Gaze Interaction in 3D Action-Adventure Games played in Different View Modes

Monika Minichberger

MASTERARBEIT

eingereicht am
Fachhochschul-Masterstudiengang

Digital Arts

in Hagenberg

im Januar 2017

Declaration

I hereby declare and confirm that this thesis is entirely the result of my own original work. Where other sources of information have been used, they have been indicated as such and properly acknowledged. I further declare that this or similar work has not been submitted for credit elsewhere.

Hagenberg, January 23, 2017

Monika Minichberger

Contents

Abstract

The integration and usage of interactive devices, has been growing steadly in recent years. Especially in the area of gaming, this trend has resulted in devices like *Nintendo Wii*, *Microsoft Kinect*, *Oculus Rift* or the *HTC Vive* becoming increasingly popular and established.

More and more, such interactive technologies are also being integrated into computer games. This, in turn, affects the players, their playing habits and their game perception, thereby opening up new and interesting fields of research.

In a select genre of games, the player can interact only with their gaze and thereby control the action. The research focus in this thesis is based on these gaze-based interactions and their influence on the players. Therefore, the extent, to which gaze-based gadgets and different player views in the three-dimensional action adventure area can influence the *presence* of the players, is investigated. This thesis first provides an overview of existing research studies on the topics of *presence* and gaze-based interaction, before the research focus of the thesis is discussed. The focus of the study is on a special game genre with gaze-based game control in two different player views. The selected game *DayZ* is declared as a survival action game and can be played alternately with and without gaze control in the first person perspective and in the third person perspective. The resulting four game scenarios are used to measure the effect of *presence*. The results of the research study shows that the game perspectives as well as the use of the gaze-based game control have a big influence on the presence of the players. Particularly the first person perspective combined with the gaze-control gave a higher value of perceptible presence compared to the scenarios, which were played in the third person perspective and without gaze-control.

Game developers and designers can use such studies to improve games and their playing experience. This thesis, together with previous similar studies, can serve as a basis for game development and game enhancement in the area of interactive technologies with gaze-based controls.

Kurzfassung

Der Einsatz von interaktiven Geräten, vor allem im Spielesektor, wächst stetig. Dies kann man vor allem in den letzten Jahren mitverfolgen. Dabei werden Geräte wie *Nintendo Wii*, *Microsoft Kinect*, *Oculus Rift* oder die *HTC Vive* bekannter und beliebter.

Immer öfter werden solche interaktiven Technologien auch in Computerspielen integriert. Dies hat natürlich Auswirkungen auf die Spieler sowie ihre Spielwahrnehmung und eröffnet somit neue und interessante Forschungsfelder. In ausgewählten Spielen kann man beispielsweise alleine durch seinen Blick interagieren und das Geschehen steuern. Der Forschungsfokus in der vorliegenden Arbeit liegt auf genau diesen blickbasierenden Interaktionen und dessen Einfluss auf die Spieler. So wird untersucht, inwiefern blickbasierende Technologien und verschiedene Spielperspektiven im 3D Action-Adventure Bereich Einfluss auf die *Presence* der Spieler haben können.

Zu diesem Zweck werden zunächst bereits existierende Forschungsstudien zu den Themen *Presence* und blickbasierende Interaktion vorgestellt, bevor dann näher auf den Forschungsschwerpunkt der Thesis eingegangen wird. Der Fokus der Studie liegt dabei auf einem speziellen Gamegenre mit blickbasierender Spielsteuerung in zwei verschiedenen Spielperspektiven. Das ausgewählte Spiel *DayZ* wird als Survival-Action-Spiel deklariert und abwechselnd mit und ohne Blicksteuerung in der First-Person-Perspektive und in der Third-Person-Perspektive gespielt. Die sich daraus ergebenden vier Spielszenarien werden genutzt, um den Effekt von *Presence* zu messen. Die Ergebnisse der Forschungsstudie zeigen, dass die Spielperspektiven sowie die Nutzung der blickbasierenden Spielsteuerung einen Einfluss auf die *Presence* der Spieler haben. Speziell die First-Person-Perspektive in Kombination mit Blicksteuerung ergaben einen höheren Wert von wahrnehmbarer *Presence* im Vergleich zu den Szenarien der Third-Person-Perspektive und ohne Blicksteuerung.

Entwickler und Designer können solche Studien heranziehen, um Spiele und deren Spielerlebnis zu verbessern. Das vorliegende Ergebnis kann zusammen mit bereits vorangegangenen ähnlichen Studien als Basis für die Spieleentwicklung und Spieleverbesserung im Bereich dieser interaktiven Technologien mit blickbasierenden Steuerungen fungieren.

Chapter 1

Introduction

Today digital games enable a wide range of experiences. Besides beautiful rendered worlds, different challenges or memorable game characters, there are ways to create a potentially richer gaming experience through a feeling called *presence*. Especially adding interactive gadgets in games, which increased in the last years enormously, such as Microsoft Kinect[1], the Oculus Rift[2] or the HTC Vive[3] offer players a different feeling in the gaming world. It becomes clear that these kinds of game control devices are getting more and more attractive for the consumer market.

The trend of tracking eye movements and the increase in technology for this continues to improve the user experience [16]. Eye tracking technology has become more accurate and attractive for the average consumer [32] and is used more and more in the gaming area, since it is added in several well-known games like *Watch Dogs 2* [58], *DayZ* [53], *Assassin's Creed (Syndicate and Rogue)* [59, 68], *Deus Ex: Mankind Divided* [57] etc. [96].[4]

With adding an eye tracking device, it can be assumed that a simpler and more natural way of playing and interacting in games will be allowed [32]. As a consequence, players feel themselves more physically based into the gaming world, or assume being their avatar. Those feelings can be described by the phenomenon called *presence*, which is a positive respons by players according to already existing studies and their results [36]. *Presence* refers in the world of games as a sense of 'being there' and as a consequence it has an impact on the gaming experience itself [30].

However, those reflections are in an early stage and have to be investigated for a better understanding of the relationship between eye tracking

[1]The Microsoft Kinect is a motion sensing input device [81].

[2]Oculus Rift is a virtual reality headset [83].

[3]HTC Vive is a virtual reality headset [100].

[4]Creation and integration of eye tracking technology in games are provided by companies Tobii and SMI. Tobii is a Swedish technology company with main focus on eye tracking and eye tracking control [96]. SMI, short for SencoMotoric Instruments is a German company with focus on eye tracking technology [85].

technologies and *presence* in games. This thesis outlines the field of gaze-based interaction and its possible impact on players in the sector of action-adventure games in first person and third person playing view. Hypotheses and scenarios of the research study should give an insight how the specific game genre, the different playing views and the usage of gaze-based interaction with an extended view, which is called *Infinite Screen Extension* (ISE), can change a players experience in games.

Following, the term of gaze interaction as well as its possibilities and the phenomenon *presence*, both referring in the end to games, will be outlined to make the experiment description in its research study more comprehensible. The main focus of this thesis can be found in Chapter 4 'Experiment' and Chapter 5 'Results', in which the perceived *presence* of gaze-based input devices on players in first person as well as in third person perspective in the genre of action-adventure games will be evaluated and results can be shown.

1.1 Structure

The first chapter of this thesis deals with the area of gaze interaction. To give an overview of techniques and possibilities in this specific sector of interactive devices, applications and games are presented and discussed.

Subsequently the phenomenon *presence* in its meaning as well as in its multidimensional concept is described. Chapter 3 'Concept of presence' also discusses the application of gaze interaction with this phenomenon and the combination with playing views. Additionally, the description of the research study built the main focus afterwards. The selected game, as well as all conditions, is described. The results section includes data measures and analysis. In conclusion, all measures and anaylses are used for a discussion and future perspective.

1.2 Motivation

Eye tracking and the usage of gaze-based control provide a tool with a wide range of applications. The technology of eye tracking is often used for usability tests to enhance websites or apps for users, or to form a new integration into human-computer interaction (HCI) to make work more efficient or simplified. The sector of integrating gaze-based interaction especially in games represents a quite interesting research field. It is hardly surprising, that gaze-based control is getting more and more attractive for games, since it provides a more natural way of playing [32].

Nevertheless, there is a limited number of studies, which deal with gazing as a control feature in games to improve eye tracking technology and gaming experience. Since case studies approach different conditions, like gaze visualization, game genre, playing view etc., next to perceived *presence*, developing and designing games with such an interactive control feature is still in its infancy.

To gain a better understanding for designing and developing games with gazing as gameplay control feature, the conclusive research study of this thesis as well as existing similar studies are fundamental. Only further case studies with focus on perceived *presence* and its different conditions, can improve games in combination with gaze-based control.

Hence, concluding research study of the thesis focuses on perceived *presence* with following conditions: gaze-based game control with ISE, different playing views (first person and third person playing view), and the specific game genre of action-adventure.

1.3 Leading question

This thesis deals with perceiving *presence* during gaze-based gameplay control in a three-dimensional action-adventure game. Referring to existing studies with gaze-based devices and focus on player perspective it could be assumed that a more natural game input device in combination with player views can generate a stronger feeling of the phenomenon *presence*. There are just a few research studies in the field of gaze-based interaction in games, which built the basis for the following research study. However, this study and thesis take up the research question:

> "How does the player's perspective (first and third person playing view) in a three-dimensional action-adventure game with an *Infinite Screen Extension* (ISE) affect the gamer's feeling of *presence*?"

1.4 Methods and approach

This thesis is based on techniques and different fields of applications in the area of eye tracking and gaze interaction as well as the concept of *presence*, which is necessary for developing and understanding the effect of *presence* on players in games. Hence, specific conditions and methods have to be set before starting the case study. As mentioned before, only one game, or game genre, was selected for the playing test sessions to receive comprehensive results, since only the game *DayZ* offered a switching between first person and third person view in combination with gaze-based interaction. Furthermore, four scenarios, with and without gaze-based ISE control, and switching the playing view between first and third person, were settled.

To answer the research question an experimental design was carried out, where participants were recruited to play each scenario. In the first phase, after playing each scenario, questionnaires of *spatial presence: self location* and *embodied presence* were presented according to a within-subject design. Hence, the order of the scenarios as well as questions was randomly assigned for each participant. After a player finished all four scenarios, with duration of 15 minutes playing time, qualitative questions, made up by the author, followed.

The data scores were collected through Measurements, Effects, Conditions Spatial Presence Questionnaire (MEC-SPQ)[5] scales of Vorderer et al. and the validated scales of Player Identification (PI)[6] by van Looy et al. [37].

The results of quantitative and qualitative questionnaires are separated into 'data analysis' and a 'qualitative score'; nevertheless, both analyses are crucial for the result of this research study and to answer the research question.

[5]MEC-SPQ: MEC Spatial Presence Questionnare is a scale development by Vorderer et al. [41].

[6]PI Questionnare is a scale development by Looy et al., which consist of several validated sections, like *Avatar Identification embodied presence* (EP) [37].

Chapter 2

Eye tracking and gaze interaction

Eye tracking can be used as media input in computer systems to vastly improve human communication with computers, as the human eye is a constantly reacting tool [84]. It is a technology that allows computers to understand where people are looking and measures an individual's eye movement. Hence, eye tracking can provide sources of interface evaluation data, which can help researchers and developers understand visual and display-based information processing.

Furthermore, captured eye movement can be used as gaze control to enable people to interact directly with interfaces of computers and other technical devices. An interaction via mouse or keyboard input to control interfaces is no longer necessary, which embodies an advantage of users such as disabled individuals.

Therefore, eye tracking, which collects data of eye movements, and gaze interaction, for controlling user interfaces, etc., offers a broad variety of interesting and challenging areas. Hence, today gaze-based interaction allows even more applications than usability tests for websites or other interfaces. The field of its usage is rising permanently.

2.1 Definition of eye tracking and gaze interaction

According to Cambridge Dictionary [74] eye tracking is declared as the "activity of studying the way that people's eyes move in order to discover what, especially in advertisements, attracts their attention". Hence, eye tracking, or gaze interaction uses information obtained by eye movement. Via infrared corneal reflection from the human's eye during HCI the direction of gaze can be recorded and analyzed. Therefore, with this control method through the

(a) (b)

Figure 2.1: Heatmaps [80] (a) are a possibility for eye tracking studies. Gaze-based interaction (b) use eye movements as control input, for example in games [96].

eye-gaze at a certain point, it is possible to select items or to get specific information from a user, by collecting of eye movement data.

Besides collecting data for improving interfaces (see Figure 2.1a), eye tracking enables a hands-free interaction via gaze (see Figure 2.1b) and can be used to guide different systems much faster compared to conventional input devices such as a computer mouse or a keyboard input [84]. Hence, gaze interaction can be denoted as a control through eye movement.

First eye tracking methods were employed in reading research in early 19th century [26, 98]. Humans were already interested in where people are looking, while reading a book. At this early stage no technical devices existed to collect data of gaze behavior. Instead, simple objects like mirrors, to follow the eye movement of a participant, were used. Next steps relied on the application of lenses, which had only a small opening with a pointer attached to it, to observe participants' eye movements and collect data. Other developments were the electro-oculographic technique, where electrodes mounted on skin around eyes to detect eye movements or changes of the retina, or wearing large contact lenses, which were used to gain information of a participants' gaze [23]. Later on in the 20th century the first recording devices, like the eye movement camera, were development and could observe where a person is looking [98].

Meanwhile the technology of eye tracking was refined to gain better measurements as well as results and track easier the natural gaze behavior. This information can be used to improve websites, apps etc., or applied in other fields like marketing, education and art, psychology and neuroscience. More importantly, it can be even used in games as a control feature, which builds the basis of this thesis and following research study.

2.2 Techniques and possibilities of gaze interaction

Availability and quality of eye tracking devices has been increasing the last years. Since the costs of this equipment decreases, the trend of usage through such interactive gadgets rises accordingly. The technology of gaze-based input is integrated in several areas since designers and developers know where the eyes are focused and gain a better understanding of human behavior next to human needs.

Therefore, eye tracking provides a new way of communication. It is a technical information system, which provides data of *presence*, actions, attention or even mental states and enables hands-free interaction. The application of eye tracking technology enables a broad variety of possibilities in assistive technology, research solutions and gaming. In the following an insight into how that technology can be used is given.

2.3 Applications of gaze interaction fields

Gaze interaction is basically used as a methodology for research solutions, such as for market research and usability testing. Typical examples are websites or apps, where layouts or placements of the menu or button are evaluated, the reaction of users to different formats and positions of advertising are tested and human behavior while playing games can be analyzed.

Since it is possible to collect data of the eye movement it is easy to get specific results of focus, actions and attention of users. The score in this field is developed by using heat and opacity maps, or saccade pathways including gaze plots to comprehend human behavior. Hence, eye tracking studies improve and optimize technology, or make human life easier [96]. In the following some applications give an insight from eye tracking technology and the usage of gaze behavior.

Eye tracking and its different score systems can be used for analyzing hand-eye coordination while doing sports (e.g. tennis, basketball as Figure 2.2a shows, etc.), how people deal with stressful situations (e.g. in motorsport, like Figure 2.2b shows), or how people intuitively navigate around airports (see Figure 2.3). By wearing glasses with an integrated eye tracker, data is collected. Therefore, research of gaze behavior can be used for improving human performance or develop effective training (see Figure 2.4) and wayfinding strategies [96].

Similar fields of HCI impact the sector of human factors and simulations. Hence, on-task assessments in various areas suchlike aircraft, operating rooms etc., can be evaluated. As an example, SMI [85] executed a study

(a) (b)

Figure 2.2: Eye tracking analyzes hand-eye coordination while playing basketball (a) or how people deal with stress situations e.g. in motorsports (b) [95].

(a) (b)

Figure 2.3: Wearables with eye tracking applied also for wayfinding strategies [97].

(a) (b)

Figure 2.4: Usage of eye tracking while working in air traffic control towers on screens (a) and watching planes (b) [94].

(a) (b)

Figure 2.5: Driver performance capturing with eye tracking wearable [85].

in cockpits through the flight simulator *SEPHIR*. In this evaluation eleven professional aviation pilots were tested and analyzed for a new control system in the cockpit for improving the user interaction and track situation awareness during flight performances.

A further and similar experiment of eye tracking, also performed by SMI [85] and in cooperation with DEWESoft [73], can be shown in the automotive area as driver machine monitoring and analysis (see Figure 2.5). In this case study human attention and vehicle performance data were analyzed. By using the head mounted eye tracking and electronics in the car, the driver should be supported for more safety on the road.

Another area of applications shows a study [8] for control of UAV's (unmanned aerial vehicle, in this case drones) with gaze. To improve flying drones more easily this experiment deals with an additional gaze control (see Figure 2.6) next to manual keyboard input. As piloting a drone a number of parameters have to be considered, since often quick reactions are crucial in consequence of obstacles or turbulence in the air.

Apart from the usage in HCI and in research projects there are other application areas. Eye tracking enables easier and faster communication within a human's environment, especially for people with disabilities, so it can also be an assistive technology, which deals with psychological and medical research.

The *EyeWriter* [71], as example, originated for a famous Los Angeles based graffiti writer and activist named *Tempt One*. Since this artist was diagnosed with ALS, an incurable disease, which physically paralyzed him (except his eyes), an international team created an open source eye tracking system for drawing by tracking his eyes. The drawing, which is created on a laptop through gazing, connected with a projector at a certain place to project it onto a wall, which can be seen in Figure 2.7. Hence, with the technology of gaze-based devices artistic work for paralyzed people is

(a) (b)

Figure 2.6: In combination with gaze control (a) the UAV should be controlled easier for flight directions (b) [8].

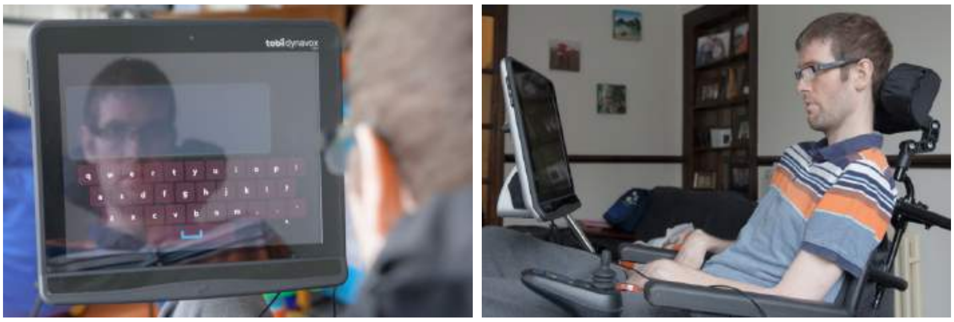
(a) (b)

Figure 2.7: The artist *Tempt One* (a) uses the *EyeWriter* for drawing graffiti (b) with his eyes [71].

feasible.

VocaliD [101] and TobiiDynavox [96] created a technology system with gaze input, which allows people with verbal or physical disabilities to communicate through a generated voice. A system that allows speech generation by usage of eye movement, which enhances the opportunity for social connections and access to education, thus, increases independence for paralyzed people (see Figure 2.8).

Besides applications in the area of usability testing, marketing and consumer research, education, or HCI, eye tracking and its measurements of gaze offers a broad variety of possibilities and applications, since the implementation and development of this technology. Next to the presented areas, a further and relatively young field of the application eye tracking



(a) (b)

Figure 2.8: With TobiiDynavox [96] and VocaliD [101] (a) verbally or physically limited people (b) are able to communicate.

and gaze-based interaction can be found in the gaming industry, which will be discussed in more detail in the following.

2.4 Gaze interaction in games

Last year's gaze-based systems found their way into the gaming world and can nowadays be used for evaluating games as well as for playing games [96]. Thus, eye tracking as an interactive input device is relatively new in the area of gaming, which brings along a new research field for developers and designers as well.

For usability evaluation an eye tracked game can help designers and developers to improve games and to determine the player's behaviors, their experience and why a game will be played again. Tobii, as an example, also uses eye tracking for enhancing gaming experience. Together with recording eye movement of participants and combining this with interviews, or validated scores of researchers, valuable insights on game play mechanics, game flow or the user interface can be collected [96].

For example [87], *Steelseries' Sentry*[1] investigated that in *Dota 2*[2] [48] a player looks every five seconds either at the map or at their items (see Figure 2.9). In this time a player does not know what his or her enemy does or cannot give commands. In such a case game developers can record the players' eye movements throughout a game session and check afterwards where they were paying attention and for how long [99].

Apart from such evaluations in games, eye tracking can be used as an

[1]Steelseries', a Danish games manufactorer, provides like Tobii and SMI eye tracking devices (called 'Sentry') for games [92].

[2]Dota 2 is an online multiplayer strategy game [88].

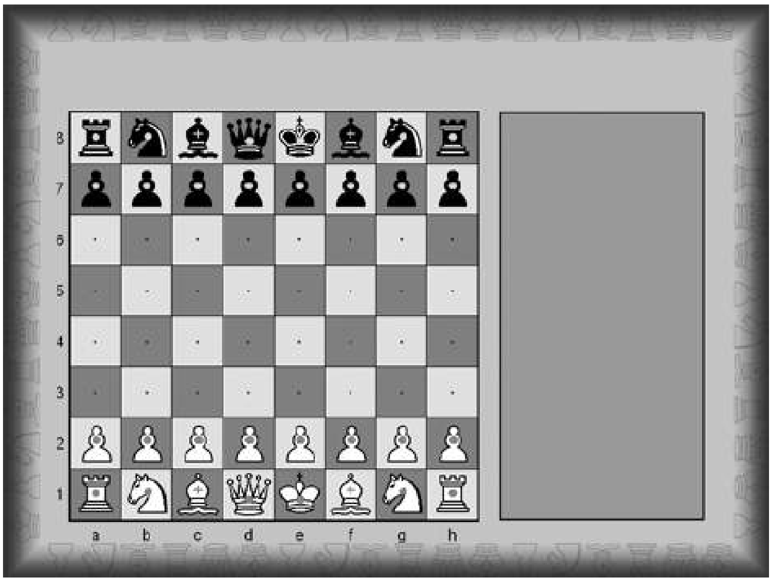
Figure 2.9: This screenshot shows the game *Dota 2* during gameplay [87]. Map and items are highlighted through yellow arrows (modified by the author).

interactive control in games as well. Gaze-based interaction can be used as a complement to standard input devices such as gamepads, keyboards and mice or only as a control opportunity. For example, the game *EyeChess* [64, 33], from Oleg Špakov, is controlled just only by eye movement. By adding an eye tracker the player controls chess pieces and places them on the chessboard (see Figure 2.10). Through blinking, eye gesture, and dwell time, the system can see where the player are looking and will place the chess pieces.

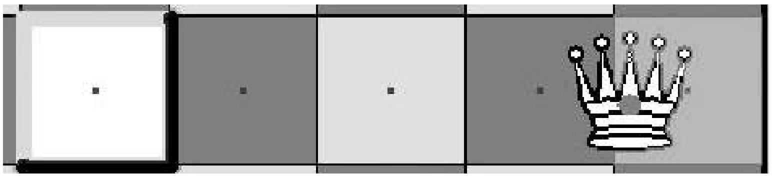
Vidal et al. [39] developed a game in which a gaze-based input, staring, is used. Hence, a player has to stare down characters in the game *Shynosaurs* [69] (see Figure 2.11). User had to balance how they choose between staring and interacting of their eyes. By staring at the enemy in *Shynosaurs*, a player can slow them down and send them away. When using gaze as an aiming control (interacting) in combination with a mouse as drag and drop function, the player saves the cuties, since they had to be placed into a save zone [39].

Since gaze-based interaction was implemented into games at early stage, nowadays this feature of control is attached into even more complex games as following examples will show. The game *Son of Nor*[3] [66] uses the eye gaze of the player as its crosshairs; by clicking on the mouse, stones can be picked up and thrown at the enemy, which is targeted by gaze (see Figure 2.12b).

[3] *Son of Nor* is a third person action-adventure game from *stillalive studios* where the player use telekinetic powers to bend the games surrounding to conquer the enemies [91].



(a)



(b)

Figure 2.10: Screenshot of the gaze-based controlled game *EyeChess* [33] (a), with detailed view (b) how the gaze selection look like.

This control feature via gazing, which is called ‘Natural Targeting’ [96], can be used in *Assassin’s Creed Syndicate* for automatically target centering (see Figure 2.13b). Therefore, it is even easier to focus on enemies and bring them down. A further feature in *Assassin’s Creed Syndicate* in combination with the gaze-based feature, is an optimization of the natural lighting conditions (see also Figure 2.13b) [96].

Another way of including gaze-input in games is through gaze awareness, where the environment in the game reacts to the players gaze. For example, in the game *The Solus Project*[4] [49], plants close themselves up when the gaze hits it as Figure 2.14b shows. Furthermore, the integration of gaze interaction provides the possibility of fading away HUD (Head-up-Display) elements. Consequently, maps or health bars, can be closed by looking away

[4]The game *The Solus Project* is a survival game in first person perspective [91].

(a)

(b)

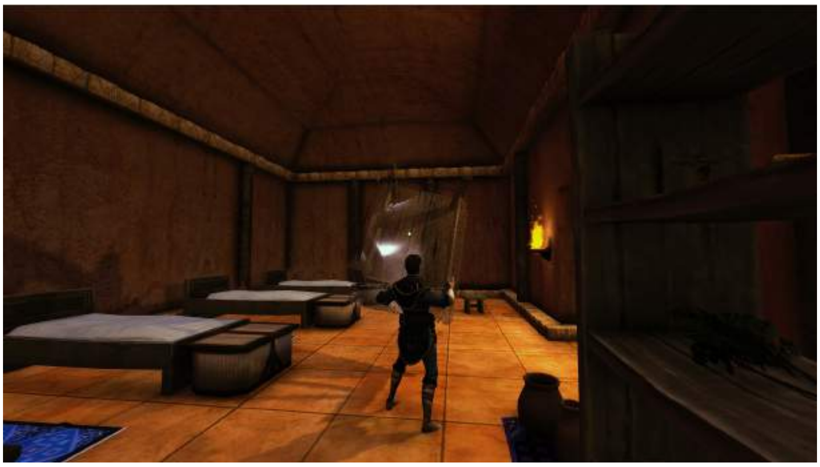
(c)

Figure 2.11: In the game *Shynosaurs* [39] (a) the enemy, Shynosaur (b), tries to kidnap cuties (c).

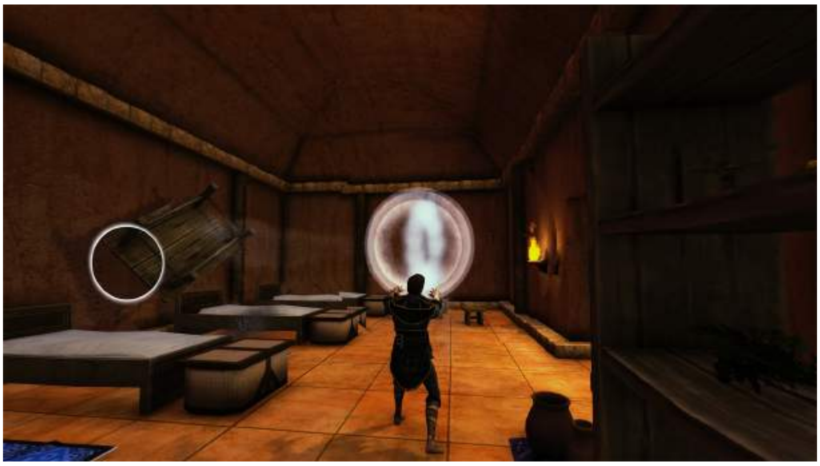
from them, or in reverse open easily.

There are several ways to use eye tracking as an interactive gaming method in games. With the usage of gazing at certain points gamers can perform whole suits of commands including moving their character or avatar, altering their viewpoint on the scene, manipulating objects and communicating with other players [15, 79], or the usage as input control, which act as a button and substitutes a mouse [11].

There is an amount of possibilities for how to integrate gaze-based interaction in different game genres to make them more attractive and more natural in its control. As a consequence research studies of different game experiences, or of the effects of interactive input devices such as gaze-based



(a)



(b)

Figure 2.12: Screenshot of standard gameplay in *Son of Nor* [96] without eye tracking input device (a). The game character focuses on the goal, the player uses gaze interaction (b) to use the table as weapon.

systems, are getting more attention by the scientific community.

Games and their integration of gaze-based interaction are rising. Nevertheless, research in this field of interactive input devices is in its infancy. A relevant factor regarding eye tracking in the experience of gaming builds the phenomenon called *presence*, which is a key factor for this thesis and research study.

(a)

(b)

Figure 2.13: The screenshot (a) shows the game *Assassin's Creed Syndicate* [96] while playing without gaze interaction. Below eye tracking is added into gameplay (b). Enemies can be targeted more easily to bring them down.

(a)

(b)

Figure 2.14: In the game *The Solus Project* [96] without gaze-based interaction (a) plants are opened from start, while during gameplay with gaze as extended control (b), a player can open plants via gaze.

Chapter 3

The concept of presence

To provide good games and gaming experiences, it has become even more important to focus on research studies in developing and designing games. Since the sector of gaming and combinations of interactive input devices are rising, designers and developers are starting to focus on measuring the impact of those combinations on players. Thereby, the concept of *presence* arises to measure effects of user experience, i.e. during gameplay.

3.1 Definition of presence

The phenomenon of *presence* is applicable in academic research. Hence, the concept of *presence* has been applied to a variety of different application fields, like education, medical domains, and media experiences, which includes the gaming area [12, 24, 36].

The relatively young field of *presence*, a term coined by Marvin Minsky[1] in 1980 [82], derived from 'tele-presence' and is a key evaluating factor for usability studies. With the definition of 'tele-presence', Minsky brings to mind that technologies would change a user's experience to one of actually 'being there' in the other world with no noticeable difference [82].

> "The biggest challenge to developing telepresence is achieving that sense of 'being there'. Can telepresence be a true substitute for the real thing?" [82, p. 46]

Hence, Minsky laid the foundation of the sensation of *presence* and its innovation and research [24]. Since this time, the field of *presence* has grown. Nevertheless, several researches tried to define *presence*; comparisons with 'engagement', 'action', 'sensation', 'perception', etc., were made. However, a precise meaning of *presence* with its diversity of systems and research areas makes it difficult to form a single definition [5, 24].

[1] Marvin Minsky was an American mathematical, computer scientist. He was called as the 'father of artificial intelligence' [78].

Presence, the shortened version of ‘tele-presence’, is according to Lombard [20], a psychological state or subjective perception in which the person’s subjective experience is altered without she or he being aware of it. This was previously described by Lee [18] and Tamborini et al. [36].

Another definition of the phenomenon *presence* is described as an experience of being engaged by the representations of the mediated world [77]. Takatalo [34] said that the concept of *presence* locates the player in the virtual environment, and the player knows that they are using a technology. However, in some cases and to some degree perception overlooks that knowledge. Since the rising of this phenomenon scientists and developers have encompassed a vast range of technologies to achieving this feeling [24]. Waterworth et al. [42, p. 39] defined *presence* as a “feeling of being located in a perceptible external world around the self”. A further definition describes *presence* as the sense that one is within the world [29].

However, *presence* represents a feeling, which is of particular interest to researches and developers nowadays. Hence, altogether *presence* can be called an interaction between user and media technology with a variety of sensory and cognitive information sent to the user to create an illusion of environment and the users’ capability to adapt to this environment [19].

At first, the meaning of *presence* could be a bit confusing. Different terminology and categorization in past studies of *presence* with almost similar statements make it difficult to develop an understanding of the precise meaning of this term. Nevertheless, the phenomenon *presence* is often referred to as a feeling of ‘being there’ inside a virtual world such as a game [20, 27, 30]. According to Freeman [5] and other scholars [10, 18, 20, 35] the phenomenon *presence* will also be described as a multidimensional concept or experience. Hence, there are different types of the concept of *presence*, which established by several researches. Nevertheless, following section about dimensions of *presence* describes only two specific categories, which are relevant to the research study of this thesis.

3.2 Dimensions of presence

Presence occurs in connection with different media types, including movies, virtual environments, or games. According to Pinchbeck and Stevens [22], *presence* and its dimensions supply valid metrics to study and comprehend game experiences. Hence, it is hardly surprising that

> “ . . . games are poised to become the ultimate presence-inducing medium, . . . ” [36, p. 238]

With the technological development for games in recent years, the experience of *presence* in games is rapidly growing. Research measuring this effect on players is in its infancy, but it is an important factor for practical and theoretical purpose as it can improve games and associated feelings. Tamborini et al. [35] said that the experience of ‘being there’ for a player has become a central component in the area of game research.

As previously mentioned *presence* is also described as a multidimensional concept or experience. Most scholars categorize *presence* in several ways [5, 10, 18, 20, 35]. This chapter defines the two dimensions of *spatial presence* and *embodied presence*, since those factors of *presence* are fundamental for the research study of this thesis.

3.2.1 Spatial presence

As mentioned previously, there are several scholars who distinguish between some dimensions of *presence* [5, 10, 18, 20, 35]. However, this multi-faceted concept of ‘being there’ displays the dimension of *spatial presence* [10], which probably receives high attention from researchers [20], since it can be found in some case studies, e.g. effective telemedical services [43], mediated educational environments like e-learning [28], or media enjoyment of players in games [36].

Tamborini et al. [36] describes the dimension of *spatial presence* through the character Kevin Flynn in the movie *Tron*[2] [67], where the protagonist Kevin moves around in the virtual world or even acting within the virtual world by jumping or grabbing something (see Figure 3.1). Kevin feels that he is ‘there’ in the game world [36]. Hence, *spatial presence* is the immersive experience that the player possesses in the mediated virtual surrounding [17], the feeling of being physically located at the place of operation [20].

Additionally, to this definition of *spatial presence*, there are some subgroups. Researches like Wirth et al. [44] divide *spatial presence* into two further categories: ‘self location’ and ‘possible actions’. Furthermore, Vorderer et al. [41] categorize *spatial presence* into nine constructs of his two-level model of *spatial presence* for measuring this dimensions of *presence*, which include as a process factor the two categories ‘spatial presence: self location’ as well as ‘spatial presence: possible actions’ [41].

Self location (SPSL): the player is physically situated within the virtual world; the user feels like he or she is located in the game’s surroundings [36].

Possible actions (SPPA): every possible action a user can take in the virtual world [44].

3.2.2 Embodied presence

Besides the feeling of being physically located in a mediated environments, *presence* offers the further dimension to feel being the character [37]. Equally

[2] *Tron* is a science fiction action-adventure film from 1982, where Kevin Flynn, the son of a computer programmer is searching for his father. By looking for him, Kevin ends up inside the digital world his father created once [76].

Figure 3.1: Kevin Flynn interacts with and within the virtual world in the movie *Tron* [76].

if character plays in a book, or in a film, their readers and viewers identify with the fictional character, are portrayed [4, p. 81]. This concept of *Avatar Identification* [37] can be shown in traditional media areas, as well as in the gaming sector since the last years. Nevertheless, readers or viewers can only relate to fictional characters from films and books as a 'follower' [37], while in games, player receive an acting and active role of the avatar [9]. Hence, players refer to their in-game identity as 'I' and feel more 'here' in the virtual worlds [45].

This concept of *Avatar Identification* by Looy et al. [37] is subdivided into three categories: 'Wishful Identification', 'Similarity Identification', and 'Embodied Presence'. Last one explains the degree to which players feel being their avatar when playing a game [37] based on the fact that one experiences one's virtual world through one's body container [3].

With advanced media development it is obvious that a higher *presence* is present between media technology and their user [42]. The concept of *presence* is in its research highly interdisciplinary. Nevertheless, the focus of this thesis is set on *presence* in games.

> "Presence, or sense of being there, is important to the video game industry and to game studies in that it offers some explanation for why a game might be repeatedly played and why it is enjoyed." [6, p. 17]

3.3 Player view

Besides the different dimensions of *presence* there are other influential factors which affect perceived *presence* in games. Reflections in this field are storyline and game genre, graphics, challenges and complexities, music and sounds, or the mode of the playing view. Since the research study of this thesis set one focus on the player view, following section exposes insights into playing perspectives.

The player perspective is, next to design choices when creating a game, a crucial part to support the experience of visual perception [6]. Different views of playing mode like isometric projection, top-down view or first person and third person perspective (which are often connected to the game genre itself) can influence the perception and the feeling of involvement of each player in the game [1]. As the research study, see 4 ‘Experiment’, focuses on the effect of players in first person and third person perspective, this section deals only with these modes of player representation.

In a first person perspective (FPP), alias first-person shooter (FPS) as Figure 3.2a shows, the player looks into the gaming world through his or her own eyes, since he or she is acting like in real life. Only parts of the game character, like arms, corpus or feet, can be seen. FPP are useful in shooter games, where accuracy is needed, while third person camera views are located mainly in exploration and adventure games. In a third person perspective (TPP) a player can see the entirely body of his or her avatar (see Figure 3.2b).

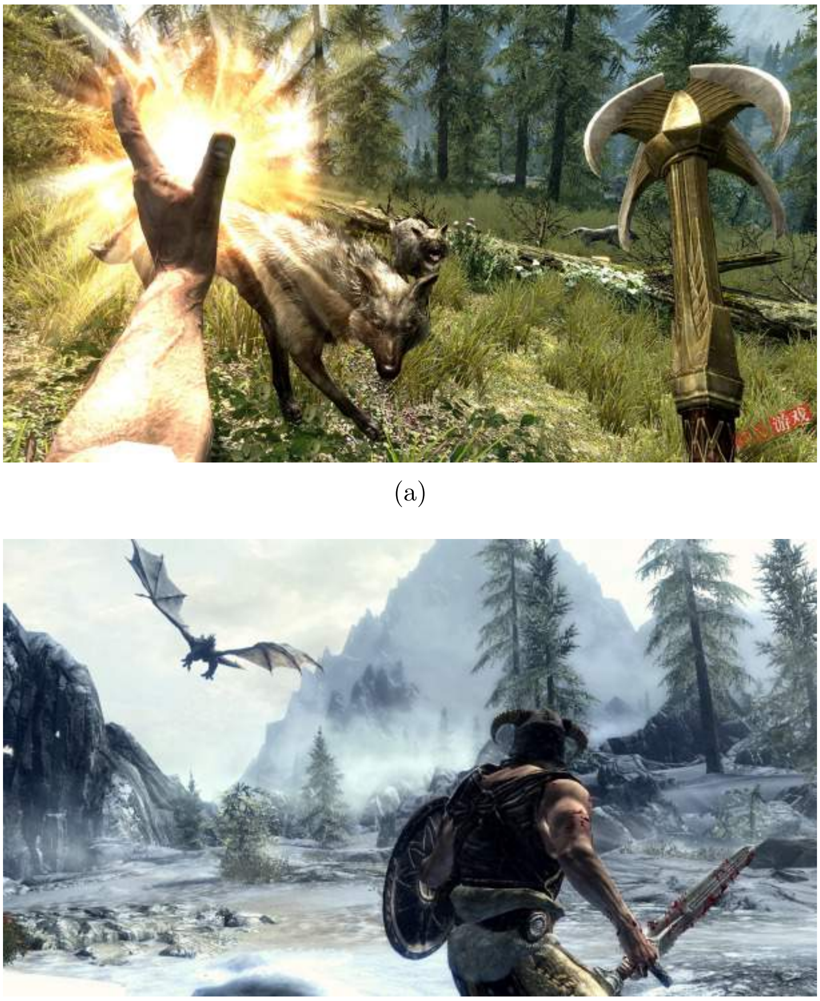
Nowadays, a broad variety of games give the player the opportunity to switch between FPP and TPP. Thus, each player can set personal preferences, depending on the game genre or different situations in the game to feels more involved, or gain a stronger degree of ‘being there’ in the game. Hereby, the question arises which playing view, FPP or TPP, will provide the stronger sense of *presence* for players. Slater et al. [31] offer a study that compared these two playing views regarding *presence*, where a higher sense of ‘being there’ was provided by FPP. Another study by Ravaja et al. [25] compared the video games *Tetris*[3] [61], *Super Monkey Ball 2* [60], *Monkey Bowling 2*[4] [56] and *James Bond 007: NightFire*[5] [51], and found a higher sense of *presence* for players of the latter game, because of the FPP during gameplay.

It can be suggested that the player feels more or less connected to its avatar and his or her location in the virtual game world by choosing the mode of a playing view as FPP as opposed to TPP. Since the camera view of FPP allows a player to see his or her entire virtual surrounding through the eyes of his or her avatar, which could arouse a feeling of acting as in real life. In comparison to this, a TPP gives the player the possibility to see his

[3] In the puzzle game *Tetris* a random sequence of Tetriminos’, different combined squares, fall down the playing field and have to arranged for eliminating.

[4] *Super Monkey Ball 2* and *Monkey Bowling 2* are plattform/party games. A player have to roll across platforms (slopes, half-pipes, or moving platforms, etc.) and obstacles to reach the goal.

[5] *James Bond 007: NightFire* is a FPS game.



(a)

(b)

Figure 3.2: FPP (a) and TPP (b) of the game *Skyrim* [91, 65].

or her game character plus a wider field of view, which is useful if a player is attacked.

Research studies which approach such topics are rare. To have a better and more comprehensive understanding in the field of *presence* in games, especially in connection with gaze-based interaction in different playing views, more research is needed. The following chapter surveys the existing research with a focus on gaze interaction as well as deployment of playing views in FPP and TPP, as background for the current study and future research directions.

3.4 Perceived presence in games

Gaze-based input is more and more used as an interactive control feature in games, since eye tracking technology become cheaper, smaller and more available [2]. Eye tracking and its research area of HCI and associated fields, such as user-experience evaluation, health, marketing, etc., already applied since the late 1970s [38]. With advances in gaze-based technology, eye tracking is becoming even more applied in games as an interaction method [2]; therefore, research for developing eye tracking technology and its impact on players are crucial.

A landmark for gaze-based control feature in games was set in 2015 with the release of *Assassin's Creed Rogue* [38], which was provided with a natural way of interaction by moving the character through gazing [96]. Nevertheless, little work has been done to date for improving and designing even better games with use of gaze-based interaction and testing players' reactions [2].

Whereas eye tracking in games has not been widely supported until recent years, it is clear that developing and research studies are rare [11]. Nevertheless, gaze-based interaction is a crucial influencing factor for *presence*. Following show an insight in the research area of gaze interaction so far and its impact on players, measured by perceived *presence*.

In the research project of Lankes et al. [17] the influence of different loci of manipulation[6] relations were tested. The 2D platform game called *Limus and the Eyes of the Beholders* [52] (see Figure 3.3) was equipped with eye tracking technology and a gamepad, based on four scenarios for the study. In three of the scenarios, players used gaze-based interaction; in the fourth scenario only a gamepad was used. Furthermore, the scenarios were different since the relation between player character and the avatar changed. The result of this study showed that gaze-based input devices had a very positive effect. The degree of the loci of manipulation also strongly influenced all the dimensions of perceived *presence* [17].

Another study from Jönsson [13] used gaze-based interaction in the FPS game *Half-Life*[7] (see Figure 3.4a), as well as in the Shootem-up game, *Sacrifice*[8] [50] (see Figure 3.4b). In the FPS game three conditions were given: In the first scenario the player used only the mouse to change the weapon and to look around. In the next scenario the mouse was replaced by an eye tracker for changing weapon and to glance around. The third and last sce-

[6] *Locus of manipulation* " ... defines as the in-game position of the player's ability to assert control over the game-world, whether this is a visible character, an implied avatar, or a graphical user interface cursor' ... " [7, p. 42]

[7] *Half-Life* [47, 89] is a first person action adventure game, where the player has to fight against aliens [91].

[8] *Sacrifice* [90] is a real-time strategy game that focuses on combat instead of resource gathering [91].

Figure 3.3: Screenshot of the game *Limus and the Eyes of the Beholder* [17].

(a) (b)

Figure 3.4: Screenshot of the FPS game *Half-Life* (a) and of the Shoot-em-up game *Sacrifice* (b) [13].

nario used a combination of mouse input and gaze-based interaction. In this third case, weapons could be changed with the eyes while the player uses the mouse to look around. In the game *Sacrifice*, only two conditions were given: aiming with mouse, and aiming with the eyes [13].

Jönsson's aim was to show that eye tracking affects players experience and with that the feeling of *presence* is a logical consequence. For both games, results show that gaze-based control was even more fun than using the traditional input devices (here, mouse) [13].

Another study from Nacke et al. [21] tested also gaze-based interaction with the FPS game *Half-Life*. Usually the camera view in *Half-Life* is controlled with the mouse, which builds the first scenario. Afterwards, gaze-based input was used to control the FPP. Results show that measured *presence* of the gaze-based interaction was high and provide a positive game experience [21].

Smith et al. [32] used in their research study a gaze-based input device next to a mouse. Three different games, each of them another genre, were tested. In *Quake II*[9] [62], a FPP game, a player controlled orientation via mouse or either by gazing (see Figure 3.5a and Figure 3.5b). In the game *Neverwinter Nights*[10] [46] (see Figure 3.5c), a role-playing game (RPG), the player had to move his or her avatar through gazing by the virtual world. The last game is called *Lunar Command*[11] [54] (see Figure 3.5d) and is categorized as action/arcade game. In this game the player had to destroy objects targeted through pointing and pressing a button at the same time.

To sum up, previously mentioned games were compared through gaze-based interaction for control of orientation, communication with the game character and the targeting of moving objects or enemies. In each game player performances were recorded, which was conducive to data analysis. Results of those game experiments in comparison show that eye-based input control in games can alter the experience of a player, since gaze features make the mediated world more immersive [32].

The game *The Royal Corgi* [70] (see Figure 3.6) was developed for a social gaze interaction case study, where characters were designed to be reactive to the players' gaze. This first person-style game uses gaze as a gameplay mechanism. Nevertheless, the game characters were still moving and walking by use of mouse and keyboard. The gaze-based feature was used to give insights (hints, personalities) on other avatars by looking at them and pressing the V key [40].

Participants played on average 5.3 games, where one game last four minutes. The study focused on intuitive gaze interaction for players, their self-consciousness of eye movements and the feeling of immersion as well as *presence* [40].

Lankes et al. [16] describes the study of a FPP gaming prototype called *Fractile* [55] (see Figure 3.7), where players use their gaze in additional to a controller (no interaction with gamepad buttons) to make parts of the gaming worlds visible. Hence, this game set the focus on exploration and storytelling. The goal of the case study was to gain a more comprehensive understanding of the concept of *presence*, which was measured through two settled conditions with a between-subject design. The first scenario included

[9] *Quake II* is a FPP game from id Software, where the player has to fight against enemies on a different planet [91].

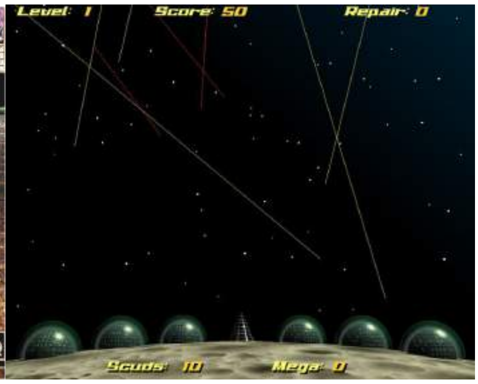
[10] *Neverwinter Nights* is a dungeons & dragons-based PC RPG game [72].

[11] In the game *Lunar Command* the player has to protect the lunar base in space from adversarial missile strikes [75].

(a)

(b)

(c)



(d)

Figure 3.5: The player aims on the enemy via gaze-based interaction (a) (b) in *Quake II* [32]. In the world of *Neverwinter Nights* (c) the player communicates through gazing. In *Lunar Command* (d) a player destroys enemy missiles via gazing at those and pressing a button [32].

(a)

(b)

Figure 3.6: Players use their gaze (a) in *The Royal Corgi* to get hints or personalities of other characters (b) [40].

Figure 3.7: Through gazing parts of the game world get visible [16].

a white rectangle, which indicated the current point of the player's gaze. In the second scenario *Fractile* was played without gaze visualization [16].

Results of the three-dimensional exploration game shows high impact of *presence*. Measurements were taken of the dimension of SPSL and SPPA, where both scenarios got the highest ratings in *spatial presence: self location* [16].

Another study for measuring player experience showed the experiment from Denisova et al. [1]. Through a between-group design the game *Sykrim* was tested. One group played the three-dimensional role-playing game (RPG) within FPP (see Figure 3.8a), while the other group played the game in the TPP (see Figure 3.8b). Both conditions had a playing time of 15 minutes and were controlled by a controller. However, results show that participants playing the condition FPP immersed higher levels of gaming experience that those who played the game in TPP [1].

In the research project of Kallinen et al. [14] two experiments, which measured the facial muscle activity, as well as self-reported *presence*, with only one experiment focused on gaze-based input, is described. Using the same game throughout, the scenarios were split into FPP (see Figure 3.9a) and TPP (see Figure 3.9b). In each view, two further scenarios were used: the eye tracker in full screen mode and a scaled-down view where random images were intermittently shown (see Figure 3.9c). Thus, in all, four scenarios were played [14].

The study revealed a higher *presence* in FPP view than in TPP. However, other factors, such as the level of player control, also influenced perceived *presence* [14].

(a) (b)

Figure 3.8: The game *Skyrim* in FPP (a) and TPP (b) [91].

(a) (b) (c)

Figure 3.9: Split scenarios of playing in FPP (a) and TPP (b), and playing with a distraction image (c) of the game *The Elder Scrolls 3: Morrowind* [14, 63].

All these studies suggest that different games genres as well as the perspective has to be considered in relationship to perceived *presence* through gaze-based interaction in games. Furthermore, some existing research suggests that the playing view, in combination with gazing, influences players' sense of 'being' in the gaming world. Unfortunately, research to date in this field of gaming experience and development remain sparse.

The next chapter presents the current research study with results of the effect on *presence* of gaze-based interaction in three-dimensional action-adventure games with switching between FPP and TPP.

Chapter 4

Experiment

The following section discusses the lack of knowledge in the field of the effects of gaze-based interaction on the phenomenon *presence*. Several previously mentioned studies, deal already with the impact of *presence* in games. These case studies conclude that gaze-based interaction devices contribute to *presence* to a certain degree, but there are several other aspects are involved in acquiring the desired effect of *presence* [17].

Different game genres, as well as the modes of playing view, game interfaces and visualization of the gaze, are discussed and each is tested separately in its own way by the previously mentioned case studies. However, the modes of playing, especially FPP and TPP, build an aspect for perceived *presence* with gaze-based input as control feature. Some research studies show that a player in FPP perceives a higher *presence* than players in TPP [1, 14].

Nevertheless, current research studies focus on players' impact through gaze-based interaction as well as switching between FPP and TPP in an three-dimensional action-adventure game, which was not developed yet in this form. Since games do not have the possibility of switching between FPP and TPP yet, this research area is still in its infancy and defined conditions were not tested before in combination of an three-dimensional action-adventure game with gaze control, since *DayZ* is the first to fulfill those conditions. Hence, this research study should reveal interesting insights for game developing and design, and how far FPP as well as TPP with and without gaze-based interaction have an influence on the players' experience.

As previous mentioned the current study focuses on a few selected factors for experienced *presence*. The first important factor is the game genre. The selected game is an action-adventure game in a three-dimensional environment, where the player navigates their character with standard input devices. With mouse and keyboard players direct where the virtual body goes and what it does. The playing view can be shifted between FPP and TPP; therefore, the choice of perspective is another relevant factor of this study. As a further element of the study, a gaze-based interaction (an eye tracking) device with *Infinite Screen Extension* (ISE) is included in some of the gaming scenarios. The feature of ISE allows player a more natural way of looking around during game play and improving situational awareness. ISE tracks the eye movement of a player across the screen; hence, it turns the in-game characters head for an extended view.

Referring to previous studies with gaze-based devices it could be assumed that a more natural game input device can generate a stronger feeling of *presence* [14, 16, 17]. However, there are just a few research studies in this field. This study and thesis takes up the research question:

> "How does the player's perspective (first and third person playing view) in a three-dimensional action-adventure game with an *Infinite Screen Extension* (ISE) affect the gamer's feeling of *presence*?"

Existing research in the area of adding interaction techniques is the basis for the following parts of the case study. The next chapters will depict the practical process to get the answers to the research question of perceived *spatial* and *embodied presence*. The following sections include the different scenarios of the game a description of the game itself, the proposed hypotheses, the procedure with the participants, and the measures and data analyses. According to this, results can be shown, which build a basis for concluding discussion.

4.1 Scenarios and selected game

Four scenarios, based on one game, were created for the research study. In the selected game the player perspective could be changed between FPP (see Figure 4.1a) and TPP (see Figure 4.1b) and between playing with or without an eye tracking input device including ISE. Hence, in FPP the player will only see some body parts, like arms, feed, and its corpus, while in TPP the whole gaming character can be seen.

The game genre is action-adventure in a three-dimensional surrounding. In order to gain a more comprehensive understanding of the phenomenon *presence*, only this one game was played. The selected game, called *DayZ*, is provided with an *Infinite Screen Extension* (ISE) by Tobii [93]. The ISE allows the player to look around a certain range of degrees for an extended view. Through this feature a player controls the view in the game, which is only restricted to what fits within the screen. ISE as an extended view turns the gaming view (camera) towards to the gaze point of the player. This feature of an extended view should allow a player of a natural viewing during gameplay.

DayZ is an open-world survival post-apocalyptic zombie massively multiplayer online (MMO) game where the player's only goal is to stay alive as

(a)

(b)

Figure 4.1: Screenshot of FPP (a) and TPP (b) while playing *DayZ* [91].

long as you can in the harsh landscape (see Figure 4.2). Without a tutorial, hints, or any help given, the players make their own decisions and find their own path, but they have to be careful; any mistake can be lethal. The player can use anything they find to stave off the flesh-craving undead, other survivors and the player's own needs, such as hunger, thirst or sickness. There are no extra lives or game-saving points. If a player fails, he or she must

Figure 4.2: Screenshot of the three-dimensional action-adventure game *DayZ* [91].

start again from the very beginning with nothing more than his or her own hands, a flashlight, and some bandages [86]. Tobii Technology provided the award winning game with an eye tracking *Infinite Screen Extension* (ISE); therefore, when the eye tracker is added to the game the screen always follows your eyes movement to give a certain feeling of game experience and *presence*.

> "The game is frightening enough on its own, but playing it with the Tobii Infinite Screen Extension is not for the fainthearted. With the screen following your eye movements, you will feel more involved than ever in what happens around you, creating a stronger sense of actually being in the game." [93, online]

With this extended view implementation the player can look around in the game in a range between 0 to 90 degrees, and the range of 45 degrees was set for the scenarios. The avatar (body) is still moved by using the mouse. This type of game includes a FPP as well as a TPP in its three-dimensional world.

As previously mentioned, there are four scenarios to measure the *presence* of the player. Critical for the research study is the mode of the playing view and the usage and non-usage of an eye tracking input device. Therefore, the participants play *DayZ* in each of the following four scenarios of game interaction and view:

1. In Scenario FPP without gaze-based interaction (Sc1st−), which can be seen in Figure 4.3, the player uses standard input devices (mouse and keyboard) for navigation. The player uses the mouse to look around and to make sure no undead are close. In this scenario the player acts in a FPS mode, seeing only the hands and feet of the game character's body plus any collected items.
2. In Scenario FPP with gaze-based interaction (Sc1st+), which can be seen in Figure 4.4 the game perspective is the same as above. However, the eye tracking feature is implemented so that the player controls the view of the character by looking around. Therefore, a wider viewing within the game world is possible.
3. In Scenario TPP without gaze-based interaction (Sc3rd−), which can be seen in Figure 4.5, the player uses the mouse for looking around and moving the game character. In this scenario, however, the player's perspective changes such that he or she can see the full body of the game character from the back.
4. In Scenario TPP with gaze-based interaction (Sc3rd+), which can be seen in Figure 4.6, the player again sees the whole body of the game character from the back, but uses the eye tracking feature in addition to the normal controls via the mouse and keyboard.

4.2 Hypotheses

Each of the proposed four scenarios for playing the three-dimensional action-adventure game *DayZ* are expected to awake a different feeling of *presence*, which is split into two aspects: first, perceived *embodied presence* (EP), and secondly, perceived *spatial presence* in its sub-dimension of *self location* (SPSL). Those two dimensions of *presence* are selected, with EP measuring the players' feeling of being the avatar, and SPSL measuring how much the player feels like part of the game world. Thereby, the following hypotheses are formulated:

4.2.1 Hypothesis 1 – Embodied presence (EP)

If a player interacts within the virtual world without seeing him or herself in a fully visualized body (mostly viewed from the back), the players receive a stronger EP. As previous mentioned research studies showed, player receive a definite higher impact of *presence* when playing in FPP and in combination with gaze-based interaction. Thus, Sc1st+ followed by Sc1st− are expected to result in a stronger player experience compared to those scenarios played in TPP. In FPP it can be assumed that the player has the impression that he or she is the avatar in the virtual world. Thus, the playing view is hypothesized to affect EP.

(a)

(b)

Figure 4.3: [91] Participant playing Sc1st− (a). In FPP (b) the player is only able to see parts of his avatar, similar to real life.

The feeling of the player should be supported by adding natural looking through gaze interaction (in this case the usage of the *Infinite Screen Extension*). In Sc3rd+, the player uses natural action with his or her eyes. However, there will definitely be a lowered EP since the player sees his or her avatar the whole time. Therefore, Sc3rd− are hypothesized to pose greater

(a)

(b)

Figure 4.4: [91] Participant playing Sc1st+ (a). The player can see in FPP (b) only parts of his avatar like in real life.

difficulty for players to identify with or to project his or her thoughts into the avatar.

(a)

(b)

Figure 4.5: [91] Participant playing Sc3rd− (a). In TPP (b) the player is able to see the entire avatar.

4.2.2 Hypothesis 2 – Spatial presence: self location (SPSL)

If a player uses a FPP in the game along with a gaze-based interaction device with the ISE, then the perceived SPSL is expected to be higher in comparison to a TPP. Because the player looks into the gaming world through his or her own eyes, a FPP contributes to a positive gaming experience of *presence*.

(a)

(b)

Figure 4.6: [91] Participant playing Sc3rd+ (a). In TPP (b) the player is able to see the entire avatar.

Furthermore, the player feels like he or she is physically in the middle of the gaming world. These assumptions are provided through existing case studies, where measured *presence* was rated higher when playing in FPP with gaze-based control in comparison to TPP and without gaze input.

In the selected three-dimensional action-adventure game *DayZ*, the player acts through a game character (avatar). As the player perceives the representation of the avatar, SPSL decreases. In other words, showing the full body of the character is hypothesized to have a negative impact on SPSL.

If there is a positive connection between the gaze-based interaction and the player, then the player experiences a stronger feeling of being part of the game world, a proposition which is tested in Sc1st+. Thus, Sc3rd− is expected to evoke the lowest level of SPSL of the four scenarios. The comparison between Sc1st− and Sc3rd+ will be interesting. Considering that in Sc3rd+ the player acts within a naturally way of looking comparing to Sc1st−.

4.3 Participants and procedure

The study was conducted at the home offices of the author in Hagenberg and Vienna. The 26 participants were recruited via e-mail and were aged from 18 to 32 years. The study group consisted of 21 male and 5 female players; women were underrepresented in this research study. However, two times a test was cancelled as a result of motion sickness of participants. Thus the analysis uses data from 24 participants: 19 (79%) male and 5 female (21%); aged 18 to 31 years (average age: 25,29); 17 students (71%) and seven workers (29%). Thirty-eight percent of participants play games several times a week, closely followed by 33% (eight participants) who play games occasionally, while 25% (six participants) play games every day, and one participant (4%) does not play games.

For each participant the process took between 90 and 100 minutes and was mainly divided into introduction, instruction to the participants, calibrating the eye tracker, playing time for each scenario (15 minutes per scenario), each followed by a quantitative questionnaire, and, finally, a discussion with qualitative questions. The experimental setting was made up of a desktop PC and a Tobii EyeX Controller as Figure 4.7 shows. The eye tracking device of Tobii uses infrared technology to track the gaze of the eyes and pointing while using the computer system. The controller was plugged in with a 3.0 USB port, watches where a player looks and feeds this information into the game he or she might play.

For the ISE, the extended view feature, the settings were comprised by the two factors ‘Sensitivity’ and ‘View angle limits’ (see Figure 4.8). This setting of an extended view turns the camera towards the gaze point of the player without centering the view on it. ‘Sensitivity’ settings includes ‘Speed’ with the setup of 1.50. This setting is responsible for how fast the camera will turn towards the gaze point of the player in the game. ‘Gradient’ was set up with 2.00 and controls the speed ramps up. The setting ‘Falloff’ with 0.80 controlled the amount of head rotation. ‘Dead Zone’ was set with 0.00 and is responsible for how much the player had to rotate his or her head from

Figure 4.7: The setup consisting of a standard PC, keyboard and mouse, a Tobii EyeX Eyetracker and headphones.

center position of the camera before it starts moving. The setting of 'Inertia' which was 6.00 controlled to reach the maximum of camera rotation. Those factors were responsible for the camera view angle. The 'View angle limits' deals with the degrees of the field of view, which can be adjusted between 0° and 90°. Tobii recommend a view angle setting below 90 degrees [96]. Hence, the setup for the 'Field of view extension', which controls the setting at which angle the camera rotation will have slowed to a complete stop, was set by 45°.

A further setting of ISE includes the control features with a toggle function to toggle ISE on or off. This was not used by players in any scenario, since it has been intrusive and sophisticating for the research study. Furthermore, the features 'Center view on disable' and 'Center view key' was not used during playing time of any condition.

In the protocol, the experimenter first welcomed the participants and provided an introduction text that gave an overview of the procedure and purpose of the study. Each participant was instructed about the game setting and the game goals. According to the within-subject design, all participants played each of the four scenarios. The average play time was about of 15 minutes per scenario.

After each scenario, players completed a questionnaire with questions on *spatial* and *embodied presence* for a scientifically proven interpretation on those player experiences. The order of the scenarios was randomly assigned for each participant. After all scenarios were played and all four questionnaires were completed, participants had the opportunity to give comments

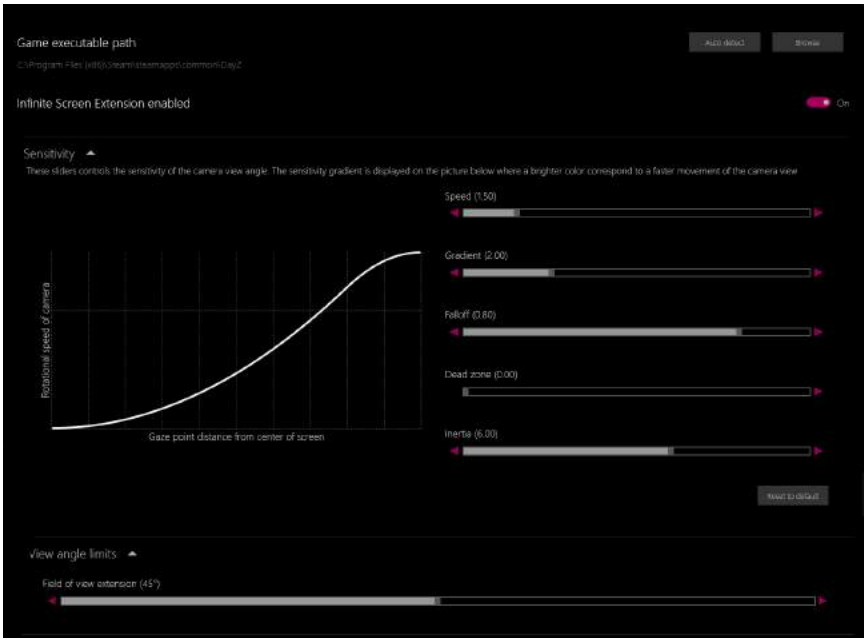


Figure 4.8: Defined *Infinite Screen Settings* (ISE) of 'Sensitivity' and 'View angle limits' [96].

on *presence*. Further qualitative questions about *spatial* and *embodied presence* were asked by the experimenter to gain a better understanding of the physical quality of the participants feeling. *Spatial presence* was measured by MEC-SPQ[1] of Vorderer et al. [41]; whereas, *embodied presence* was measured by the validated scales of Player Identification (PI)[2] by van Looy et al. [37], a degree of how much the player feel like being their avatar. Both scales are common methods for evaluating and measuring *presence*.

As the game *DayZ* has no tutorial and gives no hints at any time, the experimenter explained before starting the game all relevant controls and the goal of the game itself. In this way, gamers had no difficulties getting into the game. Additionally every participant could ask questions during the play time about the control scheme and so forth.

4.4 Measures

All data of the participants were collected by using validated scales by Measurements, Effects, Conditions Spatial Presence Questionnaire (MEC-SPQ)

[1]MEC-SPQ: Measurements, Effects, Condition Spatial Presence Questionnare is a scale development by Vorderer et al. [41].

[2]PI Questionnare is a scale development by Looy et al., which consist of several validated sections, like *Avatar Identification embodied presence* (EP) [37].

of Vorderer et al. [41] to measure SPSL and validated scales for Player Identification (PI) in games and another validated scale by van Looy et al. [37] to measure EP. Hence, the questionnaires of those scales serve to measure *spatial presence: self location* as well as *embodied presence* through a within-subject design.

Spatial presence: self location measures how far a player is physically situated within the gaming world, while *embodied presence* deals with the players feeling of being the avatar. Those two factors of *presence* together attempt to give clear results on how far player perspectives, FPP and TPP, and gaze-based vs. non gaze-based interaction have an influence on players in three-dimensional action-adventure games. Following sections give some indication of the findings of this research study.

4.5 Data analyses

The data (RBF222 design) were analyzed by means of a repeated measures analysis of variance (rANOVA). The three within-subjects factors were the experimental conditions perspective (first person versus third person) and gaze (with gaze versus without gaze), and the type of indicator for experienced *presence* (*spatial presence: self location* versus *embodied presence*). Effects at the conventional level of $p < .05$ were considered statistically significant.

Chapter 5

Results

In the following the selected items were merged in order to create a score and results can be presented. In addition to the rANOVA score, this chapter discuss the findings from the qualitative questionnaires completed by all participants.

Table 5.1 shows the descriptive statistics and Bivariate Pearson Correlation coefficients between the variables. Experienced *presence* tended to be generally higher among female participants, younger participants and participants who were not employed. Interestingly, female (as compared with male) participants reported significantly higher *spatial presence* experiences particularly for the game with the TPP. The frequency of playing games was unrelated to experienced *presence*.

Table 5.1: Means (M), Standard Deviations (SD), Zero-Order Correlations, and Cronbach's Alpha Reliabilities (in the diagonale) of the studied variables.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
Participant characteristics:														
1. Gender	0.21	−−												
2. Age	25.29	3.45	−.20											
3. Occupation	0.42	−−	−.23	.43∗										
4. Playing games	1.71	0.91	−.29	.26	−.10									
Sc1st+:														
5. Spatial presence	2.89	1.27	.23	−.34	−.27	−.00	(.96)							
6. Embodied presence	2.88	1.23	.22	−.28	−.14	−.06	.96∗	(.94)						
Sc1st−:														
7. Spatial presence	2.63	1.21	.25	−.38Ď	−.32	.05	.90∗	.83∗	(.96)					
8. Embodied presence	2.63	1.22	.23	−.42∗	−.20	.02	.85∗	.84∗	.92∗	(.93)				
Sc3rd+:														
9. Spatial presence	2.73	1.15	.41∗	−.32	−.41∗	−.17	.85∗	.80∗	.86∗	.84∗	(.95)			
10. Embodied presence	2.66	1.16	.29	−.24	−.27	−.05	.77∗	.79∗	.83∗	.90∗	.88∗	(.93)		
Sc3rd−:														
11. Spatial presence	2.30	1.08	.42∗	−.40Ď	−.35	−.09	.78∗	.74∗	.90∗	.88∗	.86∗	.86∗	(.95)	
12. Embodied presence	2.35	1.10	.26	−.23	−.25	−.03	.69∗	.72∗	.81∗	.86∗	.75∗	.86∗	.93∗	(.90)

Note. N = 24.,† $p < .10$, * $p < .05$.
Gender: 0 = male, 1 = female.
Occupation: 0 = student, 1 = employed.
Playing games: 0 = never, 1 = occasionally, 2 = several times a week, 3 = daily.

Table 5.2: Mean Differences (B) and Standart Error (SE) in *spatial* and *embodied presence* between the experimental conditions (p-values obtained from the Least Signficant Difference Test).

	Spatial presence			Embodied presence		
Comparison	**B**	**SE**	**p**	**B**	**SE**	**p**
Sc1st+ - Sc1st−	0.26	0.12	0.036	0.25	0.14	0.088
Sc1st+ - Sc3rd+	0.16	0.14	0.254	0.22	0.16	0.178
Sc1st+ - Sc3rd−	0.59	0.17	0.002	0.54	0.18	0.007
Sc1st− - Sc3rd+	-0.10	0.12	0.409	-0.03	0.11	0.803
Sc1st− - Sc3rd−	0.33	0.12	0.004	0.29	0.13	0.036
Sc3rd+ - Sc3rd−	0.43	0.12	0.002	0.31	0.12	0.018

The results of the rANOVA revealed significant main effects of perspective, F(1, 23) = 5.86, p = .024, part. η^2 = .20, and gaze, F(1, 23) = 11.15, p = .003, part. η^2 = .33. Thus, experienced *presence* was significantly higher when playing in the FPP (as compared with the TPP) condition, and when playing in the gaze (as compared with the non-gaze) condition. The main effect of *presence* was not significant, which implies that the effects of perspective and gaze did not differ for the two indicators of experienced *presence*.

No interaction effect reached significance, suggesting that the effect of perspective was similar in the gaze and non-gaze condition, and the effect of gaze was similar in the FPP and TPP condition. However, all interactive effects (except for the interaction of perspective and *presence*) were at least of small to medium size (part. η^2 = .03 – .05).

Thus, power issues might have contributed to the non-significant results (i.e., statistical significance of interactive effects is difficult to prove with a small sample size). Therefore, we additionally conducted comparisons for each pair of the four conditions separately (i.e., first person gaze, first person non-gaze, third person gaze, and third person non-gaze) using the Least Significance Difference test.

The results of these pairwise comparisons (see Table 5.2) demonstrated again that the differences between the conditions were similar for the two indicators of experienced *presence*, but they were more pronounced for *spatial* than *embodied presence*. Interestingly, gaze particularly improved experienced *presence* in the TPP condition, and only when gaze was not available was the FPP more beneficial than the TPP.

5.1 Embodied presence

In Figure 5.1 all four experimental conditions and results for player experience are shown. By use of a five-point Likert scale, ranging from 'strongly disagree' to 'strongly agree', items are rated.

The results of the rANOVA reveal that *embodied presence* (EP) in the condition FPP with gaze (Sc1st+) has the highest significant impact (M = 2.88, SD = 1.23). Whereas TPP without gaze (Sc3rd−) has the lowest result (M = 2.35, SD = 1.10). A minimal yet interesting result shows the comparison of condition FPP without gaze (Sc1st−) (M = 2.63, SD = 1.22) to TPP with gaze (Sc3rd+) (M = 2.66, SD = 1.16). A FPP without gaze was expected to produce stronger EP in players than TPP with gaze, since the player did not see the full character.

A comparison between the conditions showed that Sc1st− and Sc3rd+ (p = .803) as well as Sc1st+ and Sc3rd+ (p = .178) have highly significant differences. All other conditions do not differ considerably by their mean values. However, the results indicate that this hypothesis is only partially confirmed.

Figure 5.1: Means of *embodied presence* in the four experimental conditions (error bars represent 90% confidence intervals).

5.2 Spatial presence: self location

Results for *spatial presence: self location* (SPSL) are displayed in Figure 5.2. These results, where items rated also by a five-point Likert scale (ranging from 'strongly disagree' to 'strongly agree'), provide some support for the second hypothesis that a player in FPP along with gaze-based interaction device with ISE (Sc1st+) (M = 2.89, SD = 1.27), perceive a higher SPSL in comparison to a TPP (Sc3rd−) (M = 2.30, SD = 1.08). Since players look

Table 5.3: Means of *spatial* and *embodied presence* in the four experimental conditions (error bars represent 90% confidence intervals).

Condition	SPSL	Error	EP	Error
Sc1st+	2.889	0.443	2.882	0.432
Sc1st−	2.632	0.423	2.632	0.426
Sc3rd+	2.729	0.401	2.660	0.407
Sc3rd−	2.299	0.377	2.347	0.384

into the gaming world through their own eyes, Sc1st+ produce the highest feelings of 'being there' in comparison to Sc3rd−, which has the least impact.

An interesting result can be shown between FPP without gaze (Sc1st−) (M = 2.63, SD = 1.21) and TPP with gaze (Sc3rd+) (M = 2.73, SD = 1.15). Considering that a player in Sc3rd+ acts within a more natural way of looking comparing to Sc1st−.

Comparisons between the conditions Sc1st− and Sc3rd+ (p = .409) achieve the highest results on perceived SPSL, followed by Sc1st+ and Sc3rd+ (p = .254) and Sc1st+ and Sc1st− (p = .036).

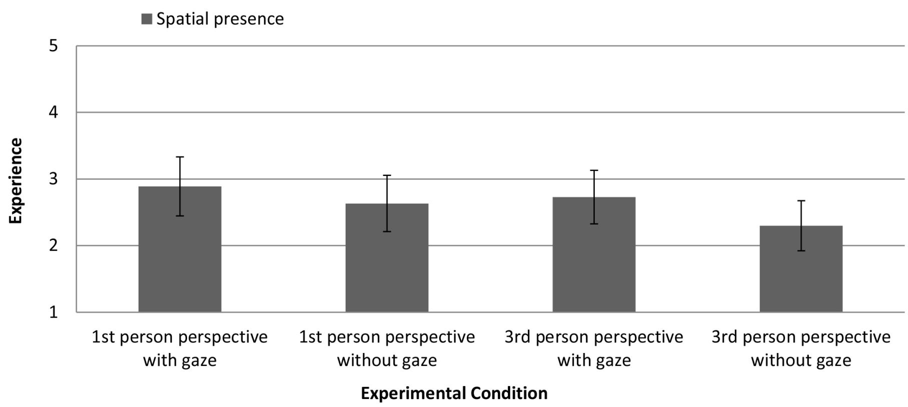


Figure 5.2: Means of *spatial presence* in the four experimental conditions (error bars represent 90% confidence intervals).

In comparison of the dimensions of *presence spatial presence: self location*, which was more pronounced, and *embodied presence* results are shown in Figure 5.3. Nevertheless, Sc1st+ (EP: M = 2.88, SD = 1.23, SPSL: M = 2.89, SD = 1.27), followed by Sc3rd+ (EP: M = 2.66, SD = 1.16, SPSL: M = 2.73, SD = 1.15), has the highest ratings in both dimensions, while Sc3rd− showed the lowest ratings (EP: M = 2.35, SD = 1.10, SPSL: M = 2.30, SD = 1.08) (see Table 5.3).

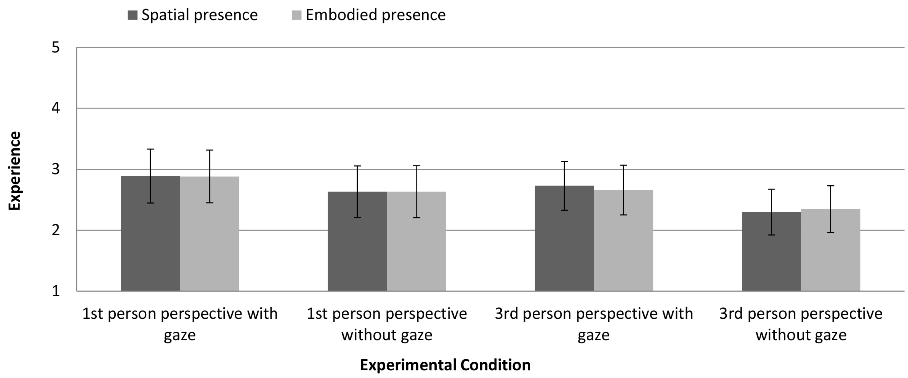


Figure 5.3: Means of *spatial* and *embodied presence* in the four experimental conditions (error bars represent 90% confidence intervals).

5.3 Qualitative score

Alongside quantitative questionnaires through validated scales by MEC-SPQ of Vorderer et al. [41] and through validated scales by PI of van Looy et al. [37] to measure *spatial presence: self location* and *embodied presence*, responses to qualitative questions, developed by the author, were compiled. Questions about the playing view (FPP and TPP) in a three-dimensional action-adventure game as well as with and without the gaze feature ISE were included. Additionally, the author observed while each participant played. This section gives a summary of observed players actions and their responses to the following questions:

1. How do you feel about the gaze interaction?
2. How far did you feel physically integrated in the gaming world? Which feelings arose?
3. Could you identify yourself with the gaming character? And if yes, in what way?

The first question focused on the *Infinite Screen Extension* (ISE) as the gaze and extended view feature input for the three-dimensional action-adventure game *DayZ*. Twenty-two of the 24 participants said that the implementation of ISE was convenient for looking around and simplified the control; although, this feeling only exists when moving the character around outdoor spaces in the gaming world. When moving the avatar in interior spaces (see Figure 5.4a), like inside the house, as well as picking up food, weapons, etc., or using the GUI (graphical user interface) (see Figure 5.4b) ISE was disruptive and disorientating (37.5%). Especially when reading teamspeak needs of the game character, which were located down

(a)

(b)

Figure 5.4: Here the player is inside a building (a) in FPP mode. When using GUI (b) while playing with ISE the player sometimes got disoriented [91].

in the left corner, ISE feature was extremely disorientating while using the GUI. Furthermore, it was observed that in a stressful situation, i.e. when the player was attacked by a zombie (see Figure 5.5a) or confronted with online players, ISE was a hindrance by virtue of sudden fear.

Nevertheless, 33% of the players wished for a wider view angle and faster looking around. Only five participants stated that ISE is conducive to realistic feel in the game and that gaze-based interaction should be more integrated in other games. Furthermore, 25% said that the ISE feature was at some point more disruptive than useful.

For some participants, gaze control triggered motion sickness. As mentioned previously, two participants had to stop the experiment, because of motion sickness (the critical point was the gaze interaction in combination with FPP).

The last two questions asked about ISE in combination of the playing views in a three-dimensional gaming world. It can be stated that 16 (67%) participants were at some point physically integrated in the gaming world, which was based on player perspective and ISE feature. Seventy-three percent of the players said that playing time needed to be longer for feelings of 'being there' to arise, or replied more generally that they always knew that they were just playing a game.

ISE in combination with FPP was the biggest factor for feeling more 'there' inside the game, based on natural feelings of movement and looking around. In contrast, most conditions with TPP were experienced as an observation post. Participants who played with night simulation (see Figure 5.5b and Figure 5.6a) feel automatically more physically based into the game world, regardless game condition played.

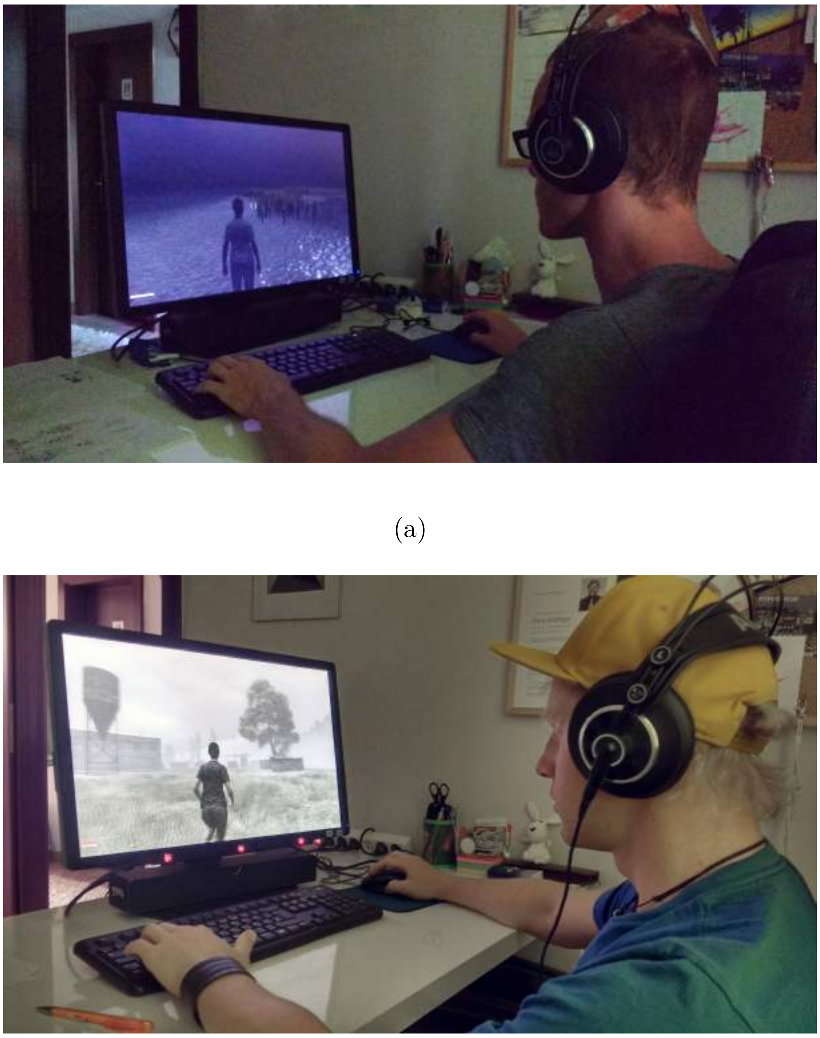
Fifty percent of the participants identified with the avatar while playing in FPP. This feeling was reinforced by a condition with gaze-based interaction. Some players felt empathy for their avatar, i.e. when their game character was hurt or hungry, collected new clothing or was attacked. Three particpants showed empathy with their avatar only when it was dying (see Figure 5.6b). Participants frequently asked for the story behind the game.

Additionally, most of the participants expressed a wish for a longer playing time than 15 minutes for each condition, especially conditions with ISE. They said that the extended view feature takes some time to get familiar with it. Furthermore, a storyline in the game would likely result in a greater identification with the game character, whether if a FPP or TPP were played.

(a)

(b)

Figure 5.5: [91] A female participant playing condition FPP with gaze interaction (a) shortly shocked as a zombie attacked her. The other particpant (b) is playing FPP without gaze in a night simulation.



(a)

(b)

Figure 5.6: [91] A male participant while playing condition FPP without gaze interaction with night simulation (a). The other male participant is playing condition TPP with gaze interaction (b), where his avatar is shortly before dying, which can be seen as the screen loses colour.

Chapter 6

Discussion

The following section summarizes and reflects the results of the research study and discusses important findings for the gaming sector with gaze-based control input within a three-dimensional action-adventure game played in FPP as well as TPP.

The study shows that the input of interactive devices as well as the playing view (FPP and TPP) has definite effects on players. Perceived *presence* (in this research study focused on the two dimensions EP and SPSL) was confirmed by collected data (RBF222 design) and rANOVA score.

Some of the anticipated hypotheses arrived as expected; generally, in comparing Sc1st− against Sc3rd+ wrong assumptions in both hypotheses were made. It was stated that FPP without gaze interaction should arouse a higher feeling of presence (SPSL and EP) than TPP with gaze-based interaction, what did not occur. It could be assumed that ISE has a decisive influence on the player experience; although the results show that gaze-based interaction do not have significantly high value at validated scales. Additionally, the condition Sc1st+ achieves the highest ratings for the impact on players in all assumptions, which was anticipated. Hence, condition Sc1st+ receives in all hypotheses the highest ratings of perceived SPSL and EP. In the following the findings are discussed in detail.

In Hypotheses 1 (H1), where EP was measured, condition Sc1st+ had the highest ratings, followed by Sc3rd+, which was not expected. The least impact was seen with condition Sc3rd−. Condition Sc1st+ received highest impact since it had a strong influence on players. In this case FPP with added ISE could be felt more real, because the player never saw the whole game character. Furthermore, a natural feeling of looking around during gameplay was given by gaze-based control. Some of the participants stated that they felt more as if they were the avatar, when finding new clothes for a nicer look, or when the avatar got ill. In comparison, condition Sc3rd− with least impact on EP the player hardly identified with the game character. Some participants stated that they felt like an observer while playing TPP without gaze interaction. Neither the pleasure of dressing the game character was in this condition critical for increasing EP, since in TPP a character with its dress can be seen permanently.

An interesting outcome of the audit shows the comparison effect on players between Sc1st− and Sc3rd+. Since the assumption FPP should offer a higher connection to the avatar the opposite condition Sc3rd+ allow only a more natural way of looking within the game world. Nevertheless, gaze-based control could be more critical for a higher EP.

Furthermore, it can be suggested that the TPP, where a player sees the avatar the whole time, increases the feeling of connecting, or being, the gaming character since all reactions of the environment are immediately visible. An example of this could be an attack by zombies or other players, as well as a symptom of falling ill, which leads slowly to death. Some participants started to feel more that they were the game character when they got hungry or ill, which was observed during several play test sessions. A further assumption, mentioned previously where the player likes to dress like their avatars, could influence the perceived EP, since most of the participants fell in love with a red school bag; although it offered a quiet sparse storage facility in comparison to the trekking backpacks. Hence, this behavior can be interpreted as avatar identification.

In addition, Hypotheses 2 (H2) about SPSL impact on players was supported by the results of the study. Condition Sc1st+ had in H1 the highest ratings, whereas Sc3rd− had the lowest. Most of the participants stated that there was a vast difference playing FPP with ISE in comparison to TPP without, which could be observed by played behind one another.

As predicted, condition Sc1st+ received the highest SPSL, because a player can be felt more physically located into a mediated world by looking into it through its own eyes. The feature of an extended view provided that feeling, since player acted like in real life, naturally looking around within the virtual world. Some participants suggested that stressful situations additionally promoted the feeling of being physically placed in *DayZ*. Furthermore, when player heard something close by FPP view in combination with ISE, it made them more nervous.

It was hypothesized that condition Sc1st− and condition Sc3rd+ both have assumptions to receive a high SPSL. Nevertheless, results show that player felt more physically based within the virtual environment at condition Sc3rd+.

As condition Sc3rd+ also has a higher rating against condition Sc1st− like in H1 measuring EP, some similar assumptions could be made. The feature of gaze-based interaction allows a higher feeling for physically based in the game, since a feeling of looking naturally was ensured. Sc1st− could only gave the option of looking into the world through the avatars eyes; thus, the player looked through their own eyes into the mediated environment and did not see the full body of the game character. Another reason for higher impact of SPSL on players in condition Sc3rd+ could be hypothesize by seeing a wider area of the environment. Hence, a player witnessed more from the virtual world and what happened in there. Some participants even stated that they feel physically more based when a noise or movement was close by.

In condition Sc3rd− the lowest ratings in SPSL were reached. This conclusion can be related to seeing the game character fully the whole time. Most of the participants stated that they felt like an observer, placed a few meters behind the avatar. A few times the term 'puppet' equated to describe the situation of TPP without gaze-based interaction.

In addition to the results and assumption made above in H1 as well as H2, it can be said that for some participants a storyline was definitively missing. This was a crucial point when answering the qualitative questions about SPSL and EP. Furthermore, for two players it was hard to identify themselves with a character placed in Russia during a zombie apocalypse.

For the game *DayZ* longer playing times would be required for the conditions with gaze-based input. The control of ISE needs more time to get familiar with it, which could have made those conditions more enjoyable and more *presence* could have been perceived. Furthermore, the settings of ISE should be tweaked, since some participants did not feel the extended view as a good way to look around naturally.

Chapter 7

Conclusion

In this thesis, the case study of perceived *spatial presence: self location* and *embodied presence* with a focus on switching the player view (first person and third person) and on the use of gaze-based interaction in a three-dimensional action-adventure game to reveal interesting insights.

In general, a positive impact on players through player view (FPP and TPP) can be presented, since it was assumed that gaze-based interaction should be a critical factor for perceived *presence*. Hence, alluring results can be presented on the effects of playing conditions in FPP and TPP in combination with gaze-based interaction as control (ISE), which should build a crucial outcome for game developers and designers. As the results show the additional input control of gazing in gameplay increases the impact on players only slightly. Thus, ISE has no strong influence on SPSL and EP, which was perhaps due to the fact that the playing time was too short and gaze-based interaction is not a common input control. A further assumption can related to ISE settings, which could be adjusted to the players. Furthermore, the game genre in the three-dimensional world could be a relavant factor for perveived SPSL and EP.

Consequently, an investigation for future researches would be the play test length, which was in this research study about 15 minutes per condition. Participants' wishes for more time when playing with the eye tracking input devices, since it takes some time to handle the new control feature and get familiar. A further interesting thought would be other adjustments for the angle view and speed upgrading for looking around. Hence, future research studies can expose this by setting more focus on natural eye behavior in real life. It can be assumed that the sector of adding gaze-based features in games will continue to rise in the next years. Nevertheless, such research studies of gaze-based interaction in different game genres and switching between FPP and TPP are crucial for designing and developing games in the future as well as understand their impact on player.

Appendix A

Quantitative and qualitative questionnaires

Embodied presence questionnaires by Van Looy et al. (*Avatar Identification* of *Player Identification* scale) [37] with five-point Likert items ranging from 'strongly disagree' to 'strongly agree':

1. When I am playing, it feels as if I am my character.
2. I feel like I am inside my character when playing.
3. In the game, it is as if I become one with my character.
4. When I am playing I am transported into my character.
5. When playing, it feels as if my character's body becomes my own.
6. In the game, it is as if I act directly through my character.

Spatial presence: self location questionnaires with 6-items version by Vorderer et al. (MEC-SPQ) [41] with five-point Likert items ranging from 'strongly disagree' to 'strongly agree':

1. I felt like I was a part of the environment in the presentation.
2. I felt like I was actually there in the environment of the presentation.
3. I felt like the objects in the presentation surrounded me.
4. It was as though my true location had shifted into the environment in the presentation.
5. I felt as though I was physically present in the environment of the presentation.
6. It seemed as though I actually took part in the action of the presentation.

Qualitative questionnaires made by the author:

1. How do you feel about the gaze interaction?
2. How far did you feel physically integrated in the gaming world? Which feelings arose?
3. Could you identify yourself with the gaming character? And if yes, so in what way?

References

Literature

[1] Alena Denisova and Paul Cairns. “First Person vs. Third Person Perspective in Digital Games: Do Player Preferences Affect Immersion?” In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. CHI ’15. Seoul, Republic of Korea: ACM, 2015, pp. 145–148. URL: http://doi.acm.org/10.1145/2702123.2702256 (cit. on pp. 22, 28, 30).

[2] Soussan Djamasbi and Siavash Mortazavi. “Generation Y, Baby Boomers, and Gaze Interaction Experience in Gaming”. In: *Proceedings of the 2015 48th Hawaii International Conference on System Sciences*. HICSS ’15. Washington, DC, USA: IEEE Computer Society, 2015, pp. 482–490. URL: http://dx.doi.org/10.1109/HICSS.2015.64 (cit. on p. 24).

[3] Nicolas Ducheneaut et al. “Body and Mind: A Study of Avatar Personalization in Three Virtual Worlds”. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI ’09. Boston, MA, USA: ACM, 2009, pp. 1151–1160. URL: http://doi.acm.org/10.1145/1518701.1518877 (cit. on p. 21).

[4] Jens Eder. *Die Figur im Film. Grundlagen der Figurenanalyse*. Marburg: Schueren, 2014 (cit. on p. 21).

[5] Jonathan Freeman. “Implications for the measurement of presence from convergent evidence on the structure of presence”. In: *Information Systems Division at the annual meeting of the International Communication Association*. New Orleans, USA: International Communication Association, 2004, pp. 101–112. URL: https://ispr.info/presence-conferences/previous-conferences/presence-at-ica-2004-proceedings/ (cit. on pp. 18–20).

[6] Jayne Isabel Gackenbach and Johnathan Bown. “Video Game Presence as a Function of Genre”. In: *Loading... The Journal of the Canadian Game Studies Association*. Vol. 5. 2011, pp. 4–28 (cit. on pp. 21, 22).

[7] Alison Gazzard. *Mazes in Videogames: Meaning, Metaphor and Design*. Jefferson: McFarland and Company, Inc, 2013 (cit. on p. 24).

[8] John Paulin Hansen et al. "The Use of Gaze to Control Drones". In: *Proceedings of the Symposium on Eye Tracking Research and Applications, ETRA 2014*. Association for Computing Machinery, 2014, pp. 27–34 (cit. on pp. 9, 10).

[9] Dorothée Hefner, Christoph Klimmt, and Peter Vorderer. "Identification with the Player Character As Determinant of Video Game Enjoyment". In: *Proceedings of the 6th International Conference on Entertainment Computing*. ICEC'07. Shanghai, China: Springer-Verlag, 2007, pp. 39–48. URL: http://dl.acm.org/citation.cfm?id=2394259.2394267 (cit. on p. 21).

[10] Wijnand A IJsselsteijn et al. "Presence: concept, determinants, and measurement". In: *Electronic Imaging*. International Society for Optics and Photonics. 2000, pp. 520–529 (cit. on pp. 19, 20).

[11] Poika Isokoski et al. "Gaze controlled games". *Universal Access in the Information Society* 8.4 (2009), pp. 323–337 (cit. on pp. 14, 24).

[12] James D Ivory and Sriram Kalyanaraman. "The effects of technological advancement and violent content in video games on players' feelings of presence, involvement, physiological arousal, and aggression". *Journal of Communication* 57.3 (2007), pp. 532–555 (cit. on p. 18).

[13] Alison Jönsson. "If looks could kill – an evaluation of eye tracking in computer games". Masterthesis. Stockholm: Royal Institute of Technology, Department of Numerical Analysis and Computer Science, 2005 (cit. on pp. 24, 25).

[14] Kari Kallinen et al. "Presence and emotion in computer game players during 1st person vs. 3rd person playing view: Evidence from self-report, eye-tracking, and facial muscle activity data". *Proceedings of the PRESENCE* (2007), pp. 187–190 (cit. on pp. 28–31).

[15] Michael Lankes, Bernhard Maurer, and Barbara Stiglbauer. "An Eye for an Eye: Gaze Input in Competitive Online Games and Its Effects on Social Presence". In: *Proceedings of the 13th International Conference on Advances in Computer Entertainment Technology*. ACE2016. Osaka, Japan: ACM, 2016, 17:1–17:9. URL: http://doi.acm.org/10.1145/3001773.3001774 (cit. on p. 14).

[16] Michael Lankes and Stefan Wagner. "Taking a Look at the Player's Gaze: The Effects of Gaze Visualizations on the Perceived Presence in Games". In: *DiGRA - Proceedings of the 2015 DiGRA International Conference*. Digital Games Research Association, May 2015 (cit. on pp. 1, 26, 28, 31).

[17] Michael Lankes et al. “Whom Are You Looking for?: The Effects of Different Player Representation Relations on the Presence in Gaze-based Games”. In: *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play*. CHI PLAY ’14. Toronto, Ontario, Canada: ACM, 2014, pp. 171–179. URL: http://doi.acm.org/10.1145/2658537.2658698 (cit. on pp. 20, 24, 25, 30, 31).

[18] Kwan Min Lee. “Why Presence Occurs: Evolutionary Psychology, Media Equation, and Presence”. *Presence: Teleoper. Virtual Environ.* 13.4 (Aug. 2004), pp. 494–505. URL: http://dx.doi.org/10.1162/1054746041944830 (cit. on pp. 19, 20).

[19] Matthew Lombard et al. “Measuring presence: A literature-based approach to the development of a standardized paper-and-pencil instrument”. In: *Third international workshop on presence, Delft, The Netherlands*. Vol. 240. 2000, pp. 2–4 (cit. on p. 19).

[20] M. Lombard et al. *Immersed in Media: Telepresence Theory, Measurement & Technology*. Springer International Publishing, 2015 (cit. on pp. 19, 20).

[21] Lennart E Nacke et al. “Gameplay experience in a gaze interaction game”. In: *The 5th Conference on Communication by Gaze Interaction – COGAIN 2009: Gaze Interaction For Those Who Want It Most*. 2010 (cit. on pp. 25, 26).

[22] Daniel M Pinchbeck and Brett Stevens. “Presence, narrative and schemata”. In: *Proceedings of Presence 2005: The 8th International Workshop on Presence*. London, UK, 2005, pp. 221–26 (cit. on p. 19).

[23] Alex Poole and Linden J Ball. “Eye tracking in HCI and usability research”. *Encyclopedia of human computer interaction* 1 (2006), pp. 211–219 (cit. on p. 6).

[24] Irene Rae et al. “A framework for understanding and designing telepresence”. In: *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*. ACM. 2015, pp. 1552–1566 (cit. on pp. 18, 19).

[25] Niklas Ravaja et al. “Emotional Response Patterns and Sense of Presence During Video Games: Potential Criterion Variables for Game Design”. In: *Proceedings of the Third Nordic Conference on Human-computer Interaction*. NordiCHI ’04. Tampere, Finland: ACM, 2004, pp. 339–347. URL: http://doi.acm.org/10.1145/1028014.1028068 (cit. on p. 22).

[26] Keith Rayner et al. *The psychology of reading*. 2nd ed. Hove: Taylor and Francis Ltd, 2012 (cit. on p. 6).

[27] B. Reeves. “"Being there": Television as symbolic versus natural experience”. PhD thesis. Stanford: Stanford University, Institute for Communication Research, 1991 (cit. on p. 19).

[28] Inma Rodríguez-Ardura and Antoni Meseguer-Artola. “E-learning Continuance”. *Information & Management* 53.4 (June 2016), pp. 504–516. URL: http://dx.doi.org/10.1016/j.im.2015.11.005 (cit. on p. 20).

[29] Richard M Ryan, C Scott Rigby, and Andrew Przybylski. “The motivational pull of video games: A self-determination theory approach”. *Motivation and emotion* 30.4 (2006), pp. 344–360 (cit. on p. 19).

[30] Ulrike Schultze. “Embodiment and presence in virtual worlds: a review”. *Journal of Information Technology* 25.4 (2010), pp. 434–449 (cit. on pp. 1, 19).

[31] Mel Slater et al. “First person experience of body transfer in virtual reality”. *PloS one* 5.5 (2010), pp. 1–8 (cit. on p. 22).

[32] J. David Smith and T. C. Nicholas Graham. “Use of Eye Movements for Video Game Control”. In: *Proceedings of the 2006 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology*. ACE ’06. Hollywood, California, USA: ACM, 2006. URL: http://doi.acm.org/10.1145/1178823.1178847 (cit. on pp. 1, 2, 26, 27).

[33] Oleg Špakov. “EyeChess: the tutoring game with visual attentive interface”. *Alternative Access: Feelings & Games* (2005), pp. 81–86 (cit. on pp. 12, 13).

[34] Jari Takatalo et al. “Involvement and Presence in Digital Gaming”. In: *Proceedings of the 4th Nordic Conference on Human-computer Interaction: Changing Roles*. NordiCHI ’06. Oslo, Norway: ACM, 2006, pp. 393–396. URL: http://doi.acm.org/10.1145/1182475.1182520 (cit. on p. 19).

[35] Nicholas Tamborini Ron. Bowman. “Presence in Video Games”. In: *Immersed in Media: Telepresence in Everyday Life*. Ed. by Paul Bracken Cheryl Campanella. Skalski. 2010, pp. 87–109 (cit. on pp. 19, 20).

[36] Paul Tamborini Ron. Skalski. “The Role of Presence in the Experience of Electronic Games”. In: *Playing video games: Motives, responses, and consequences*. Lawrence Erlbaum Associates Publishers, 2006, pp. 225–237 (cit. on pp. 1, 18–20).

[37] Jan Van Looy, Cédric Courtois, and Melanie De Vocht. "Player Identification in Online Games: Validation of a Scale for Measuring Identification in MMORPGs". In: *Proceedings of the 3rd International Conference on Fun and Games*. Fun and Games '10. Leuven, Belgium: ACM, 2010, pp. 126–134. URL: http://doi.acm.org/10.1145/1823818.1823832 (cit. on pp. 4, 20, 21, 41, 42, 48, 57).

[38] Eduardo Velloso and Marcus Carter. "The Emergence of EyePlay: A Survey of Eye Interaction in Games". In: *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*. CHI PLAY '16. Austin, Texas, USA: ACM, 2016, pp. 171–185. URL: http://doi.acm.org/10.1145/2967934.2968084 (cit. on p. 24).

[39] Melodie Vidal. "Shynosaurs: A Game of Attention Dilemma". In: *Proceedings of the First ACM SIGCHI Annual Symposium on Computer-human Interaction in Play*. CHI PLAY '14. Toronto, Ontario, Canada: ACM, 2014, pp. 391–394. URL: http://doi.acm.org/10.1145/2658537.2662979 (cit. on pp. 12, 14).

[40] Melodie Vidal et al. "The Royal Corgi: Exploring Social Gaze Interaction for Immersive Gameplay". In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. CHI '15. Seoul, Republic of Korea: ACM, 2015, pp. 115–124. URL: http://doi.acm.org/10.1145/2702123.2702163 (cit. on pp. 26, 27).

[41] Peter Vorderer et al. "MEC Spatial Presence Questionnaire". *Retrieved Sept* 18 (2004), pp. 1–13 (cit. on pp. 4, 20, 41, 42, 48, 57).

[42] John A. Waterworth et al. "Presence: Form, content and consciousness". In: *Immersed in Media: Telepresence Theory, Measurement and Technology*. Springer International Publishing, Jan. 2015, pp. 35–58 (cit. on pp. 19, 21).

[43] J.D. Westwood et al. *Medicine Meets Virtual Reality 16*. Studies in health technology and informatics. IOS Press, 2008 (cit. on p. 20).

[44] Werner Wirth et al. "A Process Model of the Formation of Spatial Presence Experiences". *Media Psychology* 9.3 (2007), pp. 493–525. eprint: http://dx.doi.org/10.1080/15213260701283079 (cit. on p. 20).

[45] D. Zillmann and P. Vorderer. *Media Entertainment: The Psychology of Its Appeal*. LEA's communication series. Lawrence Erlbaum Associates Publishers, 2000 (cit. on p. 21).

Films and audio-visual media

[46] BioWare. *Neverwinter Nights*. PC. 2002 (cit. on p. 26).

[47] Valve Cooperation. *Half-Life*. PC. 1998 (cit. on p. 24).

[48] Valve Corporation. *Dota 2*. PC. 2013 (cit. on p. 11).

[49] Sjoerd Hourences De Jong. *The Solus Project*. PC. 2016 (cit. on p. 13).

[50] Shiny Entertainment. *Sacrifice*. PC. 2000 (cit. on p. 24).

[51] Eurocom. *James Bond 007: NightFire*. PC. 2002 (cit. on p. 22).

[52] Wolfgang Hochleitner et al. *Limus and the Eyes of the Beholders*. Whom Are You Looking for?: The Effects of Different Player Representation Relations on the Presence in Gaze-based Games. 2012 (cit. on p. 24).

[53] Bohemia Interactive. *DayZ*. PC. 2012 (cit. on p. 1).

[54] Wesson International. *Lunar Command*. PC. 1993 (cit. on p. 26).

[55] Michael Lankes. *Fractile*. Taking a Look at the Player's Gaze: The Effects of Gaze Visualizations on the Perceived Presence in Games. 2015 (cit. on p. 26).

[56] Mike Minehart. *Monkey Bowling 2*. Nintendo GameCube. 2002 (cit. on p. 22).

[57] Eidos Montreal. *Deus Ex: Mankind Divided*. PC. 2016 (cit. on p. 1).

[58] Ubisoft Montreal. *Watch Dogs 2*. PC. 2016 (cit. on p. 1).

[59] Ubisoft Quebec. *Assassin's Creed Syndicate*. PC. 2015 (cit. on p. 1).

[60] Sega. *Super Monkey Ball 2*. Nintendo GameCube. 2002 (cit. on p. 22).

[61] Sega. *Tetris*. Game Boy. 1984 (cit. on p. 22).

[62] id Software. *Quake II*. 1997 (cit. on p. 26).

[63] Bethesda Softworks. *The Elder Scrolls 3: Morrowind*. PC. 2002 (cit. on p. 29).

[64] Oleg Špakov. *EyeChess*. PC. 2005 (cit. on p. 12).

[65] Bethesda Game Studios. *Skyrim – The Elder Scrolls V*. PC. 2011 (cit. on p. 23).

[66] STILLALIVE STUDIOS. *Son of Nor*. PC. 2015 (cit. on p. 12).

[67] *Tron*. Film. Drehbuch/Regie: Steven Lisberger. 1982 (cit. on p. 20).

[68] Ubisoft. *Assassin's Creed Rogue*. PC. 2014 (cit. on p. 1).

[69] Melodie Vidal. *Shynosaurs*. Shynosaurs: A Game of Attention Dilemma. 2014 (cit. on p. 12).

[70] Melodie Vidal. *The Royal Corgi*. The Royal Corgi: Exploring Social Gaze Interaction for Immersive Gameplay. 2014 (cit. on p. 26).

Online sources

[71] Free Art and Technology. *The EyeWriter*. URL: http://www.eyewriter.org/ (visited on 01/04/2017) (cit. on pp. 9, 10).

[72] NVIDIA Corporation. *Nevermwinter Nights*. URL: http://www.geforce.com/games-applications/pc-games/neverwinter-nights/description (visited on 01/07/2017) (cit. on p. 26).

[73] DEWESoft. *On-road testing, Automotive applications for on-road vehicle testing*. URL: http://www.dewesoft.com/applications/on-road-testing#adas (visited on 01/11/2017) (cit. on p. 9).

[74] Cambridge Dictionary. *eye tracking*. URL: http://dictionary.cambridge.org/dictionary/english/eye-tracking?fallbackFrom=english-german (visited on 01/10/2017) (cit. on p. 5).

[75] Lil Games. *Lunar Command*. URL: http://www.lilgames.com/lunar_command.shtml (visited on 01/10/2017) (cit. on p. 26).

[76] IMDb. *Tron*. URL: http://www.imdb.com/title/tt0084827/ (visited on 01/12/2017) (cit. on pp. 20, 21).

[77] David Jacobson. *On Theorizing Presence*. URL: http://www.hayseed.net/MOO/JOVE/presence.html (visited on 01/11/2017) (cit. on p. 19).

[78] MIT Media Lab. *Marvin Minsky, father of artificial intelligence, dies at 88*. URL: http://news.mit.edu/2016/marvin-minsky-obituary-0125 (visited on 08/06/2016) (cit. on p. 18).

[79] Reed Business Information Ltd. *Eye-tracking interface means gamers looks can kill*. URL: https://www.newscientist.com/article/dn13830-eye-tracking-interface-means-gamers-looks-can-kill/ (visited on 07/06/2016) (cit. on p. 14).

[80] Gus Lubin and Hayley Hudson. *29 Eye-Tracking Heatmaps Reveal Where People Really Look*. URL: http://www.businessinsider.com/eye-tracking-heatmaps-2014-7?IR=T (visited on 01/13/2017) (cit. on p. 6).

[81] Microsoft. *Meet Kinect for Windows*. URL: https://developer.microsoft.com/en-us/windows/kinect (visited on 06/08/2016) (cit. on p. 1).

[82] Marvin Minsky. *TELEPRESENCE*. URL: http://web.media.mit.edu/~minsky/papers/Telepresence.html (visited on 06/08/2016) (cit. on p. 18).

[83] LLC. Oculus VR. *Oculus*. URL: https://www.oculus.com/ (visited on 08/06/2016) (cit. on p. 1).

[84] SMI. *Gaze-based Interaction.* URL: http://www.smivision.com/en/gaze-and-eye-tracking-systems/applications/gaze-based-interaction.html (visited on 07/06/2016) (cit. on pp. 5, 6).

[85] SMI. *SMI Gaze and EYE Tracking Systems.* URL: http://www.smivision.com/en/gaze-and-eye-tracking-systems/home.html (visited on 08/06/2016) (cit. on pp. 1, 7, 9).

[86] STEAM. *DayZ.* URL: http://store.steampowered.com/app/221100/ (visited on 08/06/2016) (cit. on p. 33).

[87] STEAM. *Dota 2.* URL: http://www.golem.de/news/sentry-eye-tracker-ausprobiert-nur-anfaenger-starren-auf-die-mini-map-1501-111907.html (visited on 06/08/2016) (cit. on pp. 11, 12).

[88] STEAM. *Dota 2.* URL: http://store.steampowered.com/app/570/?l=german (visited on 06/08/2016) (cit. on p. 11).

[89] STEAM. *Half-Life.* URL: http://store.steampowered.com/app/70/?l=german (visited on 01/10/2017) (cit. on p. 24).

[90] STEAM. *Sacrifice.* URL: http://store.steampowered.com/app/38440/ (visited on 08/06/2016) (cit. on p. 24).

[91] STEAM. *STEAM.* URL: http://store.steampowered.com/?l=german (visited on 01/10/2017) (cit. on pp. 12, 13, 23, 24, 26, 29, 32, 33, 35–38, 49, 51, 52).

[92] steelseries. *Sentry Gaming Eye Tracker.* URL: https://steelseries.com/gaming-controllers/sentry-gaming-eye-tracker (visited on 08/06/2016) (cit. on p. 11).

[93] Tobii. *DayZ.* URL: http://www.tobii.com/xperience/apps/dayz/ (visited on 08/06/2016) (cit. on pp. 31, 33).

[94] Tobii. *Human Performance.* 2017. URL: http://www.tobiipro.com/fields-of-use/human-performance/ (cit. on p. 8).

[95] Tobii. *Sports Research.* 2017. URL: http://www.tobiipro.com/fields-of-use/human-performance/sports-research/ (cit. on p. 8).

[96] Tobii. *Tobii.* URL: http://www.tobii.com/ (visited on 08/06/2016) (cit. on pp. 1, 6, 7, 10, 11, 13, 15–17, 24, 40, 41).

[97] Tobii. *Wearable eye tracking for wayfinding research.* 2017. URL: http://www.tobiipro.com/fields-of-use/user-experience-interaction/customer-cases/airport-navigation/ (cit. on p. 8).

[98] UXBOOTH. *A Brief History of Eye-Tracking.* 2016-11-21. URL: http://www.uxbooth.com/articles/a-brief-history-of-eye-tracking/ (cit. on p. 6).

[99] Eduardo Velloso. *How eye tracking gives players a new experience in video games*. URL: http://theconversation.com/how-eye-tracking-gives-players-a-new-experience-in-video-games-54595 (visited on 01/10/2017) (cit. on p. 11).

[100] Vive. *Vive*. 2016-11-21. URL: https://www.vive.com/de/ (cit. on p. 1).

[101] VocaliD. *Finally, a digital voice made for you.* 2017-01-04. URL: https://www.vocalid.co/bespoke (cit. on pp. 10, 11).