Taking a Look at the Player's Gaze: The Effects of Gaze Visualizations on the Perceived Presence in Games

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ABSTRACT

Gaze input in the context of games proves to be an interesting and challenging field. One research area is the integration of gaze interaction into the game interface (diegetic/virtual approach) and its effects on players. In order to address this issue we conducted an experimental study consisting of two game prototypes with two variants (2D platformer/3D exploration game) focusing on presence. Results show that the game genre has a strong influence on the perceived spatial presence. The type of interface (diegetic/virtual - the players' current gaze position) plays only a minor role. However, some effects can be identified: although an explicit gaze visualization may have a negative impact, the visualization is ignored by the subjects after some playtime. Furthermore, players interpret the interface sot that it matches their perception of the game world.

Keywords

Eye tracking, presence, game interfaces, gaze-based interaction

INTRODUCTION

When looking at the technological advancements in gaming, it becomes apparent that the diversity of game input devices has increased dramatically. Controllers, such as the Oculus Rift (2015), grant players to experience digital worlds in a way that previously required expensive equipment. Nowadays, game control devices are attractive for a broad consumer market, and promise players to interact with games in more natural ways (Smith et al., 2006). This trend also applies to eye tracking technology.

Eye trackers are efficiently integrated into games as the technology has become affordable and more accurate (Sundstedt et al., 2010). Companies such as Tobii (2015) or SMI (2015) encourage developers to identify and create concepts for future gaze-based games. Several studies show that these new game controllers have a positive impact on the phenomenon called presence (e.g. Tamborini et al., 2006). In artificially established

environments like games presence refers to the sense of "being there", which has a crucial impact on other factors such as the gaming experience (Schultze et al., 2010). However, research effort within this field is only in its infancy. More insights need to be gained in order to understand the relation between intuitive controllers (such as eye trackers) and presence.

We have to acknowledge that the phenomenon does not automatically emerge when using one of these input devices. To achieve a high degree of presence, one has to consider the elements that establish a connection between the control device and the game world. These elements are, for instance, the game mechanics (effect of the device within the game world), or the way in which the device and its effects are visualized via the game interface.

The element game interface will be the focus of this article. Game interface designers are confronted with different strategies to visually integrate eye tracking data into the game world. One way to achieve this is by utilizing virtual interface elements (such as head up displays - HUDs). Another solution would is to embed the information in the game world (diegetic approach). However, the question arises which interface design strategy should a creator of a gaze-based game interface apply to achieve a high degree of presence? Which factors influence the chosen design strategy (genre, game complexity, etc.)?

We tried to shed some light on this problem by conducting an experiment consisting of two game prototypes. Each prototype represents a different genre (with distinct mechanics, perspectives, etc.) and is further subdivided into two variants (see section "Experiment Description" for further information). The proposed study should provide valuable insights, both for game interface designers and researchers, as it tries to identify several relevant design factors that contribute to presence in the context of gaze-based game interaction.

First, a state of the art analysis dealing with the topics eye tracking (especially gaze-based interaction) and presence in games is be given. Then, we will link these findings to the research conducted on game interfaces. Based on the theoretical considerations we will describe our experimental setting, our hypotheses, as well as our gathered results and the discussion.

EYE TRACKING IN GAMES
In gaming, eye tracking is a relatively new field and can be utilized in several ways (Almeida et al., 2011). Eye tracking systems can be employed for evaluating game experiences as well as interacting with games.

Concerning the evaluation of game experience, Johanson & colleagues (2008), for instance, focused on the challenges to persuade game designers to consider the relevance of usability results. By trying to find out how to involve game designers in usability-related work and identify methods which could provide new information about player behavior and experience, they were able to demonstrate the benefits of eye tracking technology as a means to solve game level related problems.

El-Nasr & Yan (2006) hypothesized that game and level design could benefit if players' visual search patterns were analyzed and understood. Level designers could improve game play by altering game level elements (textures, colors and object placement) to support players' visual attention patterns. They conducted two studies to determine if the

players' visual attention followed the bottom-up or top-down visual theories. By employing two different game genres, they came to the conclusion that due to the goal orientated nature of action-adventure games, top-down visual patterns emerge more frequently. In the second study (FPS game condition), they discovered that players concentrate on the center of the screen. These visual search patterns contrast with those found for the first game (action adventure), where players showed a more heterogeneous visual search pattern.

Apart from eye tracking as an evaluation tool, several studies were conducted to examine eye tracking as an interaction method. In one of their projects, Nacke et al. (2011) pursued a hybrid approach by creating a framework that allows rapid game development and gameplay analysis. The researchers carried out an experimental study using gaze-only interaction in a game, which highlights the framework's capacity to create games and evaluate novel entertainment interfaces.

Krejtz at al. (2014) proposed a game study focusing on the usability consequences of cueing visual attention in gaze-controlled gaming. Results indicated that such cueing influences performance and affects the subjective gaming experience. Visual cues have the effect that the game experience is less enjoyable and less immersive. It was also revealed that gaze-controlled gaming does not require additional cognitive effort. Results suggest that the applicability of cuing (or not cuing) game elements depends on the game type.

Møller Nielsen et al. (2012) presented an experiment comparing performance and game experience of gaze and mouse interaction in a 3D flying game. The researchers found that the mouse interaction not only provides a better performance and participants consider it less demanding, less frustrating and less difficult, but that gaze interaction also leads to a higher level of engagement. They concluded that gaze interaction (steering) grants players high kinesthetic pleasure due to the unique combination of fixation and motion.

Ekman and colleagues (2008) conceptualized a gaze-based game design, which makes use of gaze, blinking and pupil size to alter the game state. The design was based on the fact that the pupil size can be modified by strong emotional experiences and high cognitive effort. The proposed concept mapped the degree of pupil variation and allowed players to control game objects through the use of will-power. In another research project Smith and Graham (2006) integrated eye tracking in a first-person shooter game, a role playing game, and a classic arcade game called "Missile Command". They stated that eye tracking can significantly alter the gaming experience. When utilizing eye tracking, pointing and selecting are merged into a single action.

Although research in the context of eye tracking has received increased attention by the scientific community, it is still only at the beginning. Just recently, the workshop "Eyeplay" at the CHI Play 2014 conference highlighted several research opportunities ranging from serious games contexts to the impact of eye tracking on the gaming experience (Turner et al., 2014). One relevant factor in this regard is the phenomenon called presence.

Presence in Games
When looking at available definitions, it becomes apparent that there is a certain degree of confusion about the precise meaning of presence (Calleja, 2011). According to Lee (2004) it can be understood as a psychological state in which the artificiality of an

experience is not noticed by the subject. Schultze et al. (2010) state that the term refers to the sense of existing or of "being there" in a virtual environment. Presence is a complex phenomenon composed of various dimensions. One of these dimensions is called spatial presence and describes the sensation of a user being in the mediated environment (Behm & Morawitz, 2013). Referring to Wirth et al. (2007), spatial presence can be further subdivided into two dimensions. The first sub-dimension is termed "self-location", referring to the player's perception of being physically situated within the environment simulated by the technology. The second one deals with the perceived possibilities to act within the environment ("possible actions").

Several research projects were carried out to analyze presence in the field of game controllers (e.g. McEwan et al., 2012). Nacke at al. (2010) presented a study dealing with the impact of interaction modes (traditional game controller, Wii remote, Nunchuk) on the subjective experience (one factor: spatial presence). Nacke and his colleagues discovered that presence is experienced more significantly while using the Wii remote controller compared to the traditional controller. Following Nacke et al., the interaction with the more naturally mapped Wii remote positively influences the experience of spatial presence through self-location.

All these studies stress the importance of research in the context of presence in games (especially in regard to naturally mapped game devices). Several research attempts with well-established devices (example: Wii) were carried out to gain a better understanding of the subject. Surprisingly, little research has been carried out in the field of gaze interaction and presence. The following section should provide an overview on the current findings.

Gaze Interaction and Presence

Investigating gaze-based games and their relation to presence is fairly new. Important contributions were made by Nacke at al. (2009), who found out that the challenge of controlling the game through gaze leads to a positive spatial presence among players (as well as other game experience related factors). These results are in line with those found by Hartescu & Oikonomou (2011). Although the eye tracking devices are not as effective as their traditional counterparts (e.g. a mouse), players have a more pleasant gaming experience and a higher degree of presence. Similar findings were also discovered by Gowases et al. (2008), who used gaze-based games in an educational setting.

In another research project Lankes et al. (2014) examined the influence of different loci of manipulation relations (position of the player's ability to assert control) on presence. The researchers utilized eye tracking technology, and carried out a comparative study consisting of four scenarios based on a 2D platform game.

Three scenarios were controlled using an eye tracking device and a gamepad. They differed in their relation between the player character and the avatar. The 4th scenario was solely controlled with the gamepad. Results showed that the inclusion of gaze input to investigate this issue proved to be very effective. It was discovered that the degree of the loci of manipulation strongly influences the perceived presence and its sub-dimensions. Furthermore, in comparison to traditional approaches, gaze input facilitates presence on different dimensions. Although important steps have been taken, further research is required. A common issue of many experiments lies in the focus on input hardware comparisons (mouse, keyboard, controller, eye tracker, etc.). Research on aesthetic considerations (such as the visual representation and feedback of the gaze input)

are not available. Thus, very little is known about how these novel interaction devices should be employed to create a positive player experience. Birk and Mandryk (2013), for instance, mention that the game used in their experiment was intentionally designed to be without any dramatic elements. Consequently, visual elements such as graphics, the visualization of the interface as well as the story were not part of their investigation. They add, though, that the inclusion of dramatic and other game art elements appear to be an interesting research direction. This paper addresses this by investigating the visualization of gaze within the interface in order to achieve a high degree of presence.

THE VISUAL REPRESENTATION OF THE PLAYER'S GAZE

Schell (2008) describes the term user interface (UI) in gaming as a mediator between the player and the game as it gives the player access to the game world. This mediation manifests itself both physically and virtually: the physical interface is made up of the hardware, such as controllers and displays, while the virtual interface consists of the auditory and visual software features. Physical interfaces range from well-known input devices to more novel forms of interaction such as eye tracking devices.

The range of the virtual interfaces, on the other hand, may vary considerably, ranging from the minimal and transparent HUDs, to the solid overlays or pop-up windows. A very common interface feature is that every element is located in one dimension between the screen and the interior of the game world. These elements may be buttons or mouse pointers, etc., which are clearly distinguishable from the virtual world.

However, in other cases the boundaries between the game world and the player are not that obvious: interface features may be part of the game world while communicating with the player on the outside, or vice versa. Since they are part of the game world, these interface elements are often referred to as "diegetic". Following the structuralist-linguistic understanding of narratives, the term diegetic refers to the world in which the events of a story occur (Genette, 1980). Interface features may be an integral part even though they clearly communicate usability information to the player (current health status, maps, etc.). Furthermore, they can turn out to be external to the game world, although the elements are recognized by Non-Player Characters (NPCs). Designers propagating a diegetic approach strive to convey all system information through features that are part of the game world, such as character dialogue or animations.

When looking at the current practices in game interface design, two strategies towards the employment of elements in game interfaces exist: many interface designers try to minimize the presence of UI components as much as possible by integrating them (or at least parts of them) into the game world (Andrews, 2010; Fagerholt & Lorentzon, 2009). They argue that any sign of mediation or visibility of the system behind has a negative impact on the sense of presence (Wilson, 2006).

On the other hand, there are those researchers who claim that such features do no harm since they are needed and have become a conventional form of communication (Weise, 2008). They stress the importance of making the system information explicit and readily visible to the player. To provide a solution to this issue Llanos (2011) put forward that basically the system information should be combined with the game world, as it allows players to reason and make in-game choices based on their real-life knowledge. When this approach does not transport the relevant information, functionality, clarity and consistency are more important than world integration.

Until now, no consensus for an overall and integrative solution has been found. The matter is further complicated when considering the integration of diegetic/non-diegetic (virtual) interface elements with naturally mapped game control devices. This is especially significant for gaze-based game interaction as eye tracking devices are deemed to be a technology that fosters presence via naturally mapped interaction. Thus, we propose an experimental setting that should reveal effects of the visual representation of the player's gaze in regard to the player's experience of the phenomenon presence.

EXPERIMENT DESCRIPTION

The previous section highlighted the lack of knowledge of certain aspects concerning the impact of gaze interaction on presence. Although current research implies that interaction techniques via gaze contribute to presence to a certain degree, we deem that it is not sufficient to just include gaze input in existing or new game designs. Several aspects have to be considered to receive a desired effect.

One of these aspects is the incorporation of gaze input in the game interface. As previously stated, various strategies exist for creating compelling visual game interfaces. One approach propagates diegetic interfaces that pursue the inclusion of interface elements into the game world, while other creators share the opinion that it is more important that players are well informed about the current game situation (via virtual interface elements such as HUDs).

There is no doubt there are many open questions in this field: should designers strive for virtual interface elements to make playful gaze interaction more pleasant and also more effective, or should the interface design conceal information regarding the gaze interaction? Does the game genre play a relevant role in this consideration? Games that require twitch skills (quick reactions to situations such as in jump and run games or racing games) may require information about the current gaze position. The lack of these elements might have a negative impact on the presence experience.

The question can be generalized by asking if the gaze-related virtual interface information (e.g. the position of the players gaze via visual elements) has an impact on the player's presence. The following sections will describe our practical approach to answering this question by presenting our game prototypes (scenarios), our proposed hypotheses, the participants and chosen procedure, the measures used, as well as the data analysis.

Scenarios

We created four different scenarios based on two different games with two variations. Each game is based on a genre (2D platformer and 1st person exploration game) in order to gain a more comprehensive understanding on the phenomenon presence. By creating more than just one game we had the opportunity to carry out comparisons between games that are composed of specific game mechanics, goals, graphics, perspectives and means of interaction. We chose to create game prototypes instead of using available games and incorporate eye tracking to guarantee that the gaze interaction was tightly integrated into the game design. We also made sure that by designing the games ourselves we were in control over the various game elements. To get a better impression of the employed prototypes a brief description of the developed game designs is be given.

Game Prototype 1: Limus and the Eyes of the Beholders
The first game is called "Limus and the Eyes of the Beholders" and is based on several mechanics used in the game Super Mario World (a typical 2D platform game). It was also used in another study to investigate the relation between gaze input in the context of game mechanics and presence (Lankes et al., 2014). We chose this type of game as it represents a well-known genre with a simple game design. We took inspiration from the ghost house stages in Super Mario World: while exploring the level, Mario is confronted with an enemy called Boo. This type of enemy can only be avoided but not defeated by Mario. When the ghost detects him, it moves towards Mario's position to catch him. The only way to stop the ghosts is by having Mario look at them. When they are being watched they are scared and are unable to move. The player is constantly in the dilemma of either moving forward to reach the end of the level, or looking back to freeze the chasing enemies.
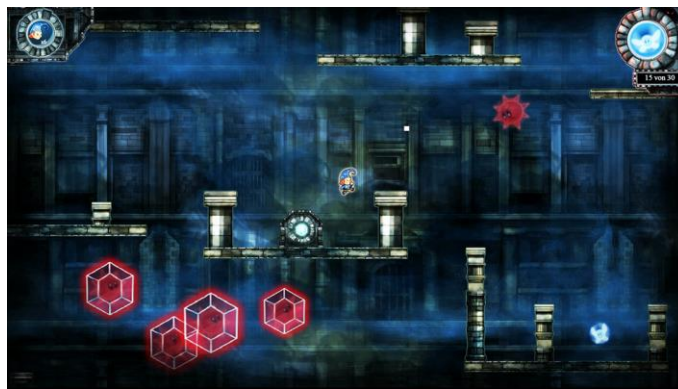
Figure 1: Game Prototype 1 called "Limus and the Eyes of the Beholders". This screenshot shows the second variant where the player's gaze is represented via a small white rectangle.

This mechanic served as the basic component for our prototype: our hero, called Limus, has to escape a dark cellar by reaching a magic portal. To grant players a certain amount of challenge, several obstacles, such as pits and small platforms, have to be mastered. The lives of Limus are limited, but can be refilled by collecting the light ghosts "Lumees" that are also present in the cellar. Additionally, sphere-shaped enemies with spikes, called "Spikees", chase the player. Their behavior patterns are similar to the previously described Boos. When they see Limus, they try to catch him. A scene including all the main actors of our game can be seen in Figure 1. As in Super Mario World the player controls the avatar (Limus) using a gamepad.

In contrast to the ghost stages of Super Mario world, though, players are not only required to use the eyes of Limus, but also their own to stop the Spikees. When players look at the Spikees they immediately freeze for 3 seconds. This gives the players time to get passed them. To provide a certain amount of challenge and a constantly increasing level of difficulty, the Spikees chase Limus until he reaches the magic portal. This means that at the end of the level 8 Spikees are in pursuit of the little wizard.

As previously stated, each game is made up of two variants: one that explicitly includes visual information about the current gaze position (abbreviation: LimR – Limus with rectangle), and another one that shows only the reaction to the gaze input within the game

world (variant: LimWR – Limus without rectangle). The visualization of the game position was done by including a small white rectangle. This simple abstract design was chosen as it should be applicable for the both prototypes. An overly stylized version may have led to unwanted material effects.

Game Prototype 2: Fractile

The second game prototype, called "Fractile", is a 1st person perspective game with a strong focus on exploration and storytelling. The players arrive at an abandoned village and are confronted with their past as several years before the players' avatar committed war crimes in this area. When players walk through the scenery, the village suddenly becomes alive as fractured images of people appear (see Figure 2). This means that only parts of the people (white shapes) become visible (like a portal to another dimension) via the players' gaze.

Figure 2: 1st person perspective game prototype called "Fractile". Depending on the current gaze position, fragments of people become visible.

The player takes the role of an observer (a passive game character). This is emphasized by the storytelling (victim and culprit) as well as the way players interact with the game world (agency). At the beginning of the game players do not know that they are responsible for the fate of the people. After some level exploration the players find out that soldiers (black shapes) invaded the village and killed its inhabitants. In the end it is revealed that the players' avatar is responsible for the tragic events as they gave the order to carry out the executions.

Players control the game with an Xbox 360 Controller and their gaze. Concerning the mapping of the gamepad controls, conventions from First Person Shooters (FPS) were used: with the left analog stick players can move forward, backward, left or right. With the right analog stick the movement of the avatar's head was realized. The game does not include any interaction with the gamepad buttons. With their gaze, however, players are able to control which parts of the memories (villagers) are shown. If players look at specific points, parts of the people will appear; if players look away, the images will fade out again. To support the interaction style (gaze interaction – fractured parts) and the serious theme of the setting (war crimes) an abstract design was chosen. The game world is composed of red, black, and grey low-polygon elements. The villagers and the soldiers, however, should be easily identified. Thus, they are made up of flat-shaded white and black shapes. As in prototype 1, two variants of the game prototype were created. FractR (Fractile with rectangle) includes a white rectangle indicating the current player's gaze

position. The second variant, FractWR (Fractile without rectangle), does not contain any virtual interface information. Only the effect of the gaze, the revelation of the village inhabitants and the soldiers, is shown.

Hypotheses

We are of the opinion that each of the proposed scenarios should arouse a different feeling of presence. The following hypotheses are formulated:

H1 – Spatial Presence Self Location (SPSL): If the player is engaged in a game with a 1st person camera perspective and a visualization of the gaze position via diegetic means, then the perceived SPSL is higher in comparison to a 3rd person perspective and an interface that explicitly shows the current gaze location.

H1 deals with the dimension that reflects the physical quality of presence and describes the impression to be physically in the middle of the virtual game environment. Since the game world is perceived through their very own eyes it is assumed that a 1st person perspective camera contributes to the presence experience.

In a traditional 2D game players act through their avatar (their representation in the game world). They are able to perceive their representation from a certain distance, which typically decreases SPSL. An interface solution that explicitly shows the current gaze position is also deemed to have a negative effect on SPSL. Players become aware of the tracking device as it constantly updates the gaze data on screen. Based on these considerations it is assumed that FractWR has higher SPSL ratings, followed by FractR, LimWR, and LimR.

H2 – Spatial Presence Possible Actions (SPPA): If the player is engaged in a game that requires twitch skills (act quickly, make decisions under pressure) and offers explicit visual feedback of the gaze position, then the perceived SPPA is higher in comparison to a game with lower pacing, reduced means of interaction or a game with no visual cues about the current gaze position.

By providing more information about the current game situation (position of gaze) decision processes during gameplay should become more effective. Furthermore, a game prototype like Limus and the Eyes of the Beholders offers more ways to interact with the game world (react to various obstacles like pitfalls or enemies, collect goodies, etc.) when compared to a game such as Fractile with little interaction possibilities. Therefore, we think that LimR will have the highest SPPA scores, followed by LimWR, FractR, FractWR.

Participants and Procedure

The study was conducted at the game exhibition "Gamestage Expo" in Linz, Austria. The sample consisted of 100 participants, aged 7 to 67 years ($M=26,18$, $SD=8,5$). Women, however, were underrepresented in our study (22% female and 78% male). We received a fairly heterogeneous sample as we randomly asked visitors of the exhibition to take part in our study. The majority of subjects consisted of pupils and students (57%), followed by working people (41%). The remaining test participants were either retirees or job seekers. Furthermore, it was found that the majority of people (44%) play computer games on a regular basis, while 25% of people noted that they play games several times a week. Additionally, subjects that play games occasionally were also part of the study (27%). Only 4% indicated that they do not play any games.

The procedure took between 10 to 15 minutes per participant. The experimental setting was made up of a desktop PC and a Tobii Rex eye tracker (game prototype: Limus and the Eye of the Beholder), and the Tobii EyeX (prototype: Fractile). The prototypes were created using the software Construct 2 and Unity3D (see Figure 3).

Figure 3: The employed setup consisting of a standard PC, a Tobii EyeX and a Tobii REX Eyetracker, an Xbox controller and headphones (Fractile game prototype).

Each subject played only one of the four prototypes, which typically resulted in 25 data sets per game prototype variant. The decision to confront participants with only one prototype variant had the drawback that a fairly low number of replies per scenario was gathered. On the other hand it had a beneficial impact concerning the reduction of learning effects (eye tracking).

The evaluation was carried out as follows: as a first step, the experimenter welcomed the participants and provided a short introductory text that gave an overview of the procedure and purpose of the study. As the control scheme and the genre of both prototypes were easy to comprehend, subjects had no difficulties to get into the games. Each evaluation part started with a tutorial showing the basic means of interaction. Participants were instructed about the setting and the game goals. When subjects confirmed that every aspect was clear to them the evaluation began. When the interaction was completed, the experimenter instructed the participants to fill out the questionnaire, which had questions on the spatial presence (self location and possible actions), as well as some demographic questions and qualitative questions about the gaming experience and the gaze interaction.

Measures

All dependent data was collected by using validated scales. To measure the spatial presence dimensions the (MEC-SPQ) by Vorderer et al. (2004) was employed as it was used in another study by Lankes et al. (2014). The questionnaire was designed to measure spatial presence and consists of nine scales. Four of the scales feature process factors, two scales refer to states and actions and three scales include trait-like personality characteristics.

Two of the process scales, spatial presence: self location (SPSL) and spatial presence: possible actions (SPPA), were utilized in the study. SPSL specifically reflects the physical quality of presence (example: "I had the feeling that I was in the middle of the

action rather than merely observing."). It measures the impression of the subject to be physically in the middle of the virtual game environment. SPPA assesses the impression of being able to act (example: "The objects in the presentation gave me the feeling that I could do things with them.") We decided to make use of short versions (4 items) of the scales (Cronbach's alpha for SPSL: 0.92 and for SPPA: 0.81) as the reported reliability of the scales was good (Vorderer at al., 2004). Our own findings, however, show lower, but still acceptable Cronbach's alpha values – SPSL: 0.61 and SPPA: 0.77. The items are rated using a five-point Likert scale (ranging from "strongly disagree" to "strongly agree"). Finally, the selected items were merged in order to create a score.

Data Analysis

In order to examine the underlying hypotheses, analysis were conducted using a one- way ANOVA. Alternatively, when the assumption of homogeneity of variances between the treatment groups had been violated, the Welch test was applied. All parametric tests were performed after validating the data for assumptions of ANOVA use. Pairwise comparisons used the Bonferroni method (or Tamhane T2 in cases where the variances are not sufficiently homogeneus) of adjusting the degrees of freedom for multiple comparisons (post-hoc-tests). All statistic tests were carried out with SPSS 20. Significance was set at $\alpha = 0.05$.

RESULTS

In the following section, the results of the study are presented. Insights are provided if the two scenarios and their variations have an influence on the perceived presence (dependent variable: spatial presence). Information on the dimensions spatial presence: self location (SPSL) as well as spatial presence: possible actions (SPPA) are presented. To provide an overview, a summary of the results (mean values and standard deviations of SPPA and SPSL) is shown in Table 1.

Scenario	SPPA	SPSL
Fractile with Rectangle (FractR)	3.16 (1.17)	2.66 (1.12)
Fractile without Rectangle (FractWR)	3.35 (0.81)	2.43 (0.81)
Limus with Rectangle (LimR)	2.86 (0.87)	3.32 (0.78)
Limus without Rectangle (LimWR)	2.75 (0.72)	3.62 (0.90)
Cronbach's α	0.61	0.77

Table 1: Means and standard deviation for spatial presence (SPSL and SPPA) on a scale from 1 (strongly disagree") to 5 ("strongly agree") per scenario. The internal consistency of the scales is shown by Cronbach's α.

Spatial Presence Self Location

Concerning the SPSL, results show that the employed scenarios have a significant impact on the perceived Spatial Presence: Self Location ($F_{3,52.6}= 2.9$, $p=.044$) (see Figure 4). It is demonstrated that the scenario Fractile without Rectangle (FractWR) has the highest SPSL value ($M=3.35$, $SD=0.81$), while the second highest SPSL score can be found in Fractile with Rectangle (FractR) ($M= 3.16$, $SD= 1.17$). Lower Self Location ratings were given in regard to the variants of the 2D game prototype: Limus with Rectangle (LimR) was rated a little bit higher ($M=2.86$, $SD=0.87$) than Limus without Rectangle (LimWR) ($M=2.74$, $SD=0.71$). However, via pairwise comparisons between the scenarios it is revealed that only FractWR and LimWR show significant differences ($p=.043$). All other mean values do not differ significantly.
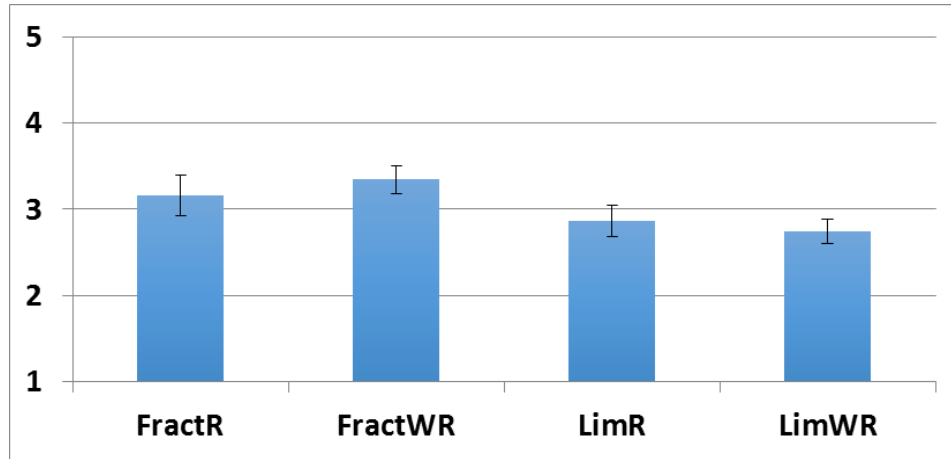
Figure 4: Means and standard error (SE) bars for Spatial Presence: Self Location of all scenarios on a scale from 1 ("strongly disagree") to 5 ("strongly agree").

Spatial Presence Possible Actions

As in the first dimension, a significant difference can be found in SPPA. The ANOVA revealed that independent variable scenario has a significant influence on SPPA ($F_{3,96}$= 9.38, $p\approx$ .000). The highest degree of SPPA is seen in the LimWR-Scenario (M=3.62, SD=0.90), followed by LimR (M= 3.32, SD=0.78). In comparison to the 2D game prototypes the 3D exploration game along with its variants was rated with lower SPPA scores: Fractile with Rectangle (FractileR) was evaluated with a mean score of M=2.66 (SD=1.11), while in FractileWR subjects gave a mean score of M=2.43 (SD=0.81). A pairwise comparison showed that the perceived SPPA in LimWR is significantly higher than in FractR and FractWR (p=.002; $p\approx$.000). Furthermore, SPPA ratings in regard to LimR received significantly better ratings than FractWR (p=.005).
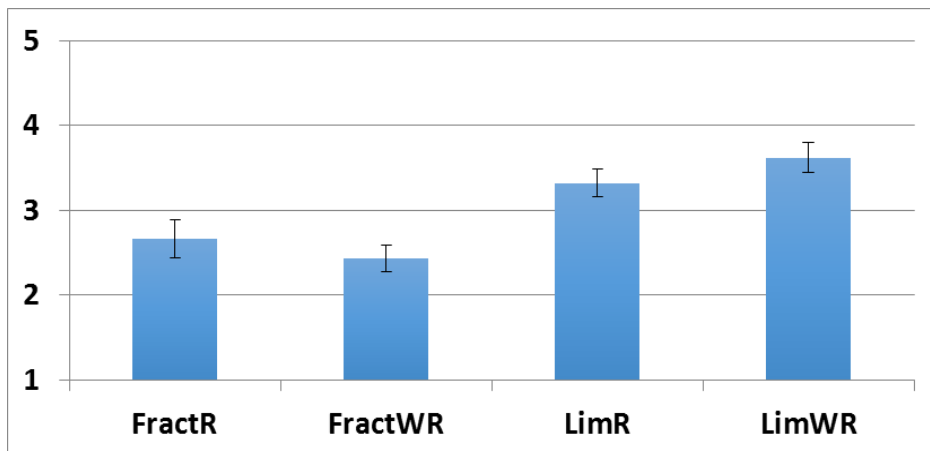
Figure 5: Means and SE bars for Spatial Presence: Possible Actions of all scenarios on a scale from 1 ("strongly disagree") to 5 ("strongly agree").

DISCUSSION

Our study shows that the employed genre has a significant impact on the perceived presence (two sub dimensions SPSL and SPPA). However, although a majority of assumptions was confirmed by the conducted experiment, the interface type had only a minor influence (difference between variations).

As anticipated in H1 FractWR had the highest SPSL ratings, followed by the second variant of the 3D exploration game (FractR). The 1st person camera perspective as well as the chosen genre had a strong influence on the scores given by the participants. A majority of FractR players mentioned that they were annoyed by the white rectangle, but only in the beginning of the play session. After some time, many participants noted that they disregarded the rectangle – they got used to it. One of the subjects indicated in the post-game interview that he was not even sure if the game included a white rectangle at all. Thus, although receiving higher SPSL scores no significant differences could be identified between FractWR and FractR.

In contrast to the assumptions of H1, results demonstrate that LimR received slightly higher SPPA scores than LimWR. An explanation can be found in the way the interface (e.g. the white rectangle) was perceived and interpreted by the participants of the study. Several subjects indicated that they see themselves as a god-like creature in the game world. It acts on a meta-level and it has to protect the little wizard. They had the impression that the white rectangle is the representation of the wizard's protector, and is therefore part of the game world.

This interpretation of the interface may be based on the control scheme and the mapping: the gaze of the player and the eyes of Limus operate independently. This means that the gaze of Limus does not have an effect on the game. It is the player's gaze that freezes the Spikees. Thus, players thought the game consists of two separate entities. These observations are confirmed by the fact that players of LimWR mentioned they were a little bit confused who they are playing.

Concerning H2 (SPPA), the employed genre also produced significant results. As it was assumed, LimWR and LimusR had the highest SPPA values. Both variants of the platform game require twitch skills, and grant players several ways to act within the game world. It has to be mentioned, however, that LimWR and LimusR do not differ significantly. This can be clarified by looking at the gaze effect feedback that was given by the game prototype. When looking at the Spikees, players immediately receive feedback via the red magical cage that encloses the enemies of the wizard. In many situations, especially later in the level, several Spikees chase the player. Therefore, players had to constantly check via their gaze if one of the enemies endangers Limus. The freeze feedback was so effective that many players took these visual cues as their primary information source of their gaze position. Thus, only minor differences in regard to the SPPA values could be found.

On the other hand, FractR and FractWR were rated with fairly low scores. The 3D exploration game does not require quick reactions, nor do players need the constant feedback about their current gaze position in order to proceed in the game. Both variants of Fractile have a strong focus on the story and do not offer any specific challenges. Thus, the type of game as well as its narrative elements have an effect on the perceived SPPA. Players mentioned that they see themselves as ghosts in the game, since they were not able to interact with the villagers.

This is also emphasized by the controls and the lack of audio feedback. Subjects reported that, in contrast to a typical first person shooter, the player's avatar in Fractile has no body but seems to float rather than walk and does not leave any traces in the game world – i.e. the avatar is only a passive character. Additionally, several subjects criticized that the exploration possibilities in the level should be increased. The reason why FractR got better SPPA-ratings than FractWR is explained by the fact that people perceived the white rectangle to observe the villagers as more useful. It gave them a feeling of being more effective.

CONCLUSION

The study revealed some alluring insights. It shows that gaze input promises great potential for game designers and researchers. The experimental study acknowledged that the game genre has a strong influence on the perceived spatial presence. The type of interface (diegetic/virtual – player's current gaze position) plays only a minor role in the context of presence. Although an explicit gaze visualization may have a negative impact on SPSL, the effects are ignored by the subjects after some time. Furthermore, the interface is interpreted in such a way so that it fits the player's perception of the game world (player as a guardian in LimR and LimWR).

However, there are some limitations. While the experiment of this paper is made up of not just one, but two game prototypes (2D platform and 3d exploration game), it would be interesting to carry out further studies based on different genres (such as action adventures or role playing games).

Furthermore, the type of the game perspective needs to be investigated in more detail. This could be achieved by creating a game prototype that utilizes a 3rd person camera perspective. Several games and game concepts have shown that the combination of gaze input and a 3rd person camera provides a rewarding game experience.

Another area for future research is the length of the play test sessions. The average playtime for each scenario was about approximately 10 minutes. The question arises, if differences in the perceived presence appear, when subjects play the game prototypes for a longer time span.

Future studies should focus on the visual quality in the context of gaze-based interfaces. Since no significant differences could be shown in regard to the type of interface solution, it makes sense to concentrate on the visual elements. One way to achieve this is by creating more stylized interface elements that have a close relation to the game world.

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