An Investigation on Aspects of Presence for Interactive Storytelling in Cinematic Virtual Reality

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Abstract

The research project Immersive Video Interaction (IVI), part of the Immersive Media Lab of the St. Pölten University of Applied Sciences, examines fictional cinematic VR pertaining to narration models, interaction concepts, and immersion. The evaluation starts out with good practice examples of cinematic VR with narration-based interaction. In the first sample, 74 projects were included in the catalog. The catalog classifies the given projects by categories such as title, year of publication, producing studio, length, platform, provider, origin, narrative interaction concept, technical interaction concept, and technical platform. Additional criteria for inclusion in the study were narrative-based interaction, fictional story, and role of the user. The research question is whether the type of technical interaction method, the different number of interaction points, and the user's role in the story influence the sense of "presence" in that specific Interactive Fiction in cinematic Virtual Reality. We used a mixed-methods approach to answer our research question. In the first phase of the study structure, three works of IFcVR were selected from the sample that were suitable as subjects of investigation. The interactive story structure and technical interaction methods of these IFcVR were analyzed.

To better understand the user's impact on the story, we visualized the story branches with their interaction points. The interplay between interaction, presence, and digital storytelling was reviewed based on user tests. During user tests, GSR and heart rate were measured to gain insights about involvement at the interaction points and a screen capture from the HMD and video recordings from a respondent camera. After the experience, a detection for GSR peaks was carried out, and the results were discussed with the test persons. In addition to the questionnaires and the collection of biometric data, qualitative, semi-structured guided interviews were conducted as part of the user test. The research focused mainly on the factors of presence: Spatial Presence, Engagement, Naturalness, Interaction, and open questions to encourage discussion. Regarding the biofeedback data, the user tests show that in the three IFcVR, the user's active role and conscious decision about the story's progress have an emotional impact on the test users. The evaluation of the user tests through interviews and questionnaires for the presence survey also shows that the users feel present in all films, although the results show significant differences in the different factors of presence.

The different amount of interaction points and the role of the user have only a minor impact on presence. This suggests that in the selected IFcVR, neither the role of the users nor the number of interaction points has a significant effect on the presence. The research shows that the technical interaction method is relevant because interaction points with visual cues reduce presence.

Keywords

Cinematic Virtual Reality, Interactive Fiction, Narrative-Based Interaction, Creative Industries, Presence Measurement

1. Introduction

The research project Immersive Video Interaction (IVI) examines IFcVR (Interactive Fiction in cinematic Virtual Reality) and the influence of user interaction on presence. The term IFcVR is proposed by [1] to stand for an Interactive Digital Narrative VR experience based on a 360° video narrative with an interactive structure. Within an interactive structure, the user can choose between different existing storylines in a computational system [2, 3, 4].

The market for VR is currently developing rapidly. The promise of immersive media generates multiple offers of VR experiences and cinematic VR. Immersion is achieved by "removing as many real-world sensations as possible and substituting these with the sensations corresponding to the VR" [5]. Immersion is defined "as an objective property of a system" [6]. It describes the extent to which a system can deliver a "vivid illusion of reality to the senses of a human participant" [7]. The concept

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of presence is used to describe the "response to a system with a certain level of immersion" [8] and is a "subjective state or feeling, including the notion of 'being there'" [7]. Presence is a rather complex construct of a variety of dimensions. For our work, we will focus on three dimensions: Spatial Presence, Naturalness, and Engagement as described by [9]. Similar to [10], presence is a multidimensional construct. We additionally use the ITC-SOPI questionnaire developed by [9]. It is standardized, easy to use, and allows for a comparison of different media types.

In terms of a future of walk-through movies and eventual cinematic metaverse, this means an increased need to explore interaction possibilities in cVR. The research aims to contribute to an understanding of IFcVR, focusing on story structure and user presence.

Initially, an investigation was conducted on good practice VR project examples and was cataloged. The catalog sorts the given projects by categories such as title, year of publication, producing studio, length, platform, provider, origin, narrative interaction concept, technical interaction methods, and technical platform. This catalog was compared to existing VR catalogs (such as one from virtuellewelten.at) and complemented accordingly. Ultimately, seventy-four projects were included in the catalog.

Criteria for inclusion in the further study were narrative-based interactive fiction and live action. From the generated catalog, three projects that fit the criteria remained for further study.

For the evaluation of presence, the scientific standard is to use questionnaires about the feeling of presence. The objective measurement of biometric data (galvanic skin response, heart rate, electroencephalography) and facial coding (EMG) are used less frequently. The HMD worn by the subject restricts observation of facial coding. Thus, only the area around the mouth can serve as a source of information for analysis by Visual Analogue Scales (VAS). Due to the inaccuracy of data when measuring EEG with the available hardware in combination with HMDs (EMOTIV Epoc+) and the limited possibilities of EMG measurements when wearing an HMD for facial coding, these two possibilities were excluded (see Table 1). The following table provides an overview of objective measurement methods:

Table 1: Overview of objective measurement methods

Method	Abbr.	Unit	Hardware / Software	What is measured?	Presence indication
Electrodermal activity	EDA/GSR	µS	Shimmer3 GSR Unit / iMotions	Skin conductance	Emotional arousal
Heart rate	PULSE	bpm	Biofeedback Schuhfried/Shimmer	Heartbeat	Stress reaction
Electro-encephalography	EEG	Complex	Emotiv EPOC+	Scalp potential	Brain activity
Electro-myography	EMG	Complex	EMTEQ, VR HMD Insert	Muscle tension	Base emotions
Eyetracking	ET	Complex	FOVE	Gaze direction	Visual attention
Facial Coding	FC	Complex	FOVE	Eye expression	Emotional state

Following initial pretests, it was decided to focus on the measurement methods GSR, heart rate, and the questionnaire ITC-SOPI, developed by [9] since it is standardized, easy to use, and allows for a comparison of different media types.

Furthermore, peaks in the measurement data and their temporal position within the IFcVR were measured. The test administration briefed the subjects on evaluating the more precise circumstances of the physical response. In addition, the ITC-SOPI test, a standardized questionnaire, is used to determine the subjective perception of presence.

The question was whether different degrees of presence can be measured in the different IFcVR and whether there is a relation to the technical interaction method, the specific interactions and decision

points in the story, and the user's role in IFcVR.

Furthermore, it was examined how subjects judge the peaks of implicit measurement of their presence when experiencing IFcVR. The presence aspects (Spatial Presence, Naturalness, Engagement) were coded in the different linguistic expressions.

2. Interactive Storytelling in IFcVR

In this investigation, "story" is used to represent a structure within the user's ability to explore a dramatic narrative designed through authorship. Thus, the definition underlying the use case refers to that proposed by [11]. He defines "non-linear text" as a work that is a sequence in its temporal or spatial presentation that is not fixed. The user's active control of the story implies feedback and co-authorship of that story [11, 3].

Hence, a story is defined as offering the user a coherent (complete) story with a beginning and an end within an emergent structure that the user can explore.

We relate to the characteristics of a digitally narrated story described by [12]. She defines them as procedural, participatory, spatial, and encyclopedic. In the context of the investigation, we interpret procedural: the sequence emerges through feedback; participatory: the user participates in authorship through feedback; spatial: Virtual Reality, and encyclopedic: a complete story with a beginning and an end.

Thus, the Interactive Digital Narrative is an expressive form in the digital medium, implemented as a computational system containing a "protostory" of potential narratives that is experienced through a process in which the participants influence the continuation of the unfolding experience that results in products representing instantiated stories [4].

Pre-structured stories with non-linear sequences that users can co-create in terms of progression already exist across the media. They are implemented with varying (degrees of) complexity, as has also been summarized by [13].

An early inter-media comparison with other media capable of showing dramatic action was carried out by [14]. Especially in the parameters of "coherence of space and time" and "presence", i.e., the feeling of physical presence at the location of the dramatic action, VR scores as an independent medium, but there are limitations concerning the figure of the active user.

[14] also point out that the interaction within narrative VR must have an instance of control by the creators to develop in terms of a dramatic plot. [15] adds that interactive narration is also always dependent on the specific definition of interaction, noting that lifelike interaction and a well-formed narrative arc are in opposition. She argues that the question of interactive narration can only be answered by understanding at what point user feedback becomes part of the narrative [15].

The narrative has developed its own codes, mechanisms of action, and technical procedures due to the peculiarities and possibilities of the medium of VR, so Ryan's [15] transmedia approach, in which interaction can be told as a narrative on all levels, can be used here. As one of the specific codes, [16] assumed that the user always has a role either as an observer or a character and either impacts the story or not in a VR interactive narrative. Further research is necessary to better understand the user's illusion in storytelling in cVR.

Therefore, further exploration is needed in order to understand interactive storytelling and the user's experience.

2.1. Selection of Cinematic Virtual Reality

Our investigation addresses selected cinematic VR (cVR) from the entertainment industry that can be experienced via HMD and is available on popular consumer VR platforms such as Steam VR, Oculus VR, YouTube VR, or Sony Playstation VR. Further distribution platforms of the selected films include specific film festivals.

During the first three months of the project, we collected several VR experiences through different search terms: interactive VR films, interactive real video VR, VR experiences, narrative VR video games,

both similar and combinations. We found the first sample of 74 VR projects registered to a catalog. The catalog lists the VR projects with title, year of publication, producing studio, length, platform, provider, origin, technical platform for distribution, and technical interaction concept. It categorizes the VR projects into the different roles within the dramatic narration: active/passive observer and active/passive actor.

Our finding regarding the sample of over 100 works of cVR: the average duration is less than 20 minutes, the main interaction method is gaze control, the role of the user is mainly that of an observer, the VR films are very often available on multiple VR platforms, the main genre is documentary, the language is English, and over 80% are produced in the USA.

The terms for cVR are: very indistinct 360-degree video, immersive or linear VR film, and cinematic VR experience.

Further criteria for inclusion in the study were live action and interactive narrative with a user taking on a role as an active observer / active character. Only the three VR projects Afterlife [17], Broken Night [18], and Playing God [19] fulfilled all the criteria. According to [1], the selection is defined as Interactive Fiction in cinematic Virtual Reality.

3. Story Structure and Interaction Methods of the Selected IFcVR

Every film uses traditional filmmaking techniques such as cinematography, lighting, etc. There is dialogue in every film and text to be read intermittently (either for instruction or for storytelling). Even though choices can be made, a strict three-act structure is always maintained.

In favor of investigating the interaction in the different projects, an analysis of the story progress with included interaction points and the comprehended interaction was performed. This requires a visual representation of the story branches. One method of story structure visualization is using the open-source software Twine (https://twinery.org/). Twine is used to create interactive stories and scripts due to its capability to connect interaction points with hyperlinks [20].

3.1. AFTERLIFE

Afterlife [17] is an IFcVR about a family that struggles after the loss of their little son. The user experiences their grief through the eyes of the child's ghost. The story changes depending on the user's gaze during the experience.

Afterlife features a story system that seamlessly changes the story based on the user's gaze. The role of the user is defined as that of an active observer. The story branches count 29 interaction points with two options and six interaction points with one to three choices. The user is often unaware of the decision process and of how the next storyline is chosen. In six instances, a controller is used to click on one of several objects, which are the only times that the user is able to consciously choose how the story progresses. During the IFcVR, ten different locations are presented to the user.

In Afterlife, the viewer starts out as a passive observer but then becomes an active one. In Broken Night, on the other hand, the user is an active observer and can change the story's outcome in a visually distinct way.

3.2. BROKEN NIGHT

Broken Night [18] tells the story of a couple who arrives at home and starts to fight. They are interrupted by an intruder who is killed in the end. Broken Night is told from the perspective of a police interview after the event. Later in the story, the user takes on the wife's point of view at the police station.

Broken Night features a simple story structure with intermittent choices between two options. Regardless of their choices, the viewer is taken back to a default story after the specific option has played out. The choices appear as a split screen that shows how the scene will play out after choosing. The user can choose the scene with their gaze. Broken Night offers four intermittent choices between two options. The user's role is that of an active observer and a passive character. The choices are

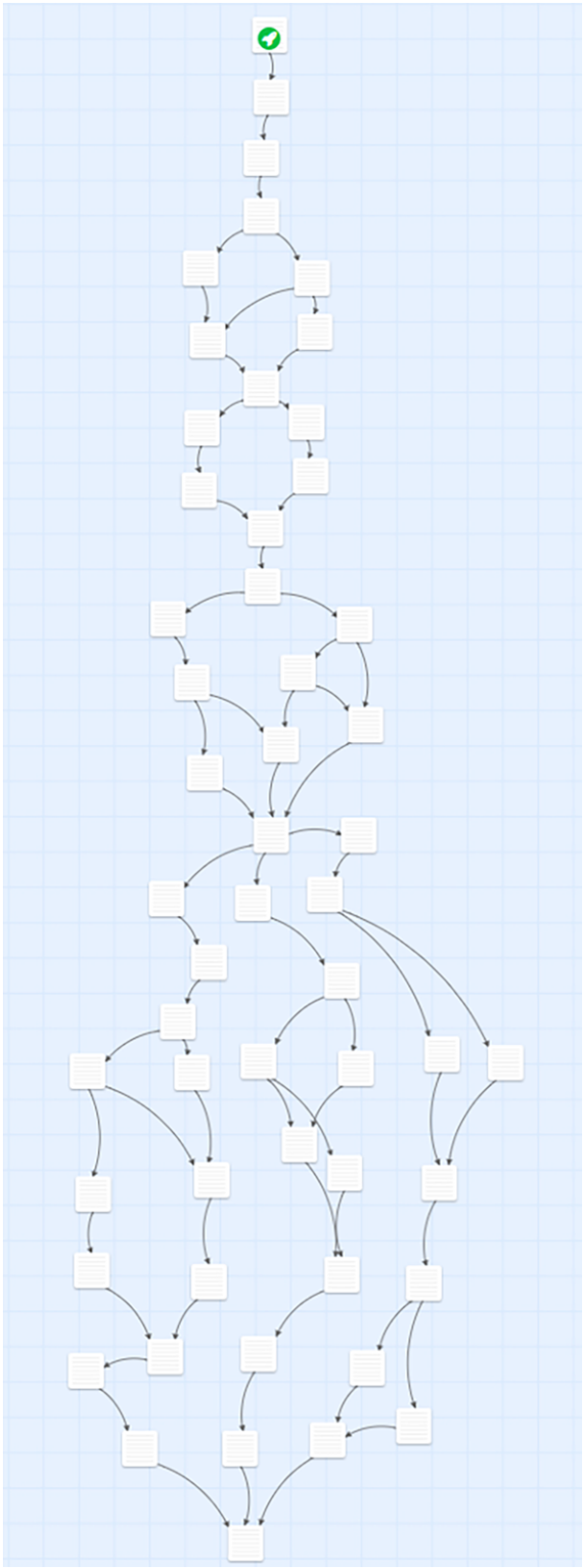

Figure 1: Story branch of the IFcVR Afterlife [17], visualized in Twine

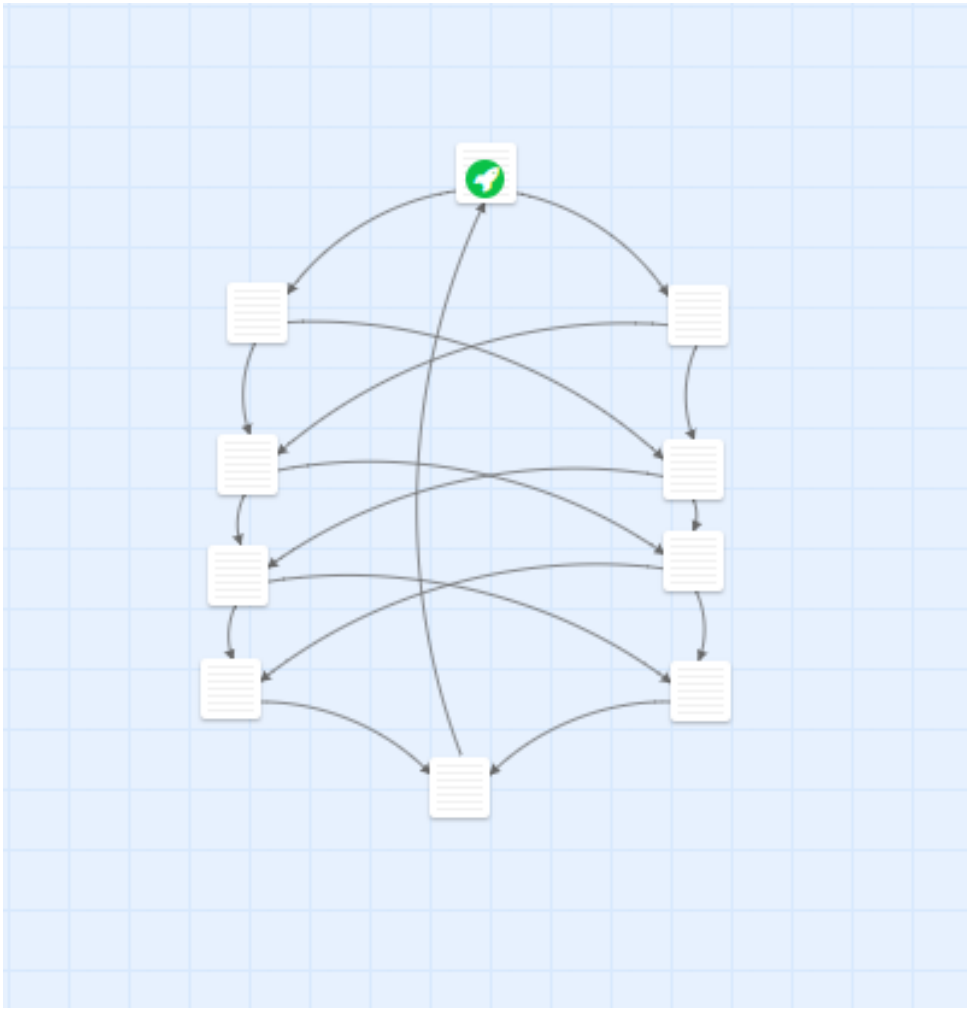

Figure 2: Story branch of the IFcVR Broken Night [18], visualized in Twine

provided as starting thumbnails that hint at the story's further development. The user acts mainly as an active observer. The story is set in five different locations.

3.3. PLAYING GOD

Playing God [19] is an IFcVR in which the user takes on the role of a futuristic robot with organic components. They act as the captain of a spaceship and must make morally difficult decisions with unclear outcomes during the voyage.

Playing God features a rather complex story with storylines that branch out wide. Some branches come to sudden ends, which is why the length of the story can vary. The player can subtly move their character and choose between options using their VR controller on a UI interface. Playing God is set in a 6-DOF (six degrees of freedom) game engine, and the user can move their character inside a small circle but cannot take more than one step in any direction. They can choose between options using their gaze on an UI interface. Each of the 20 choices has two options to choose from. The user acts as an active character with clear interactivity, and the story takes place in two different locations.

3.4. Summary Story Structure and Interaction Methods of the Selected IFcVR

When applying this information to the concept introduced by [16], it can be visualized, as seen in Figure 4. The term Ghost is comparable to the term "observer". Being active or passive can be translated into Dolan and Paret's wording of having an impact and having no impact.

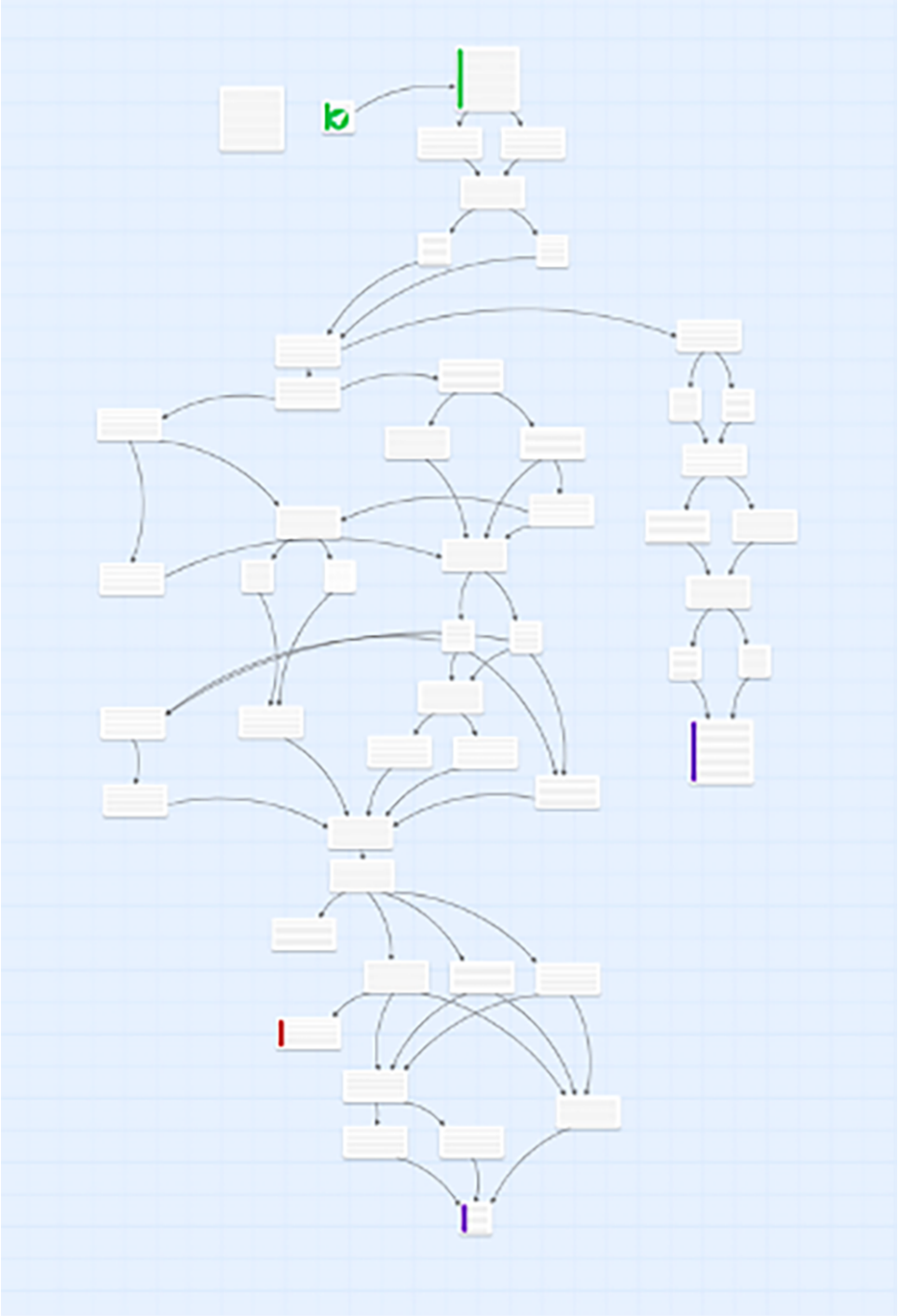

Figure 3: Story branch of the IFcVR Playing God [19], visualized in Twine

What these three films have in common is that the user decides how the story continues by choosing different branches: in two cases with visual cues (Broken Night, Playing Good) and in one case only with the user's gaze (Afterlife). Playing God uses a Graphic User Interface (GUI). Broken Night uses gaze control without a UI but with visible cues. Afterlife uses non-visible gaze control with only a few interactive parts that require user input through a controller (see Table 3).

In the three evaluated IFcVR, we found story structures of varying complexity. All appear to be tree structures, as defined by [15]. The duration of the experience varies between 10 and 45 minutes. The number of choices in each decision is similar, ranging from 1 to 3. They share gaze control as the primary technical interaction method. The role of the user is different for each IFcVR. [16] said that the

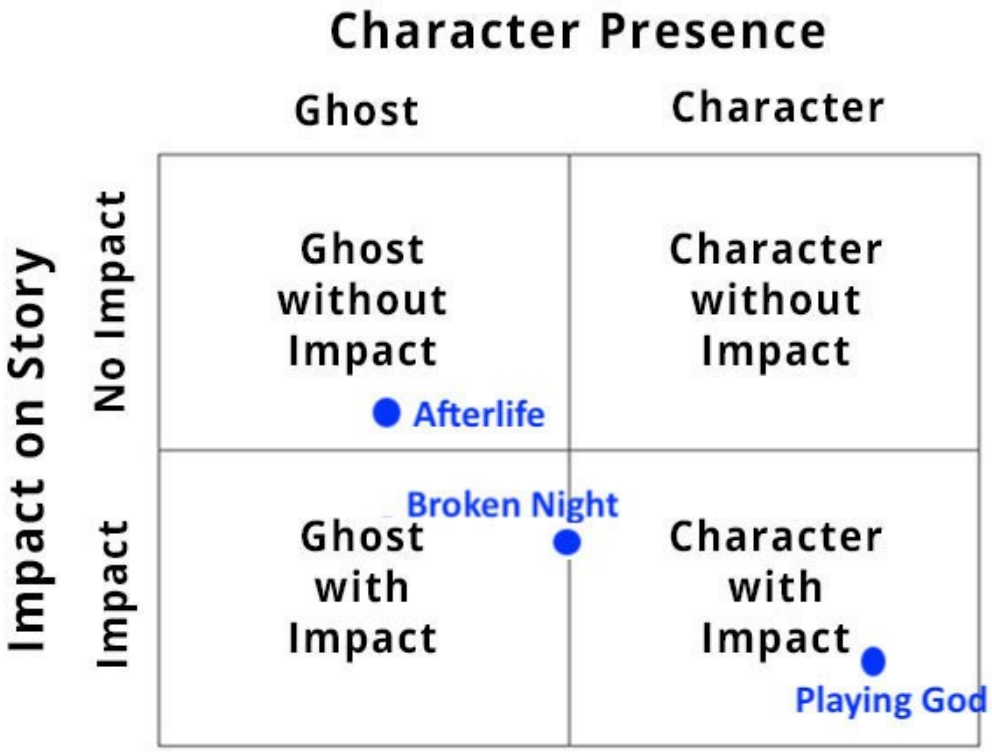

Figure 4: Impact on Story | Character presence concept visualization by [16]

Table 3: Comparison of IFcVRs: Technical Interaction Methods and User Roles

IFcVR	Technical Interaction	Role of User	Interaction	Loc.
Afterlife (35 min)	Gaze (no visual cue) and controller (clickable objects)	Active observer	29/2 (gaze) 6/1-3 (ctrl)	10
Broken Night (10 min)	Gaze with visual cue (split-screen)	Active observer, passive character	4/2	5
Playing God (10-15 min)	Gaze with visual cue (GUI buttons)	Active character	20/2	2

user always takes on the role of either a character or an observer. These three IFcVR confirm that.

4. User Tests on Aspects of Presence

In the next phase, user tests were conducted. As the first step in these user tests, presence was measured quantitatively using a questionnaire. Secondly, biofeedback data of the test users was recorded while they were experiencing the IFcVR. Both this biofeedback data (namely the Galvanic Skin Response) and semi-structured questions were used as a basis for qualitative interviews with the test subjects. In the third and final phase, the acquired data was investigated. The results of the questionnaire were analyzed quantitatively. The qualitative interviews were transcribed and coded according to the method of qualitative analysis by [21].

For the measurement of presence, there are standardized questionnaires used by the different scientific communities. The ITC-SOPI questionnaire was used to measure the individual presence of the test persons [22, 23, 24]. The Independent Television Company Sense of Presence Inventory (ITC-SOPI) consists of two parts. Part A encompasses questions after the experience, while Part B asks questions about impressions during the exposition. A score for four factors can be calculated using the questionnaire. Each factor (Spatial Presence with 19 questions, Engagement with 13 questions, Naturalness with five questions, and Negative Effects with six questions) is calculated based on the mean value from the related questions using a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree).

Besides using questionnaires for self-reporting, the subjective feeling of presence and physiological responses can also be used to analyze presence [7]. One way is to measure Galvanic Skin Response (GSR), an essential indicator of physiological arousal. It can show higher and lower levels of electrodermal activity (i.e., sweat), which, in turn, indicates higher and lower levels of emotional stimulation. Recently developed hardware such as the Shimmer3 GSR Unit enables unobtrusive measurements during VR experiences [25].

Figure 5: Shimmer3 GSR Unit (Source: Shimmer)

Additionally, qualitative interviews were conducted as part of the user test. We used semi-structured guided interviews. The questions focused on the factors of Spatial Presence, Engagement, and Naturalness as well as open questions to encourage discussion. 55 user tests were done overall. The test users were all media technology students from the St. Pölten UAS (n=55; 36 male, 19 female; aged 19 to 32, median age=22).

The participants could choose a time slot without knowing which film would be presented in which slot. To the question "Have you used an experimental virtual reality system before (beyond a consumer computer/arcade game)?", 21 (n=55) answered with "yes" and 34 (n=55) with "no". The question "How would you rate your knowledge of virtual reality (i.e., how it works)?" on a 4-point scale (none, basic, intermediate, expert) was answered with "none" by 17 (n=55), with "basic" by 32 (n=55), and with "intermediate" by 6 (n=55). None of them considered themselves experts in terms of VR knowledge.

The test was set up in such a way as to emulate a realistic viewing experience. The space was arranged to mimic a living room atmosphere. A swivel chair was placed in the middle of the room to ensure freedom of movement. In terms of HMD, an Oculus Rift S was used. The cable connecting the headset and the computer were suspended from the air using a tripod to minimize distraction. The test computer, which was used to record the session and to fill out the questionnaires, was hidden behind a curtain to minimize distractions as well and to ensure a comfortable viewing experience.

For each user, 1 - 1.5 hours were dedicated to a single test. After arriving in a separate room and filling out a release form, the test subject was accompanied to the test room. Here, the IFcVR experience was already set up and ready for the subject to enter. First, GSR sensors were attached to the hand of the subject. It was explained which data would be recorded. Subsequently, the HMD was explained so that the subject would feel comfortable when putting on the HMD. It was ensured that everything was working correctly. Then the experience started. Depending on the film, the duration was between 10 and 45 minutes. During this time, the test subject was recorded using a camera, while the Shimmer3 GSR sensors captured biofeedback data using the software iMotions (www.imotions.com). After the experience ended, the test subject was accompanied to the test computer and the presence questionnaire (ITC-SOPI) was filled out. The test supervisor then let the iMotions software analyze the biofeedback data, resulting in peaks. These markers indicate on the timeline of the experience when an emotional

Figure 6: Test setup

reaction might have taken place. This timeline, which showed the video experience of the test subject, the recorded screen of the IFcVR film, and the peak markers, was then used for the qualitative interview. After initial questions as part of the semi-structured interview ("What points in the story do you remember the most?", "How present did you feel in the experience?"), the highest peaks were shown to the test subject and discussed: what they were experiencing at this moment, how they felt, and whether they thought that the peak as suggested by the software was accurate.

The interviews were conducted and recorded directly after the test users experienced the IFcVR. Later, they were transcribed and saved as plain text documents to be imported into the software used for coding the interviews. For the basis of the evaluation of the interviews, we used the method of qualitative content analysis. With the use of the toolbox described by [21], a basic procedure is given and different variants are possible within the individual steps without the rigid structure provided by [26] and [27]. This allows for the use of a high-quality and proven evaluation and resource conservation at the same time. The latter is necessary due to the number of interviews. The following steps were performed for evaluation: selection of the data for evaluation, creation of a category system for coding, division of the material, test coding, evaluation and modification of the category system, coding, evaluation, and summary of the results. For coding the interviews, we used the open-source software Taguette (www.taguette.org). Three researchers were part of this process and the data was divided based on the interviews of the three different IFcVR. Then the main category system was built deductively upon literature research about the presence.

As a next step, the three researchers discussed and defined each category to reach a common understanding of the distinct categories. After that, all three researchers performed a test coding on the same interview and the results were compared and further discussed to refine the category system. Then the coding was performed individually by the three researchers for each IFcVR. After that, the results were discussed and summarized by all researchers involved.

The individual codings for the topic of presence per interview were considered here. Suppose several statements were made about a category, including its subcategories, e.g., a positive statement about Naturalness within an interview. These were comprehensively coded and recorded but only evaluated per interview in summary. Thus, the evaluations are based on the statements per category. This should prevent distortion of the results since test users have different communication patterns.

The IFcVR films were all experienced in English. As the interviews were conducted in German, the following category system uses the German terms from the literature and the English terms and German

translations of English terms. All the categories for the coding of the interviews are taken from the most relevant literature and definitions of VR presence. The three main categories "Spatial Presence", "Naturalness", and "Engagement" formed the basis for the subcategories.

Table 4: Category system to evaluate presence in IFcVR

Categories English Terms	Categories German Terms	References
Spatial Presence (main category 1)		
Illusion of being there	Illusion, dort zu sein; Illusion, dabei zu sein; Illusion, anwesend zu sein	[6]
Self-orientation, self-location	Selbstausrichtung, -bezogenheit, -orientierung, Selbstortung; Da-sein	[28] [29]
Physical environment	Physische Umgebung; physische Umwelt	[30] [23]
Feeling of being located	Gefühl des Verortetseins; Verortens	[31]
Being in, existing in	Sein in, vorhanden in, existieren in	[31]
Spatial presence	Räumliche Präsenz; räumliche Anwesenheit; Aufenthalt; stabile Räumlichkeit	[32] [29]
Naturalness (main category 2)		
Sensory presence	Sensorische Präsenz	[30]
Perceptual realism	Wahrgenommene Realität	[33]
Naturalness	Natürlichkeit	[10] [9]
Ecological validity	Validität der Umwelt; Richtigkeit der Umwelt; Zuverlässigkeit der Umwelt	[33]
Tactile engagement	Taktiles Eingreifen, fühlbare Interaktion, physische Interaktion	[34] [35]
Physical location	Physischer Ort	[33]
Environment	Umwelt	[33]
Sensory characteristics	Sensorische Eigenschaften	[33]
Realness	Realismus	[32]
Physical Interaction	Physische Interaktion	[29]
Plausibility	Glaubwürdigkeit	[6]
Engagement (main category 3)		
Engagement	Einsatz	[33]
Involvement	Einbindung	[33]
Psychological immersion	Psychologische Vertiefung	[33]
Social presence	Soziale Präsenz	[28] [5]
Environmental presence	Anwesenheit in der Umgebung	[36]

The main category of Engagement (category 3) does not explicitly include technical and narrative interaction methods. For this reason, another main category was added: Interaction (cat 4). Parts of the interviews were coded in this category if 1) the test subject was talking about a direct or indirect interaction, with interaction methods such as either controller input and gaze control, or 2) they mentioned how they dealt with decision-making and with decisions in the story.

As the last addition, Negative Aspects (main category 5) were coded in the interviews to account for subjective occurrences, undesirable outcomes because of technical shortcomings, or subjective preconditions. Negative aspects include headaches, dizziness, eyestrain, nausea, and others. Technical shortcomings can be low-resolution displays, a small number of frames per second, and a delay in response time. It should be noted that some test subjects are more prone to have side effects than others, which is regularly mentioned in VR research [37].

4.1. Summary User Tests on Aspects of Presence

Emotional stimulation triggers changes in skin conductance, which results in GSR peaks as mentioned in Table 1. The screenshots in Figures 7, 8, and 9 show the analysis of the peaks in iMotions. The Window

Table 6: Category system to evaluate Interaction and Negative Effects in IFcVR

Categories	References
Interaction (main category 4)	[38]
Negative Aspects (main category 5)	[37]

on the upper left side of the screenshot shows the IFcVR as seen by the test user. The respondent camera is on the upper right side, and the detected GSR peaks and their amplitude are displayed below.

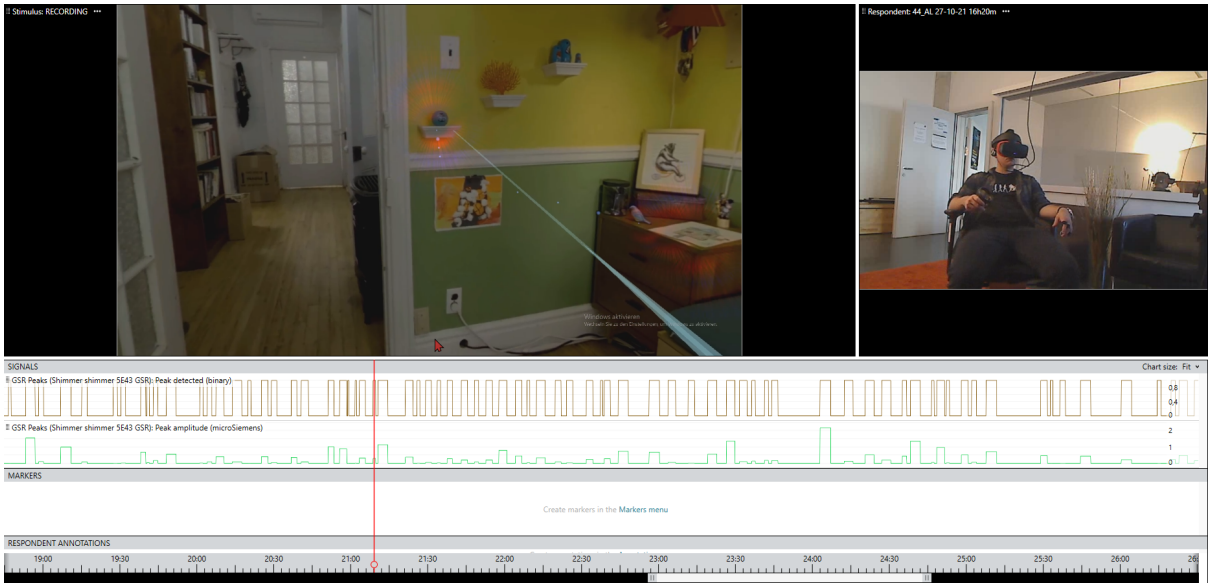

Figure 7: Screenshot iMotions Afterlife

The evaluation of the skin conductance data with iMotions for Afterlife showed that, in addition to other factors that trigger peaks and that were not evaluated in the study (such as plot, story, camera work, etc.), peaks were recorded at some of the 29 decision points that were actively made via gaze control without visual cue and especially at six decision points that were made with the controller

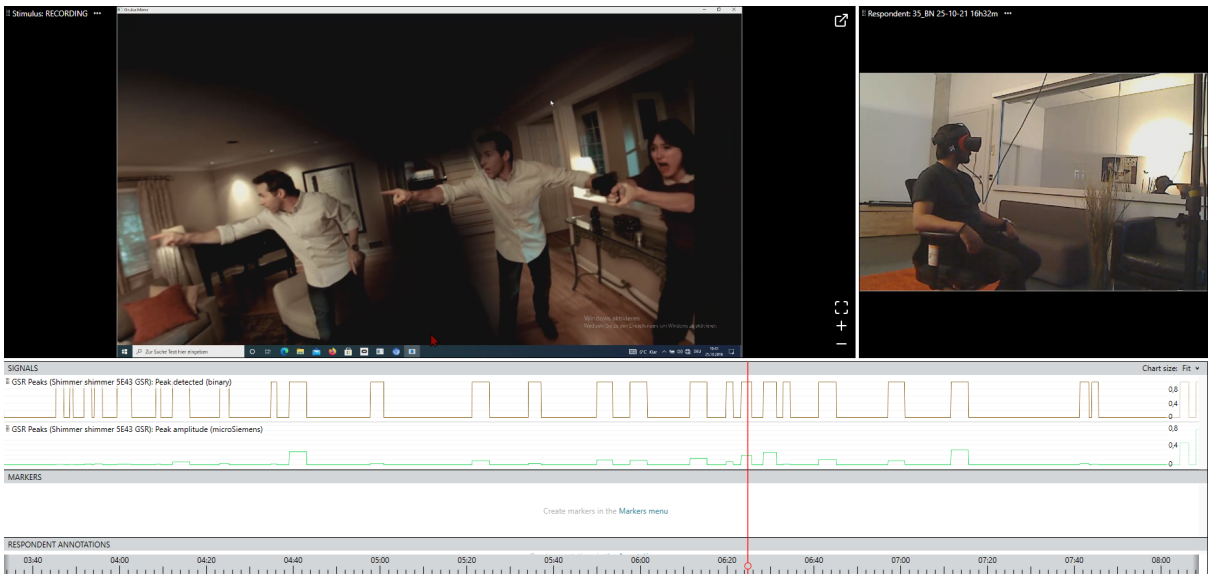

Figure 8: Screenshot iMotions Broken Night

(Figure 7).

The evaluation of the skin conductance data with iMotions for Broken Night showed that, in addition to other factors that trigger peaks and that were not evaluated in the study (such as plot, story, camera work, etc.), peaks were also recorded at the four decision points that were actively made via gaze control with a visual cue (Figure 8).

Figure 9: Screenshot iMotions Playing God

The evaluated skin conductance data with iMotions for Playing God showed that, in addition to other unevaluated factors in this study that cause peaks (such as plot, story, camera work, etc.), peaks were recorded at the twenty decision points that were actively selected via gaze control with a visual cue (Figure 9).

In summary, GSR peaks show changes in emotional arousal when the user assumes the role of an active or passive observer and when the user acts as an active or passive character while using an interactive point with a cue. If the user knows about a decision to be made, there is a peak in the data from the skin conductance measurement, meaning there is an emotional response.

4.2. Summary Questionnaire and Interviews

The resulting data from our user tests can be divided into the five previously mentioned categories: Spatial Presence, Naturalness, Engagement, Interaction, and Negative Effects. The first three categories correspond to the three factors of the ITC-SOPI questionnaire. Therefore, quantitative data resulting from the questionnaires are shown for these three categories/factors, followed by summaries of the coded qualitative interviews. The fourth and fifth categories show results from the qualitative interviews only.

Levene's Test shows homogeneity of variance in all groups for all factors, so a t-test assuming equal variances was carried out for Spatial Presence, Engagement, and Naturalness.

4.3. Spatial Presence

Results of the ITC-SOPI questionnaire show a mean spatial presence of 3.3 for Afterlife, 2.97 for Broken Night, and 3.1 for Playing God.

There are differences between the scores of the three IFcVR for the factor of Spatial Presence. Afterlife has the highest score overall. This assumption is also confirmed by statements from the interviews, such as "I had a feeling of being in the room" or "I felt like I could touch the objects around me". Results of the t-test show significant differences when it comes to the factor Spatial Presence for Afterlife

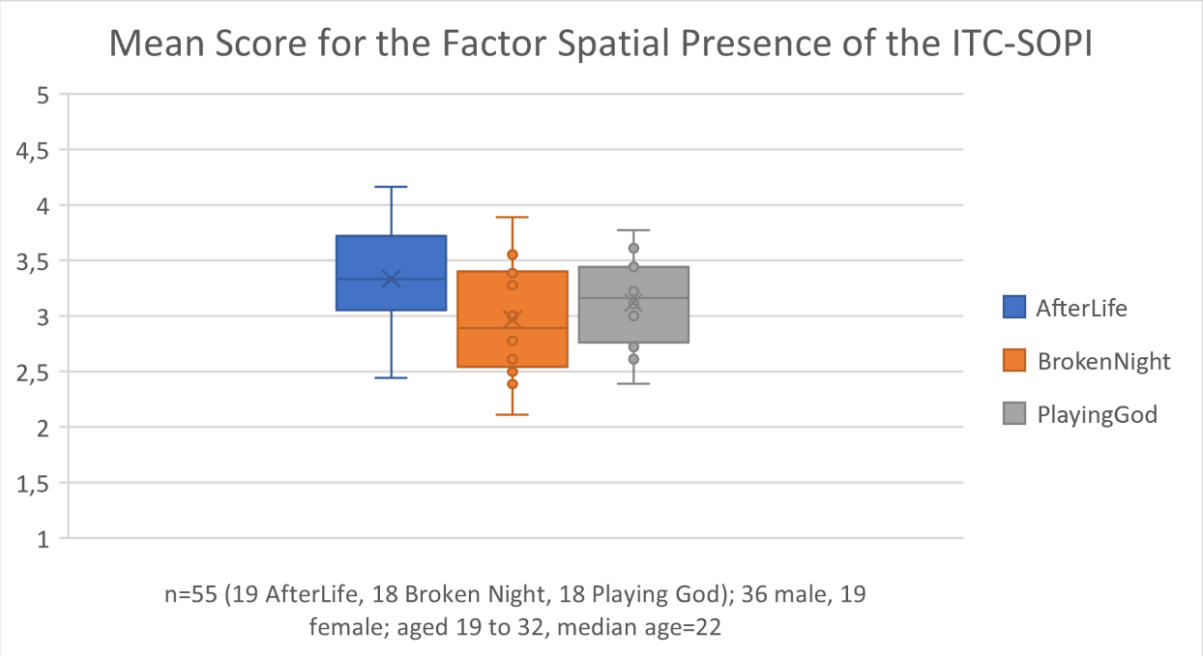

Figure 10: Mean Spatial Presence score for Afterlife (3.3), Broken Night (2.97), and Playing God (3.1)

(M=3.33; SD= 0.47) and Broken Night (M=2.96; SD=0.26), t(35)=2.30; p=0.03; d=0.76. According to [39], a value of d=0.76 means a medium difference in Spatial Presence between Afterlife and Broken Night. A comparison of Spatial Presence in Afterlife and Playing God, and Broken Night and Playing God did not result in significant differences.

In evaluating the category of Spatial Presence in the interviews, the perception of Spatial Presence - the feeling of being on location or "being in the room" - is found in a substantial number of interviews. Also, statements like "I felt like being there, being in the (living) room..." or "I made the decision and felt like being the protagonist..." or "I felt more involved and attentive because I had to take decisions..." were made, which emphasize a strong feeling of being present. It can also be observed that for the factor of Spatial Presence, there were no negative statements for Afterlife and Broken Night. Test users watching Playing God reported that they "rather felt like a ghost" and "the impact of the decisions was not really noticeable".

4.4. Naturalness

Results of the ITC-SOPI questionnaire for the factor Naturalness show that Afterlife scored m=3.8, Broken Night scored m=3.5, and Playing God scored m=2.7.

Naturalness shows the most obvious differences between the three IFcVR.

The performed t-tests show that there is no significant difference between Afterlife and Broken Night, but there are major differences between Afterlife (M=3.81; SD=0.54) and Playing God (M=2.74; SD=0.61), t(35)=5.68; p=0.00; d=1.86. According to [39], d=1.86 is a very large difference. The differences between Playing God (M=2.74; SD=0.61) and Broken Night (M=3.47; SD=0.51) also are significant with t(34)=3.93; p=0.00; d=1.31. According to [39], d=1.31 also shows a very large difference.

Differences between Afterlife and Playing God, as well as between Playing God and Broken Night are obvious from the statements in the qualitative interviews as well. Test users who saw Afterlife remarked positively that "the characters seemed three-dimensional" and "everything seems surprisingly solid, not like in conventional videogames or TV shows, like in a [three-dimensional] room..." and that they wanted to "touch objects in the room" or "put my feet on the table...". On the negative side, some parts of the experience like "he was walking through me" and "I felt like I had no hands and feet..." took them "out of the illusion". Test users felt like they "were in the room" in Broken Night, but it was

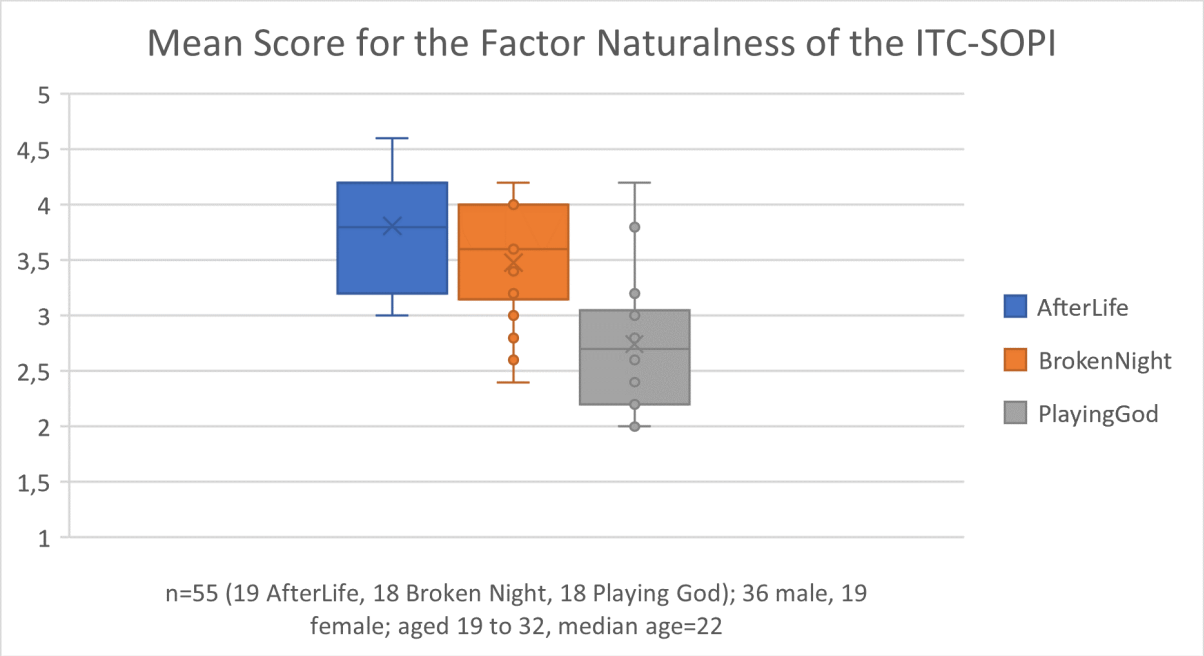

Figure 11: Mean Naturalness score for Afterlife (3.8), Broken Night (3.5), and Playing God (2.7)

apparent to them that it was "only a game", they felt like a "silent observer" and criticized that "I was aware that it was a game". Test users remarked positively about Playing God that the "spatial audio and the movement in 6-DOF felt realistic". In terms of negative feedback, they mentioned "not being in the room together with the actors" and feeling "connected to the scene via video transmission" instead.

Afterlife: 11 users out of 19 commented on Naturalness, 9 positive and 3 negative.

Two third of the comments pertaining to Naturalness were positive for Afterlife.

4.5. Engagement

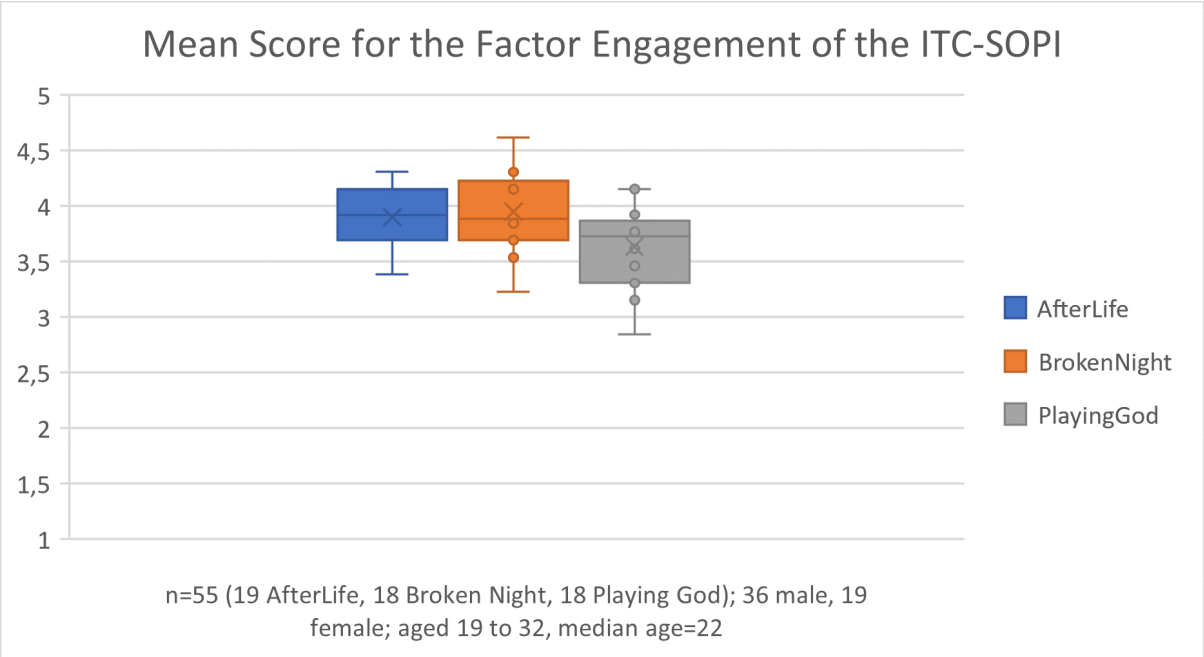

Figure 12: Mean Engagement score for Afterlife (3.9), Broken Night (3.95), and Playing God (3.6)

For the factor engagement, Afterlife scored m=3.9, Broken Night scored m=3.95, and Playing God scored m=3.6.

Broken Night and Afterlife do not show remarkable differences when it comes to the Engagement factor. Playing God scores marginally lower on this point.

The results of the t-test show no significant differences between Afterlife and Broken Night, whereas the situation is different when comparing Afterlife (M=3.89; SD=0.26) and Playing God (M=3.64; SD=0.35), t(35)=2.56; p=0.01; d=0.84. According to [39], d=0.84 means a large difference. The difference between Broken Night (M=3.95; SD=0.35) and Playing God (M=3.64; SD=0.35) is also quite large at t(34)=2.65 p=0.01; d=0.88.

The interviews paint the same picture. Even though Playing God features "a lot of obvious interaction points", the users show less Engagement. Frequent remarks from the interviews for Playing God are "I was bored by the story" and statements like "I was hoping that there would be more action...". The statements on Playing God indicate that the subjects can logically understand the participation they are supposed to have and that actions have consequences. It is striking that the active decision-making process predominantly justifies the involvement. Also, statements like "I had the feeling that they reacted to my decisions" and "I felt that I could influence the story..." were made. The interviews reveal that the respondent "can change things", and that these decisions engaged the test users because they felt that they could influence the course of the story. For Afterlife, it is noticeable that some statements remarked on the low distance to the actors, such as "I felt uncomfortable because I was nearer than I would be to a person in real life" and "she was sitting to close to me, when I was looking in the other direction and then looking back to her, that was really unpleasant". For Broken Night, test users reported that "I felt like a spectator and they [the characters] were not able to see me" and "I didn't have the feeling that I was a character, more like a narrator, somebody that could influence the story".

4.6. Interaction

Many statements confirmed that it took the test subjects some time to understand the interactions or opportunities within the story to make decisions through participation. The majority of statements were related to the controller-based interactions. It was also noted that the results of these interactions "surprised" the subjects or led to "confusion" among them. Here it is noticeable that with Afterlife, it was often the seamless and unnoticed interaction without any reference to it that pulled the users out of the story: "The interaction was not comprehensible".

It is interesting in this context that the multitude of possible interactions through eye contact - there are 29 decisions with two options each, see Table 3 - are not addressed by the active observer of the story, or only very reservedly; or when asked about the possibilities of interaction (as participation in the story), they did not recognize them as such. This is all the more striking as the possibilities are shown at the end of each chapter for the observers within the IFcVR experience and are thus made known. The responses also paint a picture of navigating cinematic VR space. Like an exposition as the first act of a linear story, in the IFcVR test, users experimented at the beginning to understand participation.

4.7. Negative Effects

Less than a third of the interviewees mentioned negative effects of the IFcVR experience with VR glasses (Oculus Rift S) and headphones. The common VR weaknesses with HMD were noted: that the "glasses pinch" or are "heavy", as well as "low resolution" and "nausea". None of the films were referred to in particular. Therefore, neither a longer film duration nor a higher number of scenes and/or a higher number of interaction points were relevant for the negative effects within the object of the study.

5. Discussion and Conclusion

The question was whether the type of technical interaction method, the different amount of interaction points, and the user's role in the story influenced presence in the three cases of Interactive Fiction in cinematic Virtual Reality (IFcVR).

To summarize the results of the first three categories - Spatial Presence, Naturalness, and Engagement - Afterlife reached the highest scores overall. These are relevant when compared to a study that used the ITC-SOPI on media experiences such as short films, computer games, cinema, IMAX 2-D, and IMAX 3-D [9]. Afterlife is the only one of the three projects that reached higher scores for the factor Spatial Presence than the overall scores of all media in the study, as mentioned earlier. When it comes to the factor of Engagement, only IMAX 2-D shows a marginally higher score than any of the IFcVRs. One limitation of this comparison is that there are no recent studies using the ITC-SOPI as extensively across different kinds of media as the study by [9]. Another limitation is the high number of variables concerning the three IFcVRs when comparing certain factors. All IFcVR show high values for Spatial Presence in the ITC-SOPI questionnaire even though there is a significant difference between the highest and the lowest scores. The results of the interviews show that users felt remarkably present in all three IFcVRs. This proves that for Spatial Presence, neither the role of the user nor the number of interaction points show dependencies.

Naturalness was noticeably lower in Playing God as compared to Afterlife and Broken Night. It featured an unrealistic environment, as indicated by most test users. For the presence factor Naturalness, the two IFcVR with a lower number of interaction points with visual interaction cues (from 4 to 6) have a comparably high score and the most significant difference compared to the IFcVR with a high number of interaction points with visual cues. This indicates that interaction points with visual interaction cues reduce presence.

Afterlife, the IFcVR with the highest Naturalness score had a realistic environment and a high number of different locations. It was also the only IFcVR shot in stereoscopic 360-degree and featured only a few elements of CGI compared to Playing God.

Playing God gave the user the most active role by letting them play a character with the most conscious decisions about the story's progress. Nevertheless, this film scored the lowest on the factor of Engagement even though clear interaction methods and a high number of interaction points were assumed to increase Engagement.

Afterlife and Broken Night had the highest scores for Naturalness and Engagement. They offer different roles for the user (from active observer to passive character) as well as different numbers of interaction points.

The different number of interaction points and the role of the user have a minor impact on presence. This suggests that in the selected IFcVR, neither the role of the user nor the number of interaction points has a significant effect on presence. The research shows that the technical interaction method is relevant because interaction points with visual cues reduce presence.

All three IFcVR offered an immersive experience to the test users and allowed them to feel present and part of the story. It can also be observed that the active role of the user and the conscious decision about the story's progress have an emotional impact and contribute to more user involvement. Interaction points with visual cues interrupt the feeling of presence, so further research should be conducted with regard to seamless interaction. Since one of the limitations of this study was the high number of different variables in all three IFcVR, the production of an IFcVR with different interaction methods and a different number of interaction points would be necessary when it comes to future work.

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