Effects of Character Guide in Immersive Virtual Reality Stories

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Abstract. Bringing cinematic experiences from traditional film screens into Virtual Reality (VR) has become increasingly popular in recent years. However, striking a balance between storytelling and user interaction can cause a big challenge for filmmakers. In this paper, we present a media review on the common strategies that constructed the existing framework of computer generated cinematic VR by evaluating over 80 real-time rendered interactive experiences across different media. We summarized the most-used methods, which creators applied to maintain a relative control when presenting a narrative experience in VR, that were associated with story-progression strategies and attention guidance techniques. We then approach the problem of guiding the audience through major events of a story in VR by using a virtual character as a travel guide providing assistance in directing viewers attention to the target. To assess the effectiveness of this technique, we performed a controlled experiment applying the method in three VR videos. The experiment compared three variations of the character guide: (1) no guide, (2) a guide with a matching art style to the video, and (3) a guide with a non-matching art style. The experiment results provided insights for future directors and designers into how to draw viewers attention to a target point within a narrative VE, such as what could be improved and what should be avoided.

Keywords: Virtual Reality · Interactive storytelling · Gaze redirection · Character design · Interaction design · 3D interface

1 Introduction

Virtual Reality (VR) has become a growing entertainment medium. It incorporates multiple types of sensory feedback including visual and auditory, and sometimes even haptic. As defined by Jerald [12], VR is “a digital environment that enables users to experience and interact as if that environment were real.” Because of this, VR can provide the audiences unprecedented film experience that encourages their free exploration of an immersive environment and interaction with virtual props and characters. In recent years, along the showcasing of many cutting-edge VR stories,

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more and more innovative techniques have been designed and developed to experiment with storytelling in virtual spaces.

The biggest challenge directors face when telling a story through VR is determining how to best guide viewers through important events of a narrative without hindering their freedom to discover the virtual world. In traditional film-making, the directors have absolute control over the storytelling process, whereas the audience can only wait and receive a selective amount of information within a set frame of the camera. In VR, viewers are encouraged to alter their senses in relation to the Virtual Environment (VE), including their points of view, location and so on. This indicates the audience's role transition from being absolutely passive to more active in VR storytelling.

However, allowing the audience more freedom to explore and interact within a narrative scenario might lead them to getting lost following a series of events that build up a story. Hence, VR filmmakers must formulate ways to maintain relative control over story presentation in order to ensure that the audience does not miss any important information about the story. One effective option is to conditionally add guiding assistance as redirecting cues to shift the user's attention toward the relevant events and objects within the VE [17].

In this research, we first present a media review to construct a framework by summarizing the most-used storytelling strategies and attention guidance techniques. We proposed and tested a new gaze redirection technique by overlaying a guiding character on top of an existing 360-degree video. The added character would react based on the user's head-tracking data, and the user's gaze was expected to follow the guide towards the focal content of a story.

To assess the effectiveness of this technique, we conducted an experiment. We chose three different 360-degree animated videos as background stories. We then created three virtual characters, where each character has a corresponding art style to a specific video, so that we could evaluate whether the guide's art style would affect the users' gaze behavior. The experiment compared three variations of the character guide: (1) no guide, (2) a guide with a matching art style to the video design, and (3) a guide with a non-matching style.

By the end of this study, we concluded what works well and what should be avoided when directing viewers' attention to a target point in VR stories with the help of a designed character guide. Future creators can follow the resulting framework and refer the experiment outcomes to develop better VR narrative experiences that are easier to follow and more enjoyable to watch.

2 Related Work

In this section, we discuss related literature about immersive stories and methods for guiding attention in applications allowing 360-degree viewing.

2.1 VR as a Narrative Medium

Throughout history, storytelling has been developed in a variety of forms in terms of the different media that carry them; these forms range from oral expression, theatrical performances, and prints to movies. As argued by Ryan [21], immersion and interactivity, have been the main motivating forces behind some major paradigm shifts in the history of narrative and human culture. Despite the types of medium the creators use, an important trend in storytelling is to raise audiences' sensory satisfaction and level of immersion associated with the story world.

The emergence of VR, as Steuer reasoned [26], fulfilled the desire to bring greater sensory depth to traditional media content by immersing viewers in a 360-degree visual environment. For this reason, VR is perceived and studied by numerous people as a medium that possesses substantial potential for telling a story through its powerful sensory input.

Aylet and Louchart [1] maintained that VR should be considered as a specific narrative medium along other traditional narrative forms such as theater, literature, and cinema. However, they pointed out that VR narrative designers must be aware of the participants' active role within the VEs. They argued that the traditional methods of presenting a story must be manipulated to ensure that the viewers will not remain passive.

Similarly, Clarke and Mitchell [6] attempted to review certain methods used in traditional film-making in order to determine whether they can be applied and situated in the construction of a VR narrative. They suggested that VR content creators abandon the traditional reliance on the continuity of time, space, and action to focus mainly on character interaction.

Various researchers and artists began experimenting with VR storytelling medium over two decades ago. For instance, back in 1996, Pausch et al. [18] found it beneficial to provide the audience with a background story and assign them a concrete goal to accomplish in the VE. More recently, Google Spotlight's DUET [13] put together a two-line story experience based on the main characters, a boy and a girl. This design allowed the audience to follow whichever story-line they preferred and watch the story develop along that line. Oculus Story Studio's Henry [14] presented an eye-contact experience between the viewers and the main character, Henry the hedgehog, creating a more intimate connection between the audience and the story. Penrose Studio's Allumette [5] followed a more traditional approach that involves several camera cuts to transfer audiences from one space and time to another, etc.

2.2 Gaze Redirection in VR

Many researchers have conducted specific studies that explored the effects of various gaze-redirecting techniques in VR. Some of them focused on designing perceptual properties that will make visual objects stand out from their surroundings, such as luminance contrast, edge or line orientation, color, and motion. For instance, Hillaire et al. [10] constructed and evaluated models of dynamic blur that combine depth of field and peripheral blur effects to direct user navigation in the VE. Smith and McNamara [23] developed a dynamic real-time color effect stimulus to redirect the user's gaze toward points of interest. Danieau et al. [8] suggested driving the user's gaze smoothly toward a point of interest by applying fade to black and desaturation visual effects outside of the area of interest.

Some researchers focused on operating the camera to change the viewer's gaze relative to a target area within the VE. Bolte and Lappe [2] proposed rotating the camera during a rapid movement of the eye between fixation points (saccade) to a non-perceivable degree. Looking at fully automated transitions analogous to cuts in traditional film, Rahimi et al. [20] and Moghadam et al. [16] conducted studies of scene transitions in VR systems to compare how different types of cuts, fades, and interpolations affect sickness and viewer ability to keep track of spatial changes in the VE. Looking at rotational adjustments that allow the user freedom to look around, Sargunam et al. [22] investigated the use of amplified head rotation, which produces a rotation angle that allows the viewing of a 360-degree virtual world by physically turning the head through a comfortable range. They also evaluated the "guided rotation" technique, which realigns a users' head orientations as they virtually translate through the VE. Stebbins and Ragan [25] explored a scene rotation-based method in a 360-degree movie, where the rotation is triggered if the user has looked at a sufficiently extreme angle for more than a particular length of time. Brown et al. [3] studied direct scene transitions and forced camera rotation for a multi-user VR narrative experience. Particularly, the direct scene transition technique makes the camera fade out and then fade back in with the event in the center of a viewer's field of vision. The forced camera rotation technique makes the user camera rotate, independently of the user, to face the event taking place.

Besides these, others took the approach of employing animated three dimensional figures as guiding indicators. Brown et al. [3] implemented a firefly as a visual distractor. The firefly would drift into a user's field of view and flied off screen in the general direction of the active story event. It would remain in the user's field of view until he/she witnessed the story event taking place. Pausch et al. [18] built virtual characters to point at or even move toward the target scene when directing user's attention. Similarly, Wernert and Hanson [28] introduced personal "guides" to help the user focus on the target subject areas in the navigation space.

2.3 Interaction with a Virtual Character

Researchers also studied the effects of human-to-virtual-character interaction as an interface design approach in real-time systems. The characters can be designed in the form of either a human or an animal. The effects are different, but each form has its own benefits.

According to Cassell [4], the advantage of designing virtual humans as interfaces is that the user has a natural ability to recognize and respond quickly to the agent's messages as in face-to-face communications. Thus, a virtual human agent can largely increase communication efficiency. In addition, based on a research by Takeuchi et al. [27], users can accomplish tasks smoothly and effectively when the behavior of a virtual agent resembles theirs. This study supported that people's experience with real social interaction will enrich their experience with human-computer interaction. Consequently, it is likely that the users will receive more valid information from a personified virtual character.

Same as humans, animals also manifest social qualities. Virtual companions may establish an emotional connection with user similar to pets. Hofmann et al. [11]

approved that "the presence of a virtual companion (compared to being alone)" led to a higher level of cheerfulness for individuals watching a comedy film. In all, mutual dependencies and closeness can be built between a virtual companion and the user, which may reduce the users' feeling of loneliness and enhance their level of enjoyment.

3 Media Review

To situate our work in the context of existing VR storytelling framework, we conducted a media review to better characterize the key attributes and differences among different forms of relevant media. We reviewed over 80 different real-time rendered interactive content on the current market. Media was identified from a variety of sources, including the Valve Steam store, Google Spotlight Stories, Oculus Story Studio, Sony Playstation VR Catalog, and various game stores. We conducted a qualitative review of different media by identifying attributes that characterize differences among different works. Examples of attributes cataloged in the full review included: supported display/system; use of 3D input; types of interaction techniques; artistic style; degree of user control; presence of characters; character response to the user/viewer; game elements and goals; and narrative and story elements. We revised the analysis through iterative review cycles when new attributes or attribute categories were added. After an analysis of all these works, we simplified the review by distinguishing four major categories based on their design objectives, content, and methods applied during presentation. The resulting categories are: (1) Interactive Experience; (2) Game; (3) Interactive Film (Not-animated); and (4) Interactive Film (Animated).

In order to study how former creators struck a balance between story presentation and user interaction, we evaluated and summarized the common qualities from each category, including the implementation of narrative, design of guidance techniques, and level of character interaction. Table 1 shows a high-level summary of the four categories, and the following sections provide additional explanation.

Table 1. A brief comparison of the differences among the four content categories

	Medium	Narrative	Gaze-redirection	Character interaction
Interactive experience	VR	No	No	None
Game	Mixed	Yes	No	High
Interactive film (Not-animated)	VR	Yes	No	None
Interactive film (Animated)	VR	Yes	Yes	None/Low

3.1 Categories and Characteristics

We summarize the major media categories identified from the media review.

Interactive Experience. The "Interactive Experience" category comprises of the works that do not involve narratives or game tasks. These works are the most abstract out of all those reviewed, as there is often a lack of clear storylines or specific goals expected to be accomplished. For content designers, the most important thing is to demonstrate to the audience that VR can be a powerful communication tool. Due to this design objective, there are usually no gaze redirection techniques created and implemented in these experiences. Depending on the content, the level of character interaction in these experiences is mostly low, or no character interaction at all. Examples of applications falling under this category include: *THEBLU: Encounter*, *Longing for Wilderness*, *In the Eyes of the Animal*, and *The Dreams of Dali*.

Game. The "Game" group refers to the works that involve a set of specific tasks expected to be accomplished throughout the experience. There is often a clear narrative involved in most games. However, the primary design objective for a gaming experience is not to tell a story; rather, the stories are generally introduced as a background context to assist users in understanding and completing their game tasks. The most common gaze redirection techniques designed for games are quite obvious, such as a GUI element of a text box that displays instructions or a symbol such as an arrow. Occasionally, the progression of the game can be paused without affecting the user's experience negatively. The level of character interaction for this category is typically medium to high. Examples of media categorized as games include: *Call of Duty*, *Pokemon GO*, *Robinson: The Journey*, and *Back to Dinosaur Island*.

Interactive Film (Not animated). "Interactive Film (Not animated)" are categorized by a documentary film type of experience. There is often a clear narrative involved, and users do not need to complete specific tasks other than watching the story. Many experiences under this category feature either places that most audience cannot go, such as the outer space or deep in the ocean, or stories that present the aftermath of a significant disaster, such as an earthquake or military attack. Consider its primary design objective as recording and displaying something the way it is; there is no gaze redirection technique being implemented. The level of user interaction included is quite limited, entailing that the users cannot necessarily affect a virtual character's action, but can occasionally feel the eye contact. Examples falling into this category include: *Journey to the Edge of Space*, *The Nepal Quake Project*, *Welcome to Aleppo*, and *The Invisible Man*.

Interactive Film (Animated). "Interactive Film (Animated)" is categorized by animation shorts that are interactive. The biggest difference between the works falling under this category and those from the aforementioned category is that interactive animations usually include the design and implementation of various gaze redirection techniques. This is done not only because the stories and styles for most animated films are creative, which makes it reasonable and less abrupt to incorporate additional guiding elements, but also, it's easier to do so with the help of CG. Several examples falling into this category include: *Windy Day*, *HELP*, *Crow: The Legend*, and *The Rose and I*.

3.2 Storytelling Strategies

In this section, we summarize the other primary types of attributes from the media review.

We summarized some prevalent strategies associated with story progression in VR from the media review. We particularly focused on evaluating the experiences under the "Interactive Film (Animated)" category, where numerous effective story-progression strategies were established.

Story progression in VR usually involves conditionally adding in constraints or creating guiding assistance. According to Nielsen et al. [17], there are three prevalent approaches in furthering the story progression in VR. First, the story automatically pauses before the user notices a target event, and whether the user has perceived that event is deduced based on his/her head or gaze direction. The story will continue only after the user turns to a certain angle and the important events and objects in the scene have been presumed as "observed". Second, certain narrative systems would dynamically present events and objects within the user's field of view. Third, the filmmaker will use directing cues (visual or auditory) to transfer the user's attention toward relevant events within the VE.

In addition to this, below we have provided in-depth explanations and other approaches of what we have summarized from the media review:

Area Restriction. A most common technique content creators use in VR storytelling is limiting the action area that is directly related to the target event within the VE. Specifically, within a 360-degree environment, about two thirds of the areas are filled with minor actions or even no action. Therefore, the user will eventually stop exploring and focus on what is actually moving in the environment. *Rain or Shine* [15] by Google Spotlight Stories is a good example of applying this technique.

Time Extension. Another general technique involves extending the interval between each crucial plot to ensure that users have enough reaction time. This strategy is similar to what Nielsen et al. [17] summarized as "story halted before the user sees an important scene." It also includes situations wherein the story continues no matter where the viewer is looking but in a very slow pace, increasing the likelihood of the viewers catching up and following the narrative. *Colosse* [19] is a VR animation that exploits this strategy, as one of its main characters moves at a very slow pace.

Distractors. The last technique involves visual or auditory cues as attention guidance tools. The distractor technique allows the storytellers to suggest an action to the audience without forcing it on them. A good example is Crytek's *Back to Dinosaur Island* VR Demo [7]. In this demo, creators utilized a dragonfly distractor that keeps bumping into the corner of the camera along with a constant wing-flapping sound to grab the viewer's attention. Additionally, auditory distractors take the form of sounds in the VE relatively close to the target event occurring. This technique assumes that the users will hear the distractors and turn to face them. For example, *Sonaria* [24] by Google Spotlight Stories demonstrates how sound could be designed to assist storytelling in VR.

4 User Study of Character Guide

Our media review revealed key differences in how different forms of immersive media handle requirements for viewer attention to activity in the 360-degree medium and the behavior of story characters. We found that among various guidance techniques in immersive VR stories, limited examples exist regarding the application of virtual characters. Moreover, the level of character interaction in works that involved narratives is typically lower or non-existent. We therefore explore the use of supplemental characters in a way that might guide viewer attention during 360-degree experiences. We conducted a study based on animated interactive films with custom-created character guides to collect empirical data about the feasibility and limitations of such an approach.

4.1 Character Guidance

It might be useful to consider using virtual characters as a gaze redirection approach when presenting a story in VR because they were helpful in facilitating the user to focus on target subject areas within a VE [18, 28]. They may induce greater understanding and improve task accomplishments [27] by enhancing information exchanging efficiency [4]. Moreover, implementing a companion type of virtual character may create emotional bonding between the user and the character, which can lead to a higher enjoyment level. Therefore, as a part of the presented research, we chose to study the effects of character guides in directing the viewers' gaze in cinematic VR.

However, as different stories have diverse designs regarding visual styles and creative outcomes, it would be difficult to custom-create a new character guide for each specific experience. Hence, we proposed the method of overlaying a separate virtual character on top of an existing 360-degree video and allowing the added character to react based on the head-tracking data in order to guide the viewer to the focal content of the story. The benefit was that it would be more useful and convenient if a working character guide could be added to other existing applications as a part of the immersive interface. For this reason, it is important that we examine whether it works, how well it works, and other associated design factors that could influence the qualifications of this approach.

Particularly, if adding an external character guide that was not created specifically to match its background story, it might not fit with the overall visual design, and users might find it distracting for their viewing experience. On the other hand, if a character guide could be designed independently of the story (that is, without worrying about matching the art style), it would be convenient for designers or developers to easily apply add character overlays to existing immersive videos without require custom design work or additional development. For these reasons, we designed our study to also investigate whether the art style of a character guide should match the presented story and thus. We tested whether a similar art style can lead to better viewing experiences or following more of the primary story animation.

4.2 User Study

For this research, we proposed to introduce a designed guiding character to lead our users through a sequence of essential story events in VR and ensure that they do not miss core activity. To provide variability in testing, the study used multiple immersive videos. We prepared three 360-degree animated videos and set them up in Unity as the background. All three stories were presented as first-person experiences, and the camera used to display the VEs was placed at the user's eye level. Each video had a distinct art style and story development. To study different character designs and matching the stories, we created three distinct virtual character guides, where each character has a corresponding art style to the video being displayed (See Figs. 1, 2 and 3).

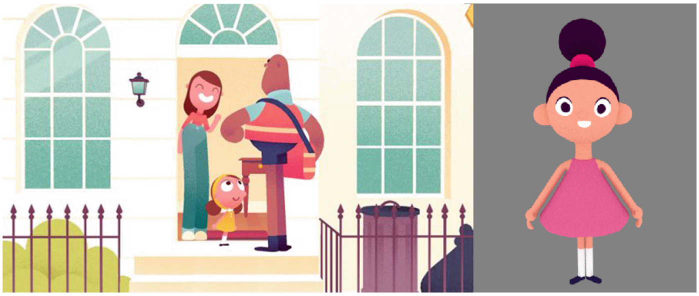

Fig. 1. The left image shows the style from *Rain or Shine* (Massie [15]), and the right shows the custom-created girl character guide designed with a matching art style for the experiment.

The experiment followed a three-way within-subjects design. To simplify the experimental procedure, we identified three groupings of the three VR videos and character guide conditions (See Table 2). The groupings can be considered an additional between-subjects factor in the experimental design.

Fig. 2. On the left, a single frame from *Colosse* (Pittom [19]) shows the story's art style, and the right shows the custom-created fox character with a matching style designed for the experiment.

We showed only one character guide at a time and hid the other when playing each VR experience. The implemented guiding characters were not a part of the storyline, nor did they affect the development of the story. The only function they served in the

Fig. 3. The left shows a still from *INVASION!* (Darnell [9]), and the right shows the custom-created rabbit character with matching art style for the experiment.

narrative scenario was to attract the viewer's attention to a target region within the VE where an important event took place. The user's gaze was expected to follow the character guide toward the goal area.

We animated each character with several body movements associated with different objectives (See Table 3), and we were able to trigger a specific action of the characters under a certain condition.

Table 2. Specific groupings of videos and guides used in the experiment.

	Video 1: *Rain or Shine* [15]	Video 2: *Colosse* [19]	Video 3: *INVASION!* [9]
Group 1	N/A (no guide)	Girl (non-matching)	Rabbit (matching)
Group 2	Girl (matching)	N/A (no guide)	Fox (non-matching)
Group 3	Rabbit (non-matching)	Fox (matching)	N/A (no guide)

Table 3. Animation design and objectives for each character guide.

	Gaze-redirecting (Horizontal)	Gaze-redirecting (Vertical)	Attention grabbing
Girl	Point left/right	Point up/down	Jump and wave
Fox	Turn to left/right	Jump up/dig down	Bark
Rabbit	Turn to left/right	Look up/down	Jump

Per VR video, there was a sequence of target scenes, wherein each target scene displayed a focal event along the story development time-line within the 360-degree VE. These scenes were determined based on: (1) The main character of the story is performing a major action; (2) The secondary character(s) is performing a major action, and the main character's action has become secondary; (3) The secondary object(s) is introduced in the story, and the main character's action has become secondary; and (4) The event in one scene must relate to the event occurring in the following scene. For example, if a user missed Scene 1, there is a chance that he would feel confused when watching Scene 2.

To help us assess when participants where viewing the primary story content during the movie narrative, we identified a "target" gaze direction throughout the duration of the story. This was done by determining the angle to use as approximately the center of story activity, and the target direction was adjusted over time as the story progressed. For analysis purposes, we considered a field-of-view (FoV) range around the target direction such that if the center of the viewer's gaze was contained within the FoV range, we could estimate that the viewer was following the primary story activity. For our purposes, we used a FoV range of 120° in the horizontal direction and 100° in the vertical direction (See Fig. 4).

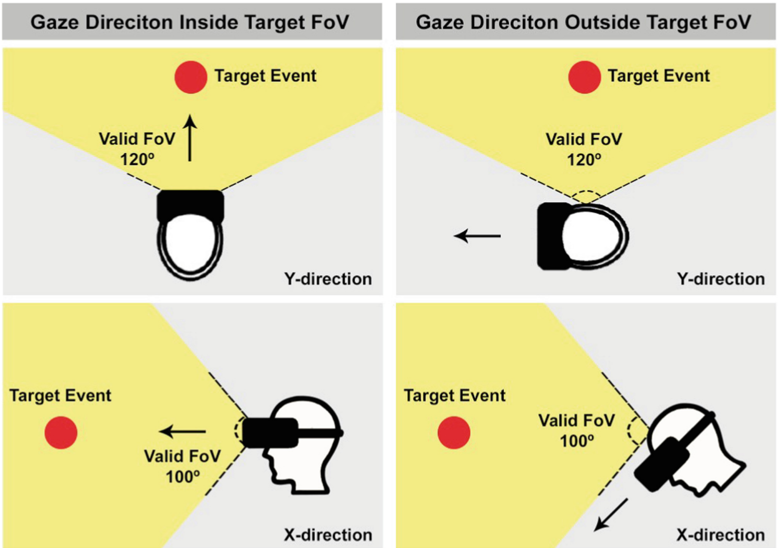

Fig. 4. The user's head orientation (gaze direction) in relation to a target event and its valid FoV along the horizontal and vertical directions.

The research was conducted with approval from our institutional review board (IRB). Each study session lasted approximately 60 min. Participants were asked to watch three animated 360-degree videos in VR, and each video lasted for approximately 4–5 min.

There were a total of 30 participants from Texas A&M University who participated in our study. Each participant completed a background questionnaire prior the study to collect information such as age, gender, education, occupation, average weekly computer usage, and experience with video games and VR.

All participants were seated during the experiment, and their interactions with the VR experiences only involved head and body rotations. We used HMDs to track their head orientation, which determined where their gazes fell throughout the experiences. We recorded and saved quantitative data every 0.2 s during the experiment, and the data included the following: (1) Run-time of each VR experience; (2) Target scene IDs for each VR experience; (3) User's head orientation (gaze direction) along X-axis and Y-axis throughout each VR experience; and (4) Guiding character's animation being triggered.

We also collected qualitative data during each study session via observing user reactions and performances. We gathered a post-study questionnaire to collect information such as preferred technique, ease of use, natural level, and sense of immersion. Lastly, we conducted an in-depth structured interview that aimed to gather detailed information about the participants' thoughts regarding their experience of interactive VR stories with a character guide. All data and findings were anonymized.

4.3 Results

Study results were analyzed based on participants' objective gaze data as well as from interviews and questionnaires.

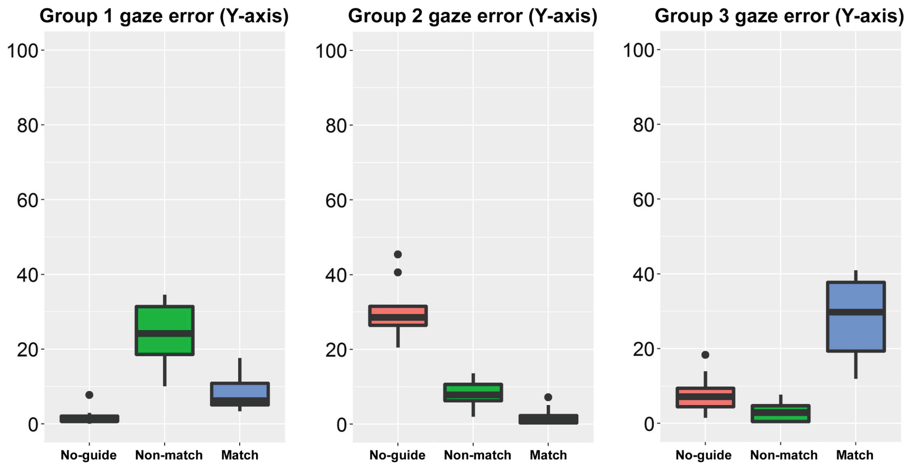

Fig. 5. Significant differences in gaze behavior for the three different VR stories, as seen in the three ordering groups.

Gaze Redirection with Virtual Character. To assess the impact of the virtual characters, we logged participant gaze data collected during the study sessions by saving head orientation from the VR tracker ever 0.2 s. We used the head orientation data with the previously described "target" directions identified for each story to determine whether the users' gazes were with the target range in a particular scene. If the user's gaze direction fell in this region during the time period that the corresponding events were occurring, we counted this as time looking at the story's target content. For analysis, we used this data to calculate the total percentage of time out of the target range, which we refer to as *gaze error*.

To simplify the presentation of results, we focus our analysis on gaze error for rotation about the vertical axis (i.e., heading or yaw), as our media review found this to be most relevant for story motion in immersive media. Significant differences were detected in gaze behavior due to different VR stories (see Fig. 5). A two-way mixed ANOVA result of the gaze error showed a significant interaction between group and character conditions with F(4, 54) = 67.76 and p ¡ 0.001. The results further indicate that all the guidance techniques used with *Rain or Shine* [15] had the smallest values, whereas all the guidance techniques used with *Colosse* [19] had the largest values.

This represents clear evidence that the movie assignments affected the gaze behavior. However, there were no significant primary effects for the group or condition factors individually. Due to the confounding of the groups, we could not be confident when comparing character conditions from this test.

Virtual Character and Art Style. Since the results showed previously are so heavily influenced by different videos, we considered the difference between each participant's gaze error and the median for the movie, which removed the variation based on the movie differences to allow the comparison of the character conditions more fairly. We normalized the results based on the overall median gaze error on y-axis-rotation for each video. A one-way repeated measures ANOVA found F(2, 58) = 0.56, indicating no evidence of differences due to character conditions; the three conditions were very similar (see Fig. 6). We found no gaze differences between added characters or matching art styles.

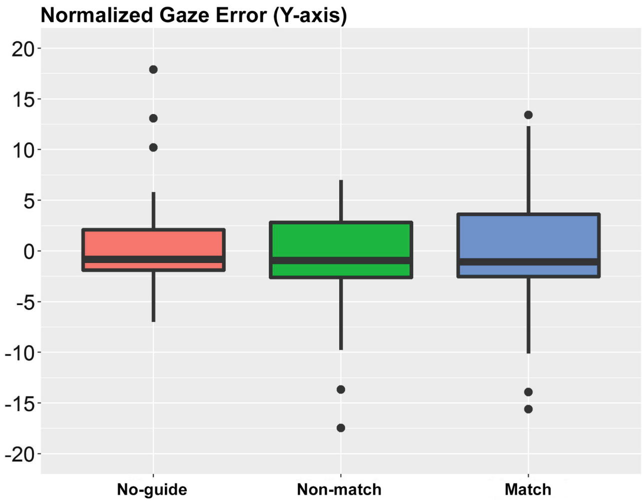

Fig. 6. Gaze differences between character conditions normalized for differences in stories.

Other than the quantitative data, we summarized some interesting results from interview responses. For example, some participants thought implementing a character guide that has a corresponding art style to the story was a contributing factor for their experience. They explained that the similar art style was more natural and made them believe that the character guide belonged to that specific story world. For these participants, if a character guide had a non-matching art style to the story, they would feel that the existence of the guiding character was unnecessary. On the other hand, some participants maintained that implementing a character guide that has a different art style to the story was more helpful, since it made the character guide stand out more from the background. In this case, the viewers felt that they were more likely to notice the guide and its redirecting actions. This was something that a guiding character with a matching art style could not achieve since it blended into the surrounding environment "too well," leading it to become indiscernible.

Level of Enjoyment. We measured the participants' ratings of level of enjoyment for each story experience. Based on the results of the post-study questionnaire, there was no concrete evidence that the participants' enjoyment level was affected by a character guide, nor did it indicate that the character's art style influenced their level of enjoyment.

According to the questionnaire and the interview, there are several possible reasons that could explain why a character guide did not contribute to the user's enjoyment: (1) The character guide made viewers less focused on the story events; (2) the character guide did not affect story development and therefore was unnecessary; (3) the character guide's art style did not match the presented story; and (4) the enjoyment level was related to whether the user understood the story regardless of the guidance condition.

Guiding Actions. As for the character guide's redirecting actions, regardless of whether the virtual character appeared in the form of a human or an animal, the guiding intentions for the horizontal direction worked well within a narrative VE. On the other hand, the guiding actions designed for the vertical direction did not work effectively as expected.

Specifically, the length of time that the user's gazes stay outside the target FoV along the x-axis was mostly not long enough to trigger the character's guidance animation for the vertical direction. Even if the guiding actions for the x-axis were triggered for a few times, many participants mentioned that they did not notice them. For instance, numerous users did not notice the fox character jumping up or digging on the ground.

Additionally, the guiding body language designed for an animal character caused certain confusion, especially for the vertical direction. For example, the majority of the users reported that they did not understand what the meaning of "jumping" or "digging" was. The reason was because we considered the character's directing actions as a part of its art style design. If we attempted to match the character's art style to its background story, the types of guiding behavior would be limited, especially for the animal characters. As a result, although the users reacted fairly quickly to certain instructional gestures such as pointing towards a direction, we could not simply have every animal character perform human-like behaviors for the purpose of our experiment. Nevertheless, we found that having the animal characters turn their bodies to face a particular direction worked well for most participants.

5 Discussion

The experiment results demonstrate that the inclusion of a virtual character that was independent from the narrative had limited effects on users' gaze performances when watching an interactive story in VR. Furthermore, the implemented character's art style, despite of whether it matched or did not match that of the background environment, made very few difference to users' gaze performance and their level of viewing satisfaction. Nevertheless, through the study we conducted, the character guide approaches still provided insights for future directors and designers into how to draw viewers' attention to a target point within a narrative VE.

One reason that no significant gaze difference was found could be due to limitation of the implementation design. Our design was to attach the character guide to the main camera's view-port; in this case, the character guide was always in sight at a fixed spot (bottom right corner) throughout the entire story-viewing experience. Even when users change their head orientation, the character guide would still follow and "float" in the corner of their vision. Although a few participants responded during the interview that they could ignore the character guide in the corner and just focused on the story content, others considered it to be quite distracting because it took their interest away from the background story. Thus, the effects of its guiding actions were restricted.

Another reason was that the guiding body language designed for an animal character posed certain challenges for us. As pointed out earlier, certain gestures and postures such as pointing are common knowledge of the human societies. However, we could not simply have every animal character perform human-like directing actions if we were to consider their actions as a part of the art style design corresponding to its background story. For these characters, the types of guiding behavior were limited. For instance, even though having the animal characters turn their bodies to face a particular direction worked for most participants, numerous users reported that they did not understand what the fox guide was trying to convey when it was "jumping" and "digging".

Lastly, ability to accurately determine gaze focal points of the users solely by tracking their head orientation. As mentioned earlier, the character guide was stuck to the bottom corner of the user's HMD view-port, and some users were able to ignore the character guide while others were not. This implied that there was a possibility that the change of some head orientation data was associated with certain story elements (such as sound cues) in the background instead of the virtual character's guiding action.

There are several alternative design factors that may help to make the character guide technique feasible for future study. One option is to create the virtual character in a form of a flying creature so that it is natural even if it is "floating" with the user's vision. In addition, we may have the character guide become less visible when the user is looking at the expected regions within the VE. For example, (1) The character may hide a portion of its body somewhere outside of the headset's view-port; (2) the character may turn to a shadow profile, as if it was an audience that the user would normally see in a theater; or (3) giving audience the choice of turning on or off the character, so that they would feel less bothered whenever they don't need it.

As for the experimental design, it is important that we train the users to understand a character's postures and its guiding intentions. This can be done by showing them a short demo with a practicing session before presenting a story. In addition, we should test the character technique with an eye-tracking system to find out the user's gaze focus more accurately. Finally, we need to further test the character guide technique in a constructed VE rather than placing it in a 360-degree video playing in the background. The guiding characters will be more natural if they can walk within the virtual space.

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