How Do Differing Input Methods Impact Player's Ability During Competitive Play in Fighting Games?

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***Abstract*—This paper looks at the impact that a number of differing input device have on player's ability while playing fighting games at a competitive level. There is much controversy surrounding what the best control method is to maximise both prowess and input speed, with many different professional defending their method harshly, add to the fact there is very little scientific research to back any of the claims up, it's still down very much to personal preference or peer pressure. The research that this paper will undertake will hopefully be able to prove which is the superior control method, and how the individual input methods impact on a player's ability over a number of different skill brackets by looking at how the ergonomics and usability of the devices interact with the participants, and their personal opinions of the devices.**

I. Introduction

THIS project looks at the impact of the use different input devices during competitive play in "arcade style" fighting games. With the arcade stick being heralded as the superior control scheme by the majority of the Fighting Game Community (FGC)[1], there is very little scientific evidence and research that has taken place to support the claims being made, as will be discussed in section II. This paper will also look at how the ergonomics of the input methods, as well as the players' skill and anthropometrics impact on the usability of said input methods at an individual level. The use of my programming component and other research techniques that I'll be employing during my research will allow me to the keep track of the inputs that the players are making during game play, which will grant me a better understanding of the overall usability of the input methods and allow me to create a much more informed conclusion. The results will be analysed in a later section. As section II shows, there is a lot of research into the overall usability of different controllers, more innately how the differing anthroprometrics of the users can impact on the usability of the controllers. However there is little exploring how it impacts on players' ability during gameplay, and what little there is only covers it from a non-competitive standpoint. The potential conclusions from this study could potentially be used in the games industry to better design input methods so that they support better competitive play for the end users. As well as help users in the competitive scene pick an input method which is scientifically proven to be better matched to them personally.

II. The Research Question

I have chosen my particular research question as I feel it is articulates exactly what I want my research to focus on, rather than focus on game specific exploits (SOCD's) that can give player's an edge by allowing them to input two directions at once, gaining the benefits from both, as most of these are either outlawed by the use of input scrubbing devices at competitive events anyway[2], then add to the fact that players need prior knowledge of these exploits to carry them out, measuring their effectiveness during competitive play with players of different skill levels would be pointless. Whereas focusing on the different input methods most commonly used at competitive events (Game Pads and Arcade Sticks), the data retrieved during my research will hopefully be able to actually show the differences that the input methods display during play and how they affect player's standings, along with how players of differing skill levels adapt to them.

III. Related Work and Research

As the main focus of this paper is on input methods, and how different users interact with them, this will be the primary focus of the related work section. The first section will cover the ergonomic qualities of game controllers and how players interact with them. This primarily because this what the bulk of the existing research focuses on. The following section will be looking more at the professional use of the input methods, as this is where most of the opinions and claims about the accuracy and usefulness of the devices come from. It will also focus on the skill aspect, players who have more experience with fighting game will obviously be better and produce more consistent results, but as I want to focus more on the input methods, additional information on the subject will be useful to allow us to draw more informed conclusions, and better analyse the data that the research produces.

A. Ergonomics, usability and the impact on users

The ergonomics of an input method must meld well with the anthroprometrics of the user to ensure that it is usable and accurate while playing games, a controller that is not intuitive, and causes a heightened amount of frustration to use for a user is one that they will not want to use[3]. However nowadays most controllers are clearly designed with ergonomics in mind, which Bhardwaj[4] goes into heavily by looking in great detail at a number of controllers which show the evolution of the inclusion of ergonomic data in controller design, with the first controller studied, the Mega Drive/Genesis controller, which failed on more criterion than more recent controllers such as the PS4 controller and the

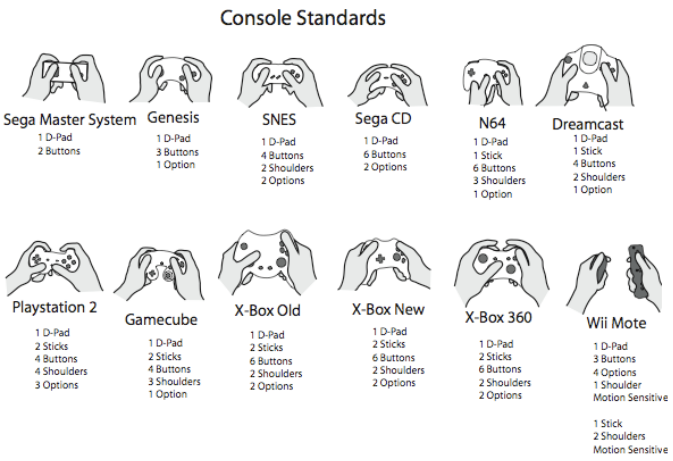

Fig. 1. Controller Evolution Timeline sourced from https://www.back2.co.uk/blog/ergonomics-a-brief-history/

Xbox 360, it is heralded as one of the greatest controllers of all time[5] due to the six button layout of the controller that allowed it greater flexibility when it came to playing a wider variety of games. However as mentioned earlier, the Mega Drive/Genesis controller failed on more criterion than the much more recently designed controllers, this was mainly down to the fact that the Mega Drive was released in a time period where most games were still played from a 2D perspective, so only a few inputs were needed, due to the decreased complexity[6], [7], whereas controllers today need to be able to provide adequate control for a much broader variety of games, from a number of different perspectives so they must ”well suited to play a wide variety of different game styles”[3], which can be seen in(fig. 1).

Which is a good point to link into what Gerling[8] states in saying that the user experience is linked to relevant the controller is they are using, to the game that they are playing. So, it would make sense that controllers for more recent consoles would be heavily influenced by set ergonomic standards such as those proposed by Tilley[9], which is the exact standard that Bhardwaj[4] used when studying his selection of input devices, as these best showed the evolution of ergonomic design choices over time when it came to game controllers, and the standards set by Tilley also outline the optimum dimensions and actuation force for things such as buttons and triggers, so it makes perfect sense to use these figures as a benchmark, as they represent the ”50th” percentile[4] with this group of people represent the group with the most average anthroprometrics, while the 5th and 9th percentile have metrics that either too small or too large to fit into the average. Therefore it is important for designers to create parts for a controller to cover the widest possible set of metrics[10], however this can be quite difficult when metrics such as hand size can vary from 13 - 19 inches as stated by Brown et al found[3] when measured with the ”Figure of 8” method created by Pellecchia[11]. As the anthroprometrics of users can vary so wildly, and hand size is seemingly the most important metric to take into account when designing a controller, it is important that controllers are small enough so that players in the 5th percentile can reach all of the buttons (Which was the main problem with the original Xbox controller, better known as the ”Duke” because of it’s size[4]), while users in the 95th percentile can still activate all the inputs easily, without additional accidental input. To further cement the fact that the controllers that clearly designed with ergonomics in mind should in theory allow users to perform better due to increased comfort and usability[3], this relation has also been found in other fields such as medical equipment, where Berguer[12] found that medical professionals using surgical instruments also had significant trouble using the instrumentation when they had hands smaller than a size six and half glove, which equates to roughly 36 percent of surgeons at the time of the research. More interesting than that though is that of the 36 percent, 87 percent of the surgeons that had significant were women, this claim is definitely valid as Tilley found that on average woman’s hands were overall smaller than men’s[9].

This is a very interesting statistic on many fronts when drawing a parallel over to talking about both video games and usability, as there are is plenty of evidence to suggest that the number of women playing video games has been on a relatively steady increase since 2006[13], however the increase was mostly prevalent within the mobile gaming sector[14], with Google finding that over 64 percent of women preferred mobile gaming over other gaming platforms[15], this increase may be caused by the sharp uptake of mobile devices in general, however the relationship between more women taking up playing games and the rise in popularity is extremely clear(fig.2). As games on mobile are normally much simpler due to the fact the hardware is normally less powerful than regular home consoles, they normally fall more into the ”casual” genre, which gives them the ability to be picked up and played in short sessions, and due to the fact that the only form of input on a mobile device is through the touch screen, this limits the ceiling of complexity that a game can have, compared to that of a console game. So they must be both intuitive and easy to control. And as Google found[15], women mostly play to relieve stress or fill an empty moment, which is pretty telling that they prefer to use games as more of a time killing tool, rather than playing it for reasons such as the story or a competitive aspect, which is why, as stated before, mobile games are normally fit more into the ”casual” part of the market.

So as such, even though there has been an increase in women playing video games, they are still very much under represented in more competitive games, especially in fighting games, which is extremely evident when looking at articles from within the FGC, all of the articles about the few female players who have been interviewed note that they play in a very much male dominated community[16], with many facing ”getting harassed, made fun of, objectified”[17] which would definitely prevent women from becoming more involved in the community. However I also feel that this will affect how future input devices will be created for fighting games such as the arcade stick will be designed, as other popular games that are heavily grounded in E-sports such as League Of Legends have had all female pro teams at points[18], are all based on PC, and thus the peripheral market has expanded to include input

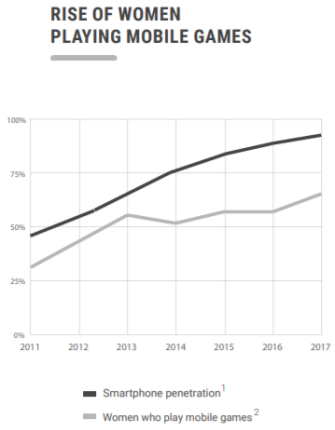

Fig. 2. Graph showing the rise in popularity of smart devices and women who play mobile games

[15]

methods that cater to users with smaller hands, such as those possessed by women, mouse manufacturers such as Zowie produce some of their popular E-sports mice in 3 different sizes[19] to cater to a wider audience of users. However the input devices that the main input device that this study will be focusing on, the arcade stick, although the sizes of the actual devices outside dimensions can vary wildly, the button layout is normally, at least for professional Street Fighter, a set layout most commonly the same as visible in(fig.3). Having a set panel layout, although making the device easy to remember once learnt and easy to produce, it's usability can depend on the size of the users hands, and how comfortable they find the orientation of the buttons, along with how familiar they are with the controller, and although these factors also transfer to the other input methods that this paper will be studying, due to the relative obscurity of the arcade stick, I feel that it will be the least user friendly compared to the other devices as participants who don't have much experience with video games will have mostly likely used one of the more conventional input devices in the past. Due to the amount of impact that the ergonomics of the input methods can have, and the vast differences in the anthroprometrics of users that were found in this section, a closer look at the input methods this paper will be covered in the next section to gain a better idea of their history and most common usages.

B. Input methods, and their affect on competitive play

There are two prevalent input methods that are used in the fighting game community, the arcade stick and the "pad". The arcade stick is held in very high regard in the FGC, and is considered almost the "default" controller for nearly all fighting games[20] except for 3D fighters such as Tekken and Soul Calibur as their predominant controller is a Playstation pad due to the design of the D-pad[21] as the reduced range of motion compared to an arcade stick makes changing direction quicker, as this is much more important in 3D fighter due to the added dimension of movement. The GameCube controller is used almost primarily in the Smash Brothers community, especially for Melee, which was the first game in the series to be launched on the GameCube and the first to gather a competitive community, even though there is a lot of disagreement within the wider FGC that if Smash should even be classed as a fighting game due to the sheer amount of restrictions that are enforced on the game to enable it to function as a competitive game, due to mostly the fact that features such as the items that appear during gameplay, and the stages that "feature layouts with natural hazards and random events that can influence the outcome of the fight, up to and including the defeat of a player"[22], whereas stages in Street Fighter are merely a visual backdrop for the gameplay. Although Smash is an interesting anomaly in the competitive scene when it comes to the actual gameplay being restricted to ensure competitive play is fair, the way that the input devices are regulated to ensure balance and fair play is a very grey area, especially at higher levels of competition. As mentioned earlier in the paper, the arcade stick is regarded as the best input method for fighting games, however the reasons for this are more to do with the history of the games than anything. Most players cite that growing up playing games such as Street Fighter 2 in an arcade, or any fighting game that had an arcade release for that matter, is the main reason that they still use an arcade stick[20], [21], [22] in competitive play, it simply feels more natural. The familiarity of the control method is the main reason, which of course makes perfect logical sense as using the same control method for an extended period of time will of course allow you to perform much more consistently during gameplay. However, the other factor that can play into the uptake of arcade stick play is the social aspect within the FGC, pad players are seen as "inferior" to players who use a stick[23] and often labelled as "scrubs", which is an FGC term for an inexperienced or new player[20]. This social pressure can lead to players switching to using a stick purely to avoid the label of "scrub", even though high level competitions such as Evolution have been won with pads, one very good example of this is the french player Luffy won the tournament for Ultra Street Fighter 4 in 2014 with a Playstation 1 pad, and his reason for using a pad was" just purely because I'm accustomed to that."[24]. This is a very interesting point as it lines up with some of the previous statements that were made earlier in this section, the reason that most player's use an arcade stick is due to the familiarity of the control scheme, it's just what they're used to, however the same can be said for pad players because as seen, they can outperform stick during high level play, so I feel that the prejudice against using different control methods has very little basis in reality. The claims that one method is "superior" over another seems to be based purely on personal preference, and what the social norm assumes it to be within the community, not on the factors that this paper has outlined that can actually have the potential to have an impact on players' performance. A claim that one control scheme is better than another can't be made without having solid evidence to support it, and the fact that player's have managed to win major events with pads also doesn't mean that they are better than other control methods, it shows that they each have innate advantages, however there is no research to determine what the advantages are of the control methods when used by player's of varying skill levels, which

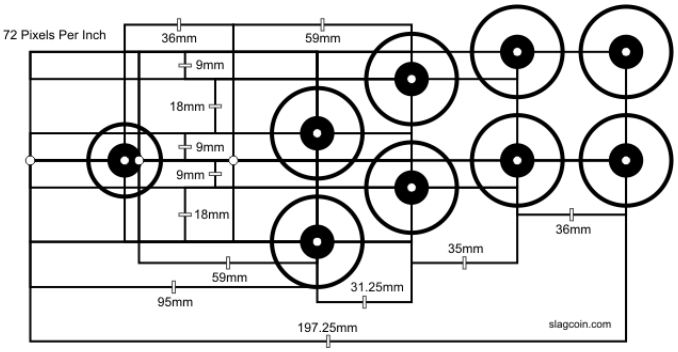

Fig. 3. Standard Japanese Arcade Button Layout[25]

is why this is what this paper is focusing on.

IV. Methodology

The research question that this is paper will be addressing is: How Do Differing Input Methods Impact Players Ability During Competitive Play in Fighting Games?, the hypothesis that have been drawn from this question are shown in table 1.

These hypotheses will be tested by comparing results from participants within different skill brackets, while using different input devices, and thus, each participant will produce 12 pieces of data following my currently planned methodology. The devices that are being tested will be an Arcade Stick, a PS4 pad and a GameCube controller. Due to the addition of the GameCube controller, which is considered the ”wildcard” input device and will hopefully cause uncertainty from all skills groups due to it’s the fact that this a strange application to be using it for, the layout will make playing a fighting game quite difficult, which will deliver some interesting results about the adaptability of the different skill brackets. Due to this we’ll be looking for a medium effect size of 0.39 across the 3 different skill brackets, and as the participants will be fighting against both A.I. opponents and human players while using the 3 input devices, the number of groups double to 6. Also, as we’re utilising repeated measures, the participants will fight both the A.I. opponent and human player twice, which is why the number of measurements lies at 12. By taking all of these parameters and using a ANOVA test[26], we find that the total sample size needed to find a clear difference is 54, even though this is quite high for an undergraduate research task, it is possible with the amount of potential participants that are available due to the circumstances of undertaking it in such an environment as a game development studio. The research will completed by participants sourced from face to face recruiting in the studio, and from one of the societies that takes place on campus that focuses heavily on fighting games, both sets of participants will be provided with the same instructions and questionnaire. As an integral part of research is to access the impact of input devices of player skill across a wide variety of skill levels, having access to these specific groups will hopefully allow me to recruit the correct number of participants that will allow me to fulfil all of the skill brackets equally, and so that it won’t have any negative affects on the data that is collected. As this research will require human participants to complete, the signing off of this methodology will also be required by Falmouth University’s research ethics board.

A. Hypothesis

Table 1 shows the hypothesis that I will be tested during this experiment, the way in which they will be tested will be by looking at the data collected from the skill groups, mainly the speed of the inputs that my research artefact will be capturing, and looking at the variance spread across the skill brackets for each of the different input methods by utilising a T-Test to analyse the data, as well as looking at the match results(Win/Lose ratio) will then allow me to see the impact that the different input methods have on player’s ability. A questionnaire will also assist in testing the hypothesises that are presented, mainly covering the more opinion based points that were brought up during the literature review, but using the quantitative data that I will be gathering in addition will help me form more informed conclusions.

B. Pre-Test procedure and Research Conditions

To ascertain the participants skill level without using a system of self-analysis, I have chosen to employ the same system as Taneichi et al[27] to assess the level of individual participants skill level, the way in which this will be conducted will be as follows: The participant will be asked to complete 3 special moves by inputting them into a the arcade stick controller as this, as discussed earlier, is the ”default” controller for Street Fighter. The version of Street Fighter that will be used is Street Fighter 5, which will be a Steam copy played on a Windows PC to allow for my research artefact to be used, which will be discussed further in subsection E. The participants will also be restricted to playing the character Ryu during both the pre-test, and during the actual experiment for much the same reason as Taneichi et al[27], to ensure that the playing field is perfectly level for all of the participants, as allowing them to pick characters would introduce a whole number of variables that could skew the results that are collected due to differences in character balance and ease of use. Each participant will be asked to try and perform each motion ten times, which will result in 30 results for each individual participant, the success or failure of each motion attempt will be recorded, and then by averaging this out from 0 to 100 percent of success, the participants will be placed into three skill brackets, with the first or ”unskilled” bracket ranging from 0-33 percent, then the ”intermediate” ranging from 34 to 66 percent, and then 67 to 100 will be classed as the ”highly” skilled bracket. The participants will be shown how to input the moves before the pre-test begins, and before every new attempt starts. To be able to test the specific hypothesis that this paper is testing that relates to usability of the input devices in relation to the participant’s hand sizes, I will also be taking a measurement of participant hand using the figure of eight method that was discussed earlier in the paper, as this proved to be as accurate and reliable as other, more time consuming methods[3], [11].

TABLE I
HYPOTHESES

	Hypothesis	Null Hypothesis	Data Source
1	The speed of inputs of players from the high skill group will be quicker in general than those in the lower skill groups when using an input method they are not familiar with.	The speed of inputs of players from the high skill group will be the same in general than those in the lower skill groups when using an input method they are not familiar with.	Input Data
2	Players in the lowest skill bracket will perform better with the PS4 controller than they will with the arcade stick or the GameCube controller due to the commonality of the device over the other 2 devices.	Players in the lowest skill bracket will perform the same with the PS4 controller than they will with the arcade stick or the GameCube controller regardless the commonality of the device over the other 2 devices.	Match Data
3	The results of games where the player's must use the GameCube controller will worsen significantly across all of the skill brackets due to the uncommon pairing of the the particular device with the game that will be played.	The results of games where the player's must use the GameCube controller will only marginally worsen across all of the skill brackets due to the uncommon pairing of the the particular device with the game that will be played.	Match Data
4	When using the arcades stick, the input time of participants with small hands will be higher than those participants with larger hands.	When using the arcades stick, the input time of participants with small hands will be the same or slower than those participants with larger hands.	Hand Data
5	Participants who have never used the arcade stick before will find that it is less intuitive to use than the other devices they will use.	Participants who have never used the arcade stick before will find that it is equally or more intuitive to use than the other devices they will use.	Questionnaire Results

C. Gameplay Data Capture and Testing The Hypotheses

Due to the fact that there are 3 variations of input method that the participants will be using, add to that they will need to fight both an AI player, and another participant with each control method, each participant will be subject to participating in 12 matches, 4 with each control method, 2 against an AI opponent, and 2 against another participant. The matches will be played in a best of 3 format The AI rounds will take place first for ease of testing. The AI will be at a pre-set difficulty and will be fighting as the same character as all the participants, Ryu. Each participant will fight with one control method after the other, and although this could introduce some "skill creep", where the participants start to learn the game and perform slightly better, the time that it would take to test everyone on one device, and then find the participants at a later point to retest them on the next device would take too much time, and most likely push the project out of scope. The participants will then move on to fighting against each other after all of them have completed their rounds against the AI opponents. The match data will be recorded by both screen capturing such as OBS, so that I can go back over the footage during the analysis process to look for any smaller details I might have missed during the earlier research sessions and being recorded in a table so that the data can be used to test the hypothesis that this paper has created. The participants inputs will also be recorded by my research artefact, which will discussed in more detail in section E. The data that this piece of software will hopefully produce will allow me to see how fast and consistent the individual participants are being with their inputs, which will help test the outlined hypotheses, and also form much more informed conclusions and claims once the data has been analysed in later sections of this paper.

D. Questionnaire

After the participants have completed all of their matches, they will also be asked to complete a questionnaire online using Google Forms. As a lot of the claims that previous researchers and writers made in the literature review about the impact and effectiveness of the input methods were based purely on personal opinion[23], [22], [20], the use of a questionnaire post use of input devices will allow me to gather some qualitative data, as although most of the hypotheses in this paper require the analysis of quantitative data to test, number 5 will require the use of participant opinion and feelings, which is why the use of a questionnaire is necessary. It will also allow us to make much broader and more informed claims about the usability of the devices across the skill groups. The questionnaire will be constructed in much the same way as Thorpe et al[6]. The questionnaire will have 2 sections, which will consist of tick box and questions, this will allow the gathering of information such as the individual participants name and gender identification, and if they've had any prior experience with any of the 3 input devices that are being tested. This will data will allow me to both keep track of what each participant thought of the input methods due to the name, and test the hypotheses that require quantitative data. Gathering the gender identification of my participants will also allow me to make claims about the earlier point that was made in the literature review about the usability issues that women could encounter when using larger devices, so having this piece of information will also help test hypothesis 4 when used in conjunction with the quantitative data that will be gathered in the pre-test. The second section will feature scale questions, along with statements regarding possible improvements that participants would make to the input devices. We feel that this is an important piece of data to gather as this will allow us to make useful suggestions, claims and possible considerations to both player's and designers alike who read this paper in future.

E. Design of the Research Artefact

Due to the fact that the research process featured in this paper is based around a measuring human interaction with pre-existing devices and using a readily available piece of

software to hold the testing on, the research artefact will be a program created purely to capture and format the participant's inputs made during the testing process. The program will run in the background during testing so that it can capture all of the inputs that it requires. It will be built in C++ using the XINPUT API [1], this is due to the project's past experience with the API and the fact that all the input devices can be configured to use XINPUT when connected to a PC. The design of the artefact will allow it to create formatted text documents that will feature the time stamped inputs of one or two participants (Depending on what portion of the research is being undertaken), these text documents will give us the quantitative data that we need to test our hypotheses, as well as being able to extract any visible trends that are present in the data. The artefact will also have the ability to accept the names of the participants before the individual match starts, so that the text files that are created post match will be have the appropriate names attached to the data. Having this feature will make it significantly easier for the team to analyse the data in the future as they'll instantly know who the match data belongs to.

F. Participants

Due to the nature of the research that this paper is looking at conducting, a variety in the skill level of the participants that we are looking at utilising is inherent to the ability to test our hypotheses, and such, no prior screening process to ensure that the participants have the correct level of competency to play the game will not be needed, which will hopefully also make recruiting potential participants much less time consuming. To ensure that the research remains in-line with the university's ethics guidelines, before the pre-test or any research takes place, the participants who agree to be recruited will be asked to sign a consent form, which will be created and curated online using Google Forms, this form will first outline the project as whole, then what the research process will involve them doing, and finally the personal data that I'll be collecting as part of the research process. The research will not commence until they have given their written consent If they do not consent to the research taking place, they will not be recruited into the research pool. Potential participants will also be randomly recruited from within the Falmouth University campus, so they should fall within the average ranges for age and gender distribution. Recruitment of participants will occur in two separate sessions, one will take place in then Games Academy building, while the other will take part in the Stannary bar, where Fight Night normally is held, because of this, all of the health and safety measures will be inherited from the outlined protocols at the locations that the research will be undertaken.

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