Measuring the Impact of Heads-Up Display on Player Experience in FPS Games.

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Påverkan av Heads-Up Display på Spelupplevelsen i FPS Spel
Abstract

In this study, we investigate the effect of Heads-Up Display on player experience and performance when playing the first person shooter games Battlefield 1 and Battlefield 4. Participants played a mission twice, once with Heads-Up Display and once without. After each session, the participant answered a PENS questionnaire. The amount of enemies killed and the amount of times the player character died during the session was recorded. No significant differences were found other than that the participants who answered that they only played first person shooter games *a few times every month* killed more enemies with the Heads-Up Display active, and that the overall amount of kills was generally lower when the Heads-Up Display was active.

**Keywords:** Heads-Ups Display, Immersion, Player Experience, First Person Shooter

Abstrakt


**Nyckelord:** Heads-Ups Display, Immersion, Spelupplevelse, Förstapersonsskjutspel
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1 Introduction

Digital Digital games are made up of vast amounts of design, graphical and programming elements. Among all the features that make a game enjoyable, there is the Heads-Up Display, commonly referred to as HUD. The HUD is an element that is very common in digital games. It provides information important to the player, such as the amount of resources the player has at his disposal, like health and ammunition to name a few. The Heads-Up Display is used to keep the player updated on the state of the game by providing information about the surrounding game world, often by giving subtle indications such as arrows, highlights or short text messages to get the player’s attention. It can be argued that the Heads-Up Display is used primarily as a substitute for the human senses, giving information that otherwise would only be possible to register through real sensations, such as pain on being hit or the adrenaline and shock from bullets flying by inches from your body. With this study we want to investigate how the Heads-Up Display affects the player experience by measuring progress and immersion. Immersion has been argued to be an important factor of game experience due to the impact it has on the player’s game experience as a whole (Ermi and Märyä, 2015) making the player more engaged to the game and more emotionally attached. This paper explores how the Heads-Up Display affects player experience and performance in the first person shooter games Battlefield 1 (EA DICE, 2016) and Battlefield 4 (EA DICE, 2013).


2 Previous Literature

2.1 Impact of a Heads-Up Display on player experience

The Heads-Up Display is the part of a digital games’ User Interface, henceforth referred to as UI, that is designed to help players by conveying useful information about the state of the game or program. Both HUD and UI influence the player in different ways, including flow (Johnson and Wiles, 2003; Caroux and Isbister, 2015) and immersion. Although most HUDs are generally good at assisting new players in learning the game, more experienced players in fast-paced games such as first person shooter games, FPS, may enjoy the games better with minimal HUD and UI (Iacovides et al., 2015). Iacovides and her colleagues explain that this is because the experienced players are distracted by looking at the HUD elements for help instead of using their existing expertise to make decisions and focus more on the gameplay. For real time strategy games, however, where there is a lot of information all the time, the HUD may enhance the player experience (Caroux and Isbister, 2015). Jørgensen (2012, p.160) on the other hand, states that the amount of integrated UI generally does not matter but that it is preferred by players if it is implemented into the game world in an elegant way. Since agency and embodiment in the game world is enabled via the interface, the sense of involvement seems to get enhanced. These observations could also explain the recent popularity of “natural” physical interfaces that focus on intuitive functionality through immediate recognition. Having too little UI on the other hand might make the learning process tougher for players new to a game.

There are several UI classifications depending on how the information is portrayed. Stonehouse (2014) mentions the four classifications: diegetic, nondiegetic, spatial and meta. Every category has its strengths and weaknesses and can be used in different combinations, causing different effects and levels of immersion. Diegetic UI elements are items in the game world that do not break immersion, something that can be seen through the characters’ point of view, such as the character’s cellphone or the Pipboy in Fallout 4 (Bethesda Software Studios, 2015). A non-diegetic UI element is the opposite of a diegetic UI; it is completely removed from the fiction and geometry.
of the game. A good example of a *non-diegetic UI* element is the hotbar in *World of Warcraft* (Blizzard Entertainment, 2004).

A *spatial UI* element is most often used when there is a need to break the narrative of a game to convey information to the player. They are still found in the geometry of the game to avoid breaking immersion; they do not however affect the narrative since they are not seen by characters in the game. The *meta UI* element is portrayed like a *non-diegetic UI* element but is incorporated into the game the same way as a *diegetic UI* element. A good example of a *meta UI* element is the speedometer in racing games, the player sees a 2D version of the speedometer on the screen while the character in the game can see a similar speedometer in the vehicle it is driving (Stonehouse, 2014).

### 2.2 Immersion as a Component of the Gameplay Experience

The concept of *immersion* is commonly used when discussing digital games and gameplay experience (Ermi and Mäyrä, 2005). Many authors have come up with different definitions for what immersion really is, but one word that keeps coming up is *presence*. A definition mentioned by Ermi and Mäyrä (2005) defines immersion as “the sensation of being surrounded by a completely other reality that takes over all of our attention, our whole perceptual apparatus”. Immersion and presence do not differ a lot in definition, the two words are sometimes used as synonyms. According to Ermi and Mäyrä (2005), in the context of digital games, it is widely preferred to use the term immersion as it more clearly connotes the mental processes involved in gameplay.

Brown and Cairns (2004) tried to make a clear and universal definition that was divided up into three levels based on the experiences of gamers: *engagement*, *engrossment* and *total immersion*. The first stage of immersion is *engagement* which is the lowest level of involvement, where the player must invest time, attention and effort. *Engrossment* is the second stage and it is achieved when the player has become emotionally invested in a game due to the time, effort and attention put into it. This makes people want to keep playing because the game becomes the most important part of the players’ attention. The last stage of Brown and Cairns’ (2004) immersion definition is *total immersion*, which can be related to presence, empathy and
atmosphere. When the player becomes detached or cut off from the reality and the virtual world is the one that matters for the moment.

Lankoski (2010, p.95) has also noted that the concept of immersion is problematic and suggests that the concept of *engagement* could help clarify the subject. Lankoski explains this by dividing it into the three major concepts; *recognition*, *alignment* and *allegiance*. *Recognition* meaning different aspects of character interpretation, *alignment* describing what kind of access the player has to a character’s actions, knowledge and affects and *allegiance* meaning how characters elicit sympathy or antipathy through positive or negative evaluation of the character. With immersion made into smaller, more comprehensive pieces, the concept might be easier to understand.

The explanation that Jennett et al. (2008) provides of immersion is a “gradual, time-based, progressive experience that includes the suppression of all surroundings, together with focused attention and involvement in the sense of being in a virtual world.”

Rouse (2005, pp.218-219) mentions that the first person point of view has been linked to immersion. Since first person shooter games have the first person point of view and currently make up a large amount of the popular games this correspond with Rouse’s assumption.

Some argue that the HUD enhances the playing experience while others think that the HUD is only used as a poor substitute in games, since games lack multiple sources of information that would otherwise automatically be handled by the human body. It can also help the player keep track of how much ammo is left and help explain why the character is out of breath and walks slowly instead of continuing to run when out of stamina. It can also be used to convey that the character is injured and in a critical condition.

The amount of UI and HUD elements may affect expert players’ immersion in games and therefore the game makers should take these design choices into consideration when making a game. The main reasons for decreasing the amount of UI and HUD elements are that they may serve as a distraction once all the controls, patterns and information are learned, and it may also give the expert players a cleaner,
more realistic and tougher immersive challenge. So instead of increasing the difficulty
of a game by altering values such as health and damage, immersion could be
increased by simply removing all unnecessary distractions (Iacovides et al., 2015).
3 Research Question and Hypotheses

The research question that will be investigated in this study is: How does the HUD affect player Immersion?

The three hypotheses are:

1. Players with more experience are more immersed with less HUD.
2. Players with less experience are more immersed with more HUD
3. Players with HUD activated will have more kills and less deaths.
4 Method

To determine if players feel more immersed with or without the HUD active, participants played *Battlefield 1* (EA DICE, 2016) and *Battlefield 4* (EA DICE, 2013) with HUD and without HUD. Participants then answered questionnaires after 10 minutes of playtime on the game with HUD to measure immersion and then played the same game without HUD for 10 minutes and answered the same questionnaire. Some participants instead played the first session without HUD, and the second session with HUD.

To determine how the HUD affected the performance of the participant, the number of enemies killed and the number of deaths to the player character was recorded during each session. *Kills* and *deaths* were chosen as they are both variables heavily affected by the performance of the player. Killing enemies is the main income of points in the game other than completion of the mission. Dying in the game is the main thing that the player attempts to avoid. Since the participants played the same mission twice, once with HUD and once without, the impact of the HUD on the performance of the player could be evaluated by comparing these variables.

The authors used R (R Core Team, 2016) will be used to analyze the data, the *Generalized Linear Mixed Model* (Bates et al., 2015) was used to analyze the kills and deaths of the participants and the *Linear Mixed Model* (Bates et al., 2015) was used to analyze the presence scores. This was done with the commands *glmer* for kills and deaths and *lmer* for presence. Both commands are part of the *lme4* package (Bates et al., 2015).

4.1 Plan

Before playing the game, the participant will answer a prerequisite questionnaire to determine experience with the game as well as overall experience with the FPS genre. After the prerequisite questionnaire has been answered, the participant will play two 10 minute play sessions or until the player finishes the mission; one session with HUD and one session without HUD, on either *Battlefield 1* (EA DICE, 2016) or *Battlefield 4* (EA DICE, 2013). The PENS questionnaire (Dennie, 2012) will be
answered after each play session. During the sessions *deaths* and *kills* will be counted to see if there is a difference in using a HUD or not.

4.2 Design

The study employed a within-subjects design where participants played two versions of the same mission in either *Battlefield 1* (EA DICE, 2016) or *Battlefield 4* (EA DICE, 2013). One version contained *non-diegetic UI* elements and in the other version the *non-diegetic UI* elements were removed, leaving only *diegetic UI* elements. *Figure 1* shows a screenshot of the original *Battlefield 4* (EA DICE, 2013) game interface with *non-diegetic UI* elements visible.

![Figure 1. Battlefield 4 with HUD](image)

4.3 Participants

Eighteen participants of varying age and gender were recruited for this study from the local area of both authors. Participants had varying experience with the games played and the first person shooter genre as a whole. All participants were familiar with the layout of a keyboard, but not necessarily familiar with the usual FPS controls. We provided a control scheme printed out on a paper and explained the controls to the participants verbally to help them familiarise themselves with the controls used in the games. The authors sought to gather as many participants as possible and have them play the games equally distributed so that both games would
have the same amount of playthroughs. The participants either played one game or both games with and without the HUD active.

4.4 Materials

*Battlefield 4* (EA DICE, 2013) was chosen because it is a popular FPS game which allows the user to completely remove the HUD. The mission “Suez Canal” was chosen because it was one of the shortest and most straightforward missions with minimal downtime due to cinematics and scripted events. It was also chosen because it matched the mission used in *Battlefield 1* (EA DICE, 2016) both in length and amount of checkpoints.

*Battlefield 4* (EA DICE, 2013) is set in a modern environment and the player’s objective in the mission is to recapture an aircraft carrier in the Suez Canal. Only the first part of this mission was used, and the mission was counted as complete if the participant managed to reach the scripted event below deck. When testing the mission it was completed in approximately 6 minutes and 30 seconds without ignoring enemies to shorten the time.

*Battlefield 1* (EA DICE, 2016) was chosen because it is similar to *Battlefield 4* (EA DICE, 2013) in realism and follows the same control scheme. The game is set during World War One and the mission played is called “The Runner - Be safe” and is a fictional recreation of the landing at Cape Helles. This mission was selected because it had an objective similar to the mission used in the *Battlefield 4* (EA DICE, 2013) version and had a similar gameplay experience as an infantry soldier. The mission was tested and completed in approximately 6 minutes and 30 seconds without ignoring enemies to shorten the time.

Both *Battlefield 1* (EA DICE, 2016) and *Battlefield 4* (EA DICE, 2013) were chosen because they both are part of the Battlefield franchise, one of the leading FPS franchises in the game industry. Both games have also received good ratings on Metacritic.com (2017), which is a website that sums up all reviews of the game made by critics. *Battlefield 1* (EA DICE, 2016) received 88 points of 100 possible and *Battlefield 4* (EA DICE, 2013) received 81 points of 100 possible. The games aim for realism and therefore use realistic physics and destruction to enhance immersion.
The non-diegetic UI elements that were removed in the diegetic version (figure 2) included: Crosshairs, teammate markers and names, minimap, objective markers, compass, ammo display, health, notifications, environment interaction, warning indicators for grenades and damage. Audio cues were still present to guide the player in both versions.

![Figure 2. Battlefield 4 without HUD](image)

To turn off the diegetic UI elements in the games played we did the following:

For Battlefield 1: After starting the mission, but before moving, the menu was entered using the ESC button from there tab options was selected, then the tab Gameplay, and from there the option Show HUD was toggled off. In Battlefield 4 the HUD was toggled off using the command console.

Players were instructed not to use any weapon crates in either versions of Battlefield 4 as they were not usable without non-diegetic UI elements, which would give players using HUD an advantage.

Both games were played on High settings with the resolution 1920x1080. The keyboard layout used was Nordic.
4.5 Procedure

First, the participants were introduced to the study and given the controls of both games shown a control scheme printed out on paper and explained verbally. The location of the study varied but it was always in a quiet environment where the author or authors could be alone with the participant, either at the local university or at the participant's house. They were then asked to answer questions regarding their gaming habits, namely how much time they had played first person shooter games and if they had played the game chosen before.

Both versions of the game or games was played for 10 minutes or until completion; we counted kills made, number of times the player character died, time and checkpoints reached. After each 10 minute session the participant filled in the PENS questionnaire (see Appendix A) and then played the mission again for 10 minutes with the other HUD settings so that it got counterbalanced. Meaning that if a participant started off playing with HUD for the first 10 minutes, the participant would then continue playing the second session without HUD for 10 minutes. The notes taken from each play test regarding statistics were filled in after each play test. Since both mission could be completed in approximately 6 and a half minutes, 10 minutes was deemed a reasonable amount of time for each mission as it would encourage the participant to complete the mission yet giving them some time to play cautiously.

The participants were not given any instructions other than the control schemes as it could affect their performance, giving some of them an advantage. Even though the authors sometimes wished they could have made an exception, no information was given, to ensure that all were treated equally.
5 Results

Box plots have been created (see figure 3 and figure 4) in order to visually present our data, where the scores of the three variables *kills*, *deaths* and *presence* are shown. The scores of these variables are compared with conditions *active HUD* (yes/no) and previous *FPS experience* (measured by how often they play FPS games).

In the box plots, the boxes represent the first and third quartiles, where the middle line inside of the box is the median. The whiskers give the range of the most extreme data points and the dots represent the outliers.

*Figure 3. Kills and Deaths statistics.*

*Figure 3* is a comparison of how well the players did in both games, with or without HUD, based on how often they play FPS games, which is displayed on the x-
axis. The box plot on the left shows the number of enemies killed in a mission on the y-axis. The box plot on the right shows the amount of deaths suffered in a mission on the y-axis. Both box plots display the usage of HUD through different coloured boxes, blue for missions played with HUD and red for missions played without HUD.

![Figure 4. Presence Values](image)

*Figure 4* shows the amount of presence the participants felt when playing the games with and without HUD. The presence levels are displayed on the y-axis and are compared based on how often participants play FPS games, which is shown along the x-axis. The box plot displays the usage of HUD through different coloured boxes, blue for missions played with HUD and red for missions played without HUD.
Table 1. Regression results: Kills ~ FPS * HUD and Deaths ~ FPS * HUD

<table>
<thead>
<tr>
<th></th>
<th>Kills</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>3.18</td>
<td>1.44</td>
</tr>
<tr>
<td></td>
<td>(0.17)</td>
<td>(0.17)</td>
</tr>
<tr>
<td>HUDYes</td>
<td>-0.14</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>FPSA few times every month</td>
<td>0.17</td>
<td>-0.45</td>
</tr>
<tr>
<td></td>
<td>(0.33)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>FPSA few times every week</td>
<td>0.58</td>
<td>-0.63</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.42)</td>
</tr>
<tr>
<td>HUDYes:FPSA few times every month</td>
<td>0.53</td>
<td>-0.25</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.42)</td>
</tr>
<tr>
<td>HUDYes:FPSA few times every week</td>
<td>0.13</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.43)</td>
</tr>
<tr>
<td>AIC</td>
<td>497.36</td>
<td>277.96</td>
</tr>
<tr>
<td>BIC</td>
<td>512.02</td>
<td>292.63</td>
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<tr>
<td>Log Likelihood</td>
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<tr>
<td>Num. obs.</td>
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<td>60</td>
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<tr>
<td>Num. groups: ID</td>
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</tr>
<tr>
<td>Var: ID (Intercept)</td>
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<td>0.19</td>
</tr>
</tbody>
</table>

*** p < 0.001, ** p < 0.01, * p < 0.05

Table 2. Regression results: Presence ~ Game * FPS + HUD

<table>
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<tr>
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<th>Presence</th>
</tr>
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<tbody>
<tr>
<td>(Intercept)</td>
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</tr>
<tr>
<td></td>
<td>(0.25)</td>
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<tr>
<td>GameBF4</td>
<td>-0.01</td>
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<td></td>
<td>(0.22)</td>
</tr>
<tr>
<td>FPSA few times every month</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>(0.49)</td>
</tr>
<tr>
<td>FPSA few times every week</td>
<td>-0.51</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
</tr>
<tr>
<td>HUDYes</td>
<td>-0.34</td>
</tr>
<tr>
<td></td>
<td>(0.18)</td>
</tr>
<tr>
<td>GameBF4:FPSA few times every month</td>
<td>-0.73</td>
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<tr>
<td></td>
<td>(0.59)</td>
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<tr>
<td>GameBF4:FPSA few times every week</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
</tr>
<tr>
<td>AIC</td>
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<td>BIC</td>
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<tr>
<td>Var: Residual</td>
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</tbody>
</table>

*** p < 0.001, ** p < 0.01, * p < 0.05
The results for player performance are presented in *table 1* and the results for the participant presence scores are presented in *table 2*. These figures show that there are some differences in the results. The differences in number of deaths per mission shown to the right in *table 1* and the differences in participants perceived presence shown in *table 2* are not significant. The difference in number of kills per mission shown to the left in *table 1* is significant and shows that participants that played FPS games only *a few times every month* generally had a higher number of enemies killed when playing with the HUD active. However, the overall number of enemies killed was lower when the HUD was active. The number of enemies killed is affected more by the previous FPS experience than by the amount of HUD present on the screen, more experienced players generally managed to kill more enemies. This is shown in the left box plot in *figure 3*, where players with more experience are shown to have killed more enemies.
6 Discussion

6.1 HUD impact on Immersion

The first hypothesis examined was that “players with more experience feel more immersed when playing without HUD”. The second hypothesis was that less experienced players would feel more immersed with the HUD active.

The results of this study were not significantly different when looking at the presence scores. We did not find any significant differences in presence scores between the conditions, HUD and no HUD. Therefore, the data does not support our first or second hypothesis. Jørgensen (2012, p.160) mentioned, that the UI and HUD would increase the involvement and hence increase the feeling of presence. Since our data did not show any significant differences, our results cannot back this statement.

6.2 HUD impact on performance

Iacovides et al. (2015) concluded that the HUD only impacts the immersion of expert players but did not measure how the HUD impacted the performance of the player. We found that even though the results did not show significant differences in the presence scores of less experienced players when the HUD was active, the results did show that the HUD had an impact on how the player progressed in the game as they managed to kill more enemies when the HUD was inactive. As opposed to the players that only played a few times every month, the results showed that the overall number of kills decreased when the players played with HUD activated. This is the opposite of the third hypothesis “Players with HUD activated will have more kills and less deaths”. The only participants with significant differences in number of enemies killed were the participants that only played FPS games a few times every month. These participants killed more enemies with the HUD active as the hypothesis suggests. The amount of deaths were not significantly different with or without HUD activated.

During the study we found that the amount of enemies killed was affected more by the participants prior experience with the FPS genre than by the HUD. The
participants with more experience had a tendency to die less, resulting in a higher number of enemies killed per death, giving them higher kill to death ratios.

6.3 Future Research & Notations

A possible reason for us not getting any significantly different results is that we were unable to recruit enough people, which led to a smaller pool of participants that varied a lot in gaming experience, with the majority having little to none experience with FPS games. Since the majority of the participants answered in the questionnaire that they played FPS games less than once a month the pool was quite one-sided, which has most likely impacted the results. In the study conducted by Iacovides et al. (2015) the participants were screened to make sure that they enjoyed playing FPS game. This, along with the fact that they only had two different tiers of experience is most likely one of the factors that make our results differ from theirs.

We hope that our findings, although not significantly different, could be of help to others for further research within game studies and especially the impact that the HUD has on the player experience. To get more precise results, the researcher could have larger groups of participants with a more even distribution of previous experience in gaming, to see if there are any significant differences among the different groups. The researcher should consider having more alternatives to choose from when answering the questions about earlier experience. There were a lot of participants who had played FPS games under a long period of time but not so much during the last year. A solution to this could be to add a question regarding the estimated number of hours played FPS games in addition to how often and selecting participants depending on those answers.

Something that was noted but was not recorded was the many positive and negative facial and auditory expression that the participants performed during gameplay. This shows just how much games affect the player, maybe even without them knowing it. Many of the participants reacted to what happened in the game differently, most of the players did however try to engage one of us with idle talk and comments on what happened. This could be interesting for future research, measuring how another person in the room impacts the player immersion and performance.
We also noted that the player behavior changed drastically when playing without the HUD. In *Battlefield 1* (EA DICE, 2016) the players took a more careful approach and preferred to play stealthy, sneaking up on their enemies and executing a melee attack. In *Battlefield 4* (EA DICE, 2013) the players instead used cover a lot more, peeking over quickly to spot enemies without getting shot before taking cover again. Most likely because they no longer had a radar that showed them where enemies were located, which made it difficult due to all the smoke and fire present in the mission.

Something that may have affected the results is the impact of a learning curve among the participants, meaning that they could have learned where to go and where all the enemies were located while playing the first session. Although only one participant managed to complete a *Battlefield 1* (EA DICE, 2016) session within the given time limit, it is suspected that the number of kills and deaths may have been affected which in turn affects the outcome of the study. We had anticipated some difference between the first and second session and to limit the impact on results approximately half of the participants played the first session with HUD and the other half played the first session without HUD.
7 Conclusions

The data did not show any significant difference when playing with HUD in terms of presence. Previous experience with FPS games did however affect the amount of kills and deaths during the missions. Participants playing with HUD generally had less kills, however, participants that answered that they play FPS games a few times every month killed more enemies when the HUD was active. There were no significant differences in the amount of deaths when comparing the session with the HUD active and the session with the HUD inactive.
References


Appendix A

PENS: Physical/Emotional/Narrative Presence Scale

1. When playing the game, I feel transported to another time and place.

2. Exploring the game world feels like taking an actual trip to a new place.

3. When moving through the game world I feel as if I am actually there.

4. I am not impacted emotionally by events in the game (-).

5. The game was emotionally engaging.

6. I experience feelings as deeply in the game as I have in real life.

7. When playing the game I feel as if I was part of the story.

8. When I accomplished something in the game I experienced genuine pride.

9. I had reactions to events and characters in the game as if they were real.
Appendix B

Control Scheme