept indefinitely on password-protected secure computers in a locked room in the IMPACT lab.

Right to Withdraw:
• Your participation is voluntary and you can answer only those questions that you are comfortable with.
• Whether you choose to participate or not will have no effect on your position (e.g. employment, class standing, access to services) or how you will be treated.
• You may withdraw from the research project for any reason, at any time without explanation or penalty of any sort by not completing the tasks, by not submitting your questionnaire, or by not completing it before handing in the questionnaire.

• Your right to withdraw from the study will apply until you submit your questionnaire at the end of the study as your name will not be associated with your data but instead by a participant number randomly assigned to you. Once you have left the lab, the researcher will not be able to identify which data belongs to you.

Follow up:

If you would like to obtain a summary of the results, please contact any of the researchers at the top of page 1.

Questions or Concerns:

• Contact the researcher(s) using the information at the top of page 1;
• This project has been approved on ethical grounds by the University of Regina Research Ethics Board. Any questions regarding your rights as a participant may be addressed to either the University of Regina committee at (306-585-4775 or research.ethics@uregina.ca). Out of town participants may call collect.

Consent:

Your signature below indicates that you have read and understood the description provided; have had the opportunity to ask questions and have those questions answered.

I consent to participate in the research project. A copy of this Consent Form has been given to me for my records.

_______________________________________________________________________________

Name of Participant Signature & Date

_______________________________________________________________________________

Researcher’s Signature & Date

A copy of this consent form will be left with you, and a copy will be taken by the researcher.
Appendix B
Demographic Survey

Eyetracker Study Questionnaire - Part 1

Demographic Information

Age: ................................................................................................................................

Gender: ...........................................................................................................

Favourite Video Game Genre: .................................................................................

Hours a week spent playing video games: .........................................................

At what age did you play your first video game: ...........................................

What system do you play the majority of your video games on: ......................

Have you used an eyetracker to play video games before: ............................

Have you used a VR headset to play video games before: ..............................

Do you use glasses or contacts while playing video games: .............................

Is your vision corrected by other means: .......................................................

Physical or Neurological Disability: .................................................................
Appendix C

System Usability Scale

**Circle Control Method Used:**

- Eyetracker
- Xbox Controller

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**System Usability Scale**


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<thead>
<tr>
<th>Statement</th>
<th>Eyetracker</th>
<th>Xbox Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I think that I would like to use this system frequently</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I found the system unnecessarily complex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I thought the system was easy to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I think that I would need the support of a technical person to be able to use this system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I found the various functions in this system were well integrated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I thought there was too much inconsistency in this system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I would imagine that most people would learn to use this system very quickly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I found the system very cumbersome to use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I felt very confident using the system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I needed to learn a lot of things before I could get going with this system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strongly disagree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix D

Enjoyment Questionnaire

With this control method did you find the game to be...

<table>
<thead>
<tr>
<th></th>
<th>Very Boring</th>
<th>Somewhat Boring</th>
<th>Unremarkable</th>
<th>Somewhat Fun</th>
<th>Very Fun</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O----------</td>
<td>O---------------</td>
<td>O-------------</td>
<td>O-------------</td>
<td>O--------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very Easy</th>
<th>Somewhat Easy</th>
<th>Unremarkable</th>
<th>Somewhat Challenging</th>
<th>Very Challenging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O--------</td>
<td>O--------------</td>
<td>O-------------</td>
<td>O-------------------</td>
<td>O-----------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very Frustrating</th>
<th>Somewhat Frustrating</th>
<th>Unremarkable</th>
<th>Somewhat Engaging</th>
<th>Very Engaging</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O----------------</td>
<td>O-------------------</td>
<td>O-------------</td>
<td>O----------------</td>
<td>O-------------</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Very Fatiguing</th>
<th>Somewhat Fatiguing</th>
<th>Unremarkable</th>
<th>Somewhat Effortless</th>
<th>Very Effortless</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O-------------</td>
<td>O-----------------</td>
<td>O-------------</td>
<td>O----------------</td>
<td>O-------------</td>
</tr>
</tbody>
</table>
Appendix E
Exit Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Eyetracker</th>
<th>Xbox Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which gaming controller did you prefer playing with?</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Which control scheme was easier to learn?</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Which control scheme was easier to use?</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Which control scheme felt more natural?</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Which control scheme was more fun?</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Which control scheme more immersive?</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

Using the eyetracker control brought something fun to the game that the other controller did not:

<table>
<thead>
<tr>
<th></th>
<th>Wholly</th>
<th>Somewhat</th>
<th>Unremarkable</th>
<th>Somewhat</th>
<th>Wholly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>Disagree</td>
<td></td>
<td></td>
<td>Agree</td>
<td>Agree</td>
</tr>
</tbody>
</table>

I think I would be able to use the eyetracker as competently as the xbox controller with practice:

<table>
<thead>
<tr>
<th></th>
<th>Wholly</th>
<th>Somewhat</th>
<th>Unremarkable</th>
<th>Somewhat</th>
<th>Wholly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>Disagree</td>
<td></td>
<td></td>
<td>Agree</td>
<td>Agree</td>
</tr>
</tbody>
</table>
I would use an eyetracker to play video games in the future:

O------------------O------------------O------------------O------------------O

Wholly          Somewhat       Unremarkable       Somewhat       Wholly
Disagree        Disagree       Agree            Agree