Am I a Bunny? The Impact of High and Low Immersion Platforms and Viewers' Perceptions of Role on Presence, Narrative Engagement, and Empathy during an Animated 360° Video

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ABSTRACT

This study used both quantitative and qualitative data to assess whether a High Immersion viewing platform (virtual reality headset) elicits stronger feelings of narrative engagement and empathy compared to a Low Immersion platform (smartphone) when viewing an animated 360° video. In line with prior research, participants (N = 65) reported greater feelings of presence in the High Immersion condition compared to Low Immersion. However, immersive condition was not significantly related to narrative engagement or empathy. Interview responses revealed that participants' perceptions of their role in the film experience (i.e., Character, Observer, or Other/Not Sure) varied and were significantly related to narrative engagement. Participants who saw themselves as a Character (versus Observer) reported higher narrative engagement and empathy. Findings suggest that although a more immersive viewing platform can enhance presence during a 360° video experience, a clear understanding of viewer role is both difficult to achieve and critical to story comprehension and empathy.

Author Keywords

360° Video; Presence; Narrative Engagement; Empathy; Virtual Reality; Head-Mounted Display; Immersion; User Experience; Magic Window.

ACM Classification Keywords

H.1.2 User/Machine Systems; Human Factors.

INTRODUCTION

In recent years there has been an increase in commercially available immersive technology including advanced head-mounted virtual reality (VR) displays such as the HTC Vive and Oculus Rift, as well as smartphone-based

technologies such as Google Cardboard and Samsung Gear. Alongside this expansion has been parallel growth in the availability of 360° video, which can be viewed on smartphones, VR headsets, or even computer screens. In general, 360° video portrays stories and images with a wider field of view compared to conventional video, allowing users to engage with content differently and potentially making stories more compelling and accessible. Major news corporations such as *The New York Times*, *Washington Post*, and *The Guardian* have been utilizing 360° video as a tool for journalism [11]. As of spring 2017, over one million 360° videos have been posted on Facebook, supporting the idea that there is major appeal to the general public in consuming content in this way [2].

Developers and filmmakers are actively finding ways to make film, virtual reality, and panoramic video more engaging and impactful [18, 27, 30, 38]. Though the same 360° video can be viewed on advanced headsets, smartphones or computer screens, the platforms differ in their immersive features. There is a popular belief as well as some empirical evidence that more advanced, immersive technologies may enable users to better connect with stories, and to experience more empathy compared to less immersive technologies [10, 13, 41]. Many questions remain surrounding the ways in which users of more immersive technologies, such as 360° video and VR, engage with the narrative elements of content. Viewers in 360° video have control over where they look, meaning that narrative formats and editing techniques that work well in traditional film, such as zooming in on a character for emphasis, do not translate to a more immersive format and can be jarring for the user [24, 31]. Moreover, one implication of feeling present in the virtual world is that viewers sometimes struggle to make sense of their role in the action, which can distract them from the content [29, 31]. The current study explored these issues by examining how both immersive technology and viewers' understanding of their role in a 360° video experience related to viewers' sense of presence and their engagement with story and characters.

Immersive Technology and Presence

The appeal of newer, commercially available VR systems lies largely in their immersive qualities, which foster a

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sense of presence. Throughout this paper we will use the commonly accepted ideas that the term *immersion* references a characteristic of the display system itself and the term *presence* indicates the user's sense of being in the virtual environment, disassociated from the real world [24, 26, 28]. There are a number of characteristics of immersive technology that have been found to impact a user's feeling of presence such as frame rate, viewing angle/area, tracking latency, visual quality and sound [14, 16, 36, 39]. Although 360° videos can be viewed across platforms, when seen in advanced head mounted displays (HMDs), content is presented in a stereoscopic display, with closed peripheries, allowing viewers to look in any direction with 3D views. On a smartphone or flat screen, viewers can still pan to see a 360° field of view but they can also see the outside world. Viewers also see the content in 2D. The link between immersive technology and presence is relatively well-established [9]. However, this study provides additional empirical evidence to inform researchers and content creators about viewers' narrative engagement and empathy while viewing 360° video across different platforms.

The Impact of Perceived Role

Another implication of any immersive technology is that viewers must make sense of their role in the story, whether that be as a passive observer or some other character. Baños and colleagues [3] found that not only was there a physical aspect to users' feeling of presence, but that the environment and its content needed to have an appeal and believability to the user, which moves beyond the simple technological aspects of immersion and into elements of the environment and the content itself, leading to presence. One model posits that presence is constructed through a two-step process: the user must use spatial cues to identify the virtual space as being "plausible", and then the user must experience themselves as being located within the virtual environment [9, 43]. Similarly, Slater references the idea of a "plausibility illusion" in that the user not only believes the events they see are actually happening but that those events directly involve the user [36].

Research to date has not directly examined how viewers construct their self-identity in a VR experience. However, emerging evidence suggests confusion about one's role can make it more difficult for viewers to engage with 360° video and other VR content [29, 31]. Users need an understanding of who they are, not just where they are [29]. Research has demonstrated that having a virtual body and feeling some sort of ownership over it helps viewers engage with content [4, 20]. However, many questions remain about the cues viewers use to determine their role in virtual experiences. Immersive narratives have the potential to allow people to temporarily expand the boundaries of the self (TEBOTS), helping them to experience something new as though it is happening to them [37]. Through this process, viewers who are immersed in an engaging story are able to connect to the characters even when the story depicts experiences the viewer has never had themselves

[19]. This type of plausibility may come about even if the circumstances are impossible [6, 14]. Self-identity of the user may be a crucial component for content designers to consider as they seek to encourage users to engage with stories and empathize with characters. Given that confusion about one's role can occur, it is important to understand the contextual features that encourage viewers' understanding of the developer's intended narrative. Additionally, an examination of how differences in perceived role affect the viewer's subjective experience would be informative for both researchers and the developers who are creating content.

Narrative Engagement and Empathy

A commonly-held assumption is that in addition to fostering a sense of presence, immersive technologies will encourage users to be more engaged and empathetic. VR has been lauded as the "ultimate empathy machine" [27] in that it has the potential to connect users to people, places, and lived experiences. Some scholars have posited a connection between feelings of presence and emotional engagement; experiences that foster or encourage the feeling that a user is 'really there' are thought to contribute to empathetic feeling [13]. Many VR experiences and 360° videos have addressed global issues like the Syrian Refugee Crisis [1], homelessness [10] and disabilities like macular degeneration [42].

Well-crafted narratives can elicit strong emotional responses from those engaging with the material, even when they are presented in low immersion mediums [15, 19, 37]. Scholars have examined narrative engagement as a combination of several psychological factors, including attentional focus, narrative presence, narrative comprehension, and emotional engagement [7]. Of specific interest to research in narrative virtual reality and 360° video is measuring the extent to which a user empathizes with characters in a story [24]. Empathetic impact can be understood through a combination of state and trait empathy. Trait empathy measures a person's disposition to be empathetic while state empathy is a more dynamic measure of many factors that can impact empathy at a given time [44].

Only one study has directly examined empathy in the context of different viewing platforms, and showed that more immersive technology seems to foster empathy [13]. One explanation is that larger image size can cause viewers to experience stronger emotions [8, 22, 41]. With only a few recent studies having explicitly examined these issues, more research is needed to explore the link between immersion and narrative engagement and empathy. Although VR and 360° video developers can use audio and visual cues to draw the user's attention to specific parts of a story, the developer cannot ultimately control where the user is looking because the user has autonomy [24]. This lack of control over viewers' gaze can lead to a lower sense of narrative understanding, especially when users are not

familiar with audiovisual cues in VR [29, 31]. Two recent studies [24, 39] suggest that more immersive technologies facilitate users' engagement with the story, although this pattern was only statistically significant in one of the studies [39]. Users report that when they look around during a 360° video they feel like they will miss part of the story (i.e., Fear of Missing Out) [31]. This can particularly be an issue for people who have never experienced immersive technology [24]. When users experience 360° video or an immersive VR headset for the first time, they may situate themselves and act differently than those with prior experience, making it important to account for this variable when looking at presence, narrative engagement, and empathy outcomes.

The Current Study

In the current study we experimentally controlled level of immersion and we elicited user's perceptions of role to investigate effects of these two factors on presence, narrative engagement, and empathy in 360° video. We randomly assigned participants to either a 2D Smartphone (Low Immersion) or 3D VR headset (High Immersion) 360° video experience with a mildly emotional piece of professionally designed animated content. Validated survey measures of presence and narrative engagement were used to compare users' subjective experience in the two viewing platforms. In addition, participants were asked open-ended interview questions about their immersive experience. Follow-up questions prompted the participants to reflect on who they were in the film and how they knew. Questions addressing user experience with professionally designed commercial content, as opposed to carefully controlled immersive experiences in a laboratory setting, are important both for purposes of external validity as well as to ensure designers are maximizing the technology's potential to engage the user in a meaningful way. Because viewer emotions, personality traits, and prior experience with VR are known to shape how content is interpreted [17, 21, 23, 34], we accounted for both trait empathy and prior experience when testing the study hypotheses.

Hypotheses

In line with past research, we expected that viewers in the VR headset (High Immersion) condition would report a greater sense of presence than those in the Low Immersion condition, even when prior experience with VR and trait empathy were taken into account. After verifying that our experimental manipulation functioned as expected with regards to presence, it was also expected that viewers in the VR headset condition would report higher narrative engagement and state empathy than those in the smartphone condition when accounting for the covariates. Finally, in limiting the amount of contextual narrative information available to viewers before the experience, we hypothesized that users who were unable to correctly identify their role in the narrative would experience lower levels of narrative engagement and empathy.

METHOD

Participants

A total of 80 participants were recruited online using Facebook and Craigslist postings. Respondents were screened via email and were required to be 18 years or older, fluent in reading and speaking English, and able to travel to the research site for an hour-long session. Two participants were dropped due to outlier scores on the Common Humanity subscale of the Compassion Scale (used to assess trait empathy), two were excluded due to questionnaire responses indicating a response set (i.e., the same response chosen for every question), one was excluded because of an error in study administration, and 10 were dropped due to equipment malfunction. The final sample included 65 participants ages 18-64 years ($M = 35.6$ years, $SD = 12.8$) of which 37 identified as women, 26 as men, one as gender fluid, and one indicated "prefer not to say". In terms of race and ethnicity, 40 participants identified as White, 10 Asian, seven Black/African American, one Hispanic/Latino/Spanish, and seven Other. Thirteen participants reported they had a postgraduate degree, 34 were college graduates, 11 had some college, three reported trade/technical/vocational training, two were high school graduates, one had some high school, and one preferred not to say.

Procedure

All procedures were approved by an independent Institutional Review Board. Participants completed screening questions via email and were then invited to the research site. Participants were randomly assigned to the Virtual Reality Headset (High Immersion) or Smartphone (Low Immersion) conditions. When they arrived, a research assistant explained the study, time commitment, and compensation. All participants provided written, informed consent prior to beginning the study. Questionnaires were completed on a laptop using the online Google Forms interface in the presence of the research assistant. Before viewing the film, participants completed two measures: the Compassion Scale [32], which assesses trait empathy and the Big Five Inventory-10 (not analyzed here), for a total of approximately 5-10 minutes. The Big Five Inventory was not of interest in this study and was therefore excluded from this report.

Experimental Manipulation

Participants viewed the film while seated in a swivel chair in a quiet area. In the Headset condition, they wore an Oculus Rift headset with built-in headphones. In the Smartphone condition, they were given a Samsung Galaxy 6 phone with the Within VR app and standard over-the-ear headphones that were plugged into the audio jack on the phone. The current study was part of a larger data collection in which participants viewed two 360° videos on the same platform, each with a post-survey and interview. In this study we focus only on one video: *Invasion*, a short, CGI VR film by Baobab Studios. This study used commercially available versions of the film for both

conditions. In the Smartphone condition, participants navigated the film's scenes by moving and tilting the phone (i.e., "Magic Window" format), and were informed that they could pan by moving the phone if they were not aware of that option. Participants were given no information about the story or their role prior to viewing the film.

The film is about aliens arriving on Earth and interacting with wildlife creatures, in particular, a bunny who will help the viewer (who is also portrayed as a bunny) thwart the aliens. In *Invasion*, the viewer is not invisible, but is one of the characters who is targeted by the comical yet threatening moves by the aliens. Including the viewer as a character was considered a very forward thinking step in the use of 360° film when it was designed and the creators utilized a variety of effects to try to help the user feel as though they were part of the experience [12]. In the Oculus headset version of *Invasion*, looking down at one's own "body" reveals that the user inhabits a rabbit's body in the virtual world. In the commercial phone version, the user can look around and move the viewer in a 360° fashion, but cannot see their own body. In both versions, Oculus and phone, any interaction is implied by the way the CGI animation is set up (e.g., the bunny "hides" behind the user when the aliens appear); there is no user interface for viewer interaction with the virtual world.

Post-Film Procedure

After viewing the film, participants completed two questionnaires (approximately 5-10 mins total): the Presence Questionnaire and the Narrative Engagement Scale. The research assistant also conducted a post-film interview (approximately 10-20 mins). When the study was complete, participants were thanked and given the compensation (a \$30 Amazon gift card).

Measures

The Compassion Scale [32]

This scale evaluates how participants typically act or feel towards others. Participants read 24 statements regarding various types of compassionate behaviors (e.g., "I like to be there for others in times of difficulty", "I try to avoid people who are experiencing a lot of pain") and rate themselves on a scale from 1 = "Almost Never" to 5 = "Almost Always". This study used only the total compassion score (referred to hereafter as Trait Empathy). Reliability was first assessed using Cronbach's alpha. Adequate internal consistency was observed for the 'common humanity' construct (alpha = 0.72) and indifference construct (alpha = 0.70), but low reliability was observed for the other 4 scale constructs (kindness: alpha = 0.58, separation: alpha = 0.59, mindfulness: alpha = 0.30, disengagement: alpha = 0.44). The measure was revised by omitting items to maximize Cronbach's alpha for all concepts. The constructs of mindfulness and disengagement were omitted because of low internal reliability. The remaining 4 constructs (kindness, indifference, common humanity, and separation) had alphas of 0.58, 0.78, 0.78, and 0.59, respectively. Given the

low reliability observed for 2 of the 4 subscales, confirmatory factor analysis (CFA) examined the degree to which a four-factor model fit the revised 14-item scale. Using a maximum likelihood estimator, comparative fit index (CFI) = 0.920, root mean square error of approximation (RMSEA) = 0.065 (90% confidence interval: 0.000 to 0.101), and standardized root mean square residual (SRMR) = 0.092. The CFA statistics suggest that despite low reliability for some of the subscales, a four-factor model was a relatively good fit of the observed data.

Presence Questionnaire (modified from [45–47])

The scales used here evaluate the participant's relative experience of presence within an environment. Using a 7-point Likert scale on 24 statements, participants self-evaluate their level of presence within a digital environment. Using metrics such as feelings of control, relatedness to the "real world", interactions in the virtual space and visual/haptic realism, participants are ranked on a level of presence. Items that were not relevant to the film content were dropped (e.g., "How much were you able to control events?", "How compelling was your sense of moving around in the virtual environment?", "During the media experience how well were you able to observe the style of dress of the people you saw/heard?", items referencing 'assigned tasks or required activities'). Items that were not relevant to this particular film content were dropped. The original questionnaire has been shown to be a reliable measure in previous research; the modified 10-item measure had a Cronbach's alpha of 0.87 for the current study, suggesting adequate internal consistency. This study used the total score on the Presence Questionnaire (hereafter, Presence).

Narrative Engagement Scale (adapted from [7])

This scale examines how the participant engages with narrative across four subscales: narrative understanding (narrative realism and cognitive perspective taking, how viewers comprehend the narrative; "At points, I had a hard time making sense of what was going on in the program"), attentional focus (whether the viewers are focused or distracted; "I found my mind wandering while the program was on"), emotional engagement (emotional arousal in either positive and negative direction, feeling empathy and sympathy for the characters; "I felt sorry for some of the characters in the program"), and narrative presence (presence having to do with the story, "entered the story"; "At times during the program, the story world was closer to me than the real world"). The total score on this scale is referred to as Narrative Engagement below. The emotional engagement subscale of the Narrative Engagement Scale was used as a measure of state empathy (hereafter, Empathy). The narrative presence subscale measures a related but separate aspect of presence than the PQ, and was developed specifically with media where subjects experience a story. As the original scale was developed and validated with television programs, it was necessary to

modify the measure for use in a VR study by changing the word “program” to “experience”. Individual subscales were given equal weight in the calculation of the full Narrative Engagement score. For this study, individual subscales had Cronbach’s alphas ranging from 0.76 to 0.88, and the full scale had an alpha of 0.86, suggesting acceptable reliability. The Emotional engagement subscale had an alpha of 0.76 for this sample.

Interviews

Open-ended interview questions were posed verbally and responses were recorded on an audio recorder and transcribed at a later date.

1. Retell the story in your own words
2. Who were you in this experience? How did you know?
3. What, if any, emotions did you feel in this experience?
4. Did the bunny know you were there? Why?
5. Did the aliens know you were there? Why?
6. What did you like best about this experience?
7. What did you like least about this experience?
8. If you could change anything about it, what would you change?

RESULTS

Preliminary Analyses

An independent-samples t-test demonstrated that the Headset and Smartphone groups were not significantly different from one another in trait empathy (i.e., Compassion Scale; $t(64) = 0.39, p = .700$). A chi square analysis was used to demonstrate that the two groups were not significantly different in terms of prior experience with VR ($\chi^2(1) = 3.38, p = .066$). Both variables were retained as potential covariates in the models that follow.

Predicting Presence, Narrative Engagement, and Empathy

Descriptive statistics and correlations between all measures are provided in Table 1. All of the survey measures were significantly, positively intercorrelated with the exception of State Empathy and Trait Empathy. Linear regression was used to examine the role of condition (VR Headset - High

Immersion, Smartphone - Low Immersion) and subsequently, participants’ perceptions of their role in the experience, on presence, narrative engagement, and empathy when accounting for baseline empathy and prior experience with VR. Models were selected using the R (version 3.3.2) [33] ‘step’ function in the ‘stats’ package. This stepwise approach to model selection automatically adds and drops individual predictors and interaction terms until the best-fitting model is reached (i.e., AIC is minimized). Only predictors that make a significant contribution to model fit are maintained, regardless of their individual significance level. The Bonferroni correction was used to adjust the critical alpha level for multiple comparisons and reduce Type 1 error [5]. With a correction for six comparisons (testing effects of condition and role perceptions on PQ, NES, and emotional engagement, in turn), p-values smaller than $.05/6 = .0083$ were considered significant.

The Effect of Condition: VR Headset versus Smartphone

The first set of regression analyses selected the best-fitting models with potential predictors being Condition, Prior VR Experience, Trait Empathy, and interactions among them (Table 2). Participants in the VR Headset condition reported significantly greater feelings of presence than participants in the Smartphone condition ($B = 1.06, p = .001$). Condition did not make a significant contribution to the model predicting participants’ reports of Narrative Engagement or Empathy more specifically.

Role Perceptions: Character, Observer, or Other/Not Sure

Participants’ perceptions of their role in the film were assessed using responses to the interview question “Who were you in this experience? How did you know?”. Responses fell into three categories: Character (i.e., Bunny or other character in the film), Observer (i.e., non-participating viewer), and Other/Not Sure. Role perceptions were significantly related to Condition ($\chi^2(2) = 9.75, p = .008$). More participants in the VR Headset condition believed they were a character in the story compared to the Smartphone condition, in which more participants believed they were merely observers ($\chi^2(1) = 5.22, p = .022$). See Figure 1).

Variable	Mean	SD	Median	Min	Max	1	2	3	4
1. Compassion Scale	4.20	0.43	4.31	2.94	4.94	--			
2. Presence Questionnaire	5.38	0.99	5.50	3.40	6.90	.28*	--		
3. Narrative Engagement	5.07	1.11	5.25	2.25	6.92	.31*	.60***	--	
4. Empathy	4.50	1.44	4.67	1.00	7.00	.04	.30*	.57***	--

Note. * $p < .05$, ** $p < .001$.

Table 1. Descriptive Statistics and Correlations between Pre-test and Outcome Measures

Predictor	Models with Condition and Covariates			Models with the Addition of Role Perceptions		
	Presence	Narrative Engagement		Presence	Narrative Engagement	
	Total Score	Total Score	Empathy	Total Score	Total Score	Empathy
Intercept	2.17(1.06)	6.43(1.28)*	3.50(0.18)*	2.17(1.06)	1.58(1.25)	3.94(0.27)*
Condition: Headset (vs. Phone)	1.06(0.31)*	-0.53(0.27)	--	1.06(0.31)*	--	--
Prior VR experience: Yes (vs. No)	1.18(0.32)*	-0.39(0.27)	--	1.18(0.32)*	--	--
Trait Empathy (Compassion Scale)	0.54(0.25)	-0.72(0.30)	--	0.54(0.25)	0.73(0.29)	--
Condition: Headset * Prior VR experience: Yes	-0.85(0.44)	--	--	-0.85(0.44)	--	--
Who Were You: Character (vs. Observer)				--	0.81(0.28)*	1.06(0.38)*
Who Were You: Other/Not Sure (vs. Observer)				--	0.46(0.35)	0.68(0.47)

Note. Raw Estimate(Standard Error). * Indicates significance at Bonferroni adjusted p-value of .0083. -- Indicates predictors not selected by the stepwise procedure.

Table 2. Linear Regression Models Predicting Presence, Narrative Engagement, and Empathy

Figure 1. Participants' Role Perceptions by Condition

The second round of regression analyses examined role perceptions by testing their relation with the outcome variables along with Condition and the Prior VR Experience and Trait Empathy covariates. The best-fitting models predicting each outcome variable were built again, this time with the addition of Role Perception as a potential predictor (See Table 2). Given the relation between Condition and Role Perception, this set of analyses helped clarify which variables were the most useful for predicting presence, narrative engagement, and empathy. The role perception variable was coded as a dummy variable with three levels and "Observer" as the reference group. Changing the dummy coding of Role Perceptions did not reveal any additional significant differences.

Role perceptions did not make a significant contribution to the model predicting Presence, indicating that Condition was a stronger predictor of presence. Conversely, the best-fitting model predicting Narrative Engagement included role perceptions but not Condition. More specifically, participants who thought they were a character (as opposed to an observer) reported significantly higher Narrative Engagement ($B = 0.81, p = .006$). Role perceptions were also a significant predictor of Empathy. Participants who thought they were a character in the film reported more Empathy than those who thought they were an observer ($B = 1.06, p = .007$). There were no significant differences between participants who believed they were an observer and those who said Other/Not Sure.

Participant Comments about Their Role

Further information about viewers' understanding of their role in the film experience was collected during the interview. Participants' answers to the questions "Did the bunny know you were there? Why?" and "Did the aliens know you were there? Why?" were analyzed for content themes. Participants' reasoning about these issues centered around whether or not they perceived that the bunny or aliens (a) interacted with them or (b) looked at them. These responses were examined in conjunction with participants' Role Perceptions (See Table 3). A z-test for the difference in population proportions was used to examine whether there were significant differences in the proportion of participants in each group who mentioned that the bunny or aliens interacted with them or looked at them. Participants

who believed they were a character were significantly more likely than other participants to report that the bunny had interacted with them ($z = 2.91$, $p = .004$). Similarly, participants who believed they were a character in the experience were also more like to say that the bunny looked at them compared to those who thought they were an observer ($z = 3.05$, $p = .002$).

Role Perceptions	Interacted with me	
	Bunny	Aliens
Character	22/26 ^a	20/26
Observer	12/26 ^a	14/26
Other/Not Sure	8/13	8/13
	Looked at me	
	Bunny	Aliens
Character	18/26 ^b	7/26
Observer	7/26 ^b	3/26
Other/Not Sure	9/13	2/13

^{a,b} Proportions differ significantly, at the Bonferroni-adjusted alpha level of .004.

Table 3. Participant Comments about the Bunny and Aliens (proportion of participants)

DISCUSSION

This study investigated how immersive technology and viewers' understanding of their role relate to viewers' experience of presence, narrative engagement, and empathy while viewing a CGI 360° video called *Invasion*. As expected based on prior research, participants in the High Immersion (VR headset) condition reported stronger feelings of presence than participants in the Low Immersion condition. Contrary to our hypothesis, we found no effect of immersive condition on narrative engagement or empathy. However, in line with our predictions, participants who correctly identified themselves as a character in the film experience reported more narrative engagement than participants who believed they were an observer. This was true even when allowing prior experience with VR and trait empathy, as well as immersive condition, to play a role in predicting narrative engagement. More specifically, participants who believed they were a character in the film reported more state empathy than participants who thought they were an observer. There weren't any significant differences between participants who said they were observers and those who said Other/Not Sure. Participants' comments during the interview revealed that their understanding about their role in the story was shaped in part by whether they thought the bunny looked at or interacted with them.

The significant boost in presence reported by participants in the High Immersion compared to the Low Immersion condition is in line with previous research and theory about immersive technologies [14, 16, 36, 39]. The High Immersion condition using the Oculus Rift headset had

numerous immersive advantages that imitate the ways in which viewers interact with reality (e.g., turning one's head to view a panorama). Verifying the effect of immersive technology on presence, even when accounting for prior experience with VR, confirmed that our experimental manipulation functioned as expected. Notably, and in line with past research [31], viewers who had prior experience with VR reported stronger feelings of presence compared to viewers without prior experience.

A major goal of this study was to assess the impact of immersive technology on viewers' feelings of involvement with the story and characters. Feeling present is important, but in order for 360° video to be effective, users need to feel involved in the narrative and care about characters [36]. We hypothesized that participants in the more immersive VR headset condition would report higher narrative engagement, which includes attention to the narrative, story comprehension, and feelings of involvement with the story and characters. In particular, we expected that participants in the more immersive condition would feel more empathy for the characters than those in the less immersive condition. Contrary to our hypotheses, immersive condition did not have a statistically significant impact on narrative engagement or empathy. Our findings replicate those of MacQuarrie and Steed [24], who found that narrative engagement in 360° video was higher when using more immersive technology, but the difference was not statistically significant. This lack of difference may indicate that immersive technology has a small but non-significant effect on narrative engagement and empathy. Alternatively, the findings could be due to the emotional valence of the piece. The plot features comical aliens coming to Earth and trying, and failing, to shoot a bunny with their lasers. If a more emotionally compelling story were used, perhaps with emotional features to which users can relate their own experience, differences between viewing platforms may have emerged. Finally, it is also possible that with a larger sample of participants, we may have seen a significant difference.

A major contribution of this study is that it investigated participants' beliefs about their role in the story. No information about the viewer's intended role was given prior to the viewing experience. Participants' comments after the film experience revealed variation in how they interpreted their role. Viewers in the more immersive VR headset condition were more likely to perceive their role as a character in the narrative, whereas those in the smartphone condition were more likely to see themselves as an observer. A subset of participants in both conditions were unsure about their role. One possible reason why immersive technology was associated with the viewer knowing they were a character is that the advanced headset offers increased spatial perspective, which enabled them to better understand their relative position within the scene [24]. It is notable that even though the content was relatively straightforward, and the creators made a

concerted effort to provide information within the story about the viewer's role, there was still confusion among viewers when no prior explanation was provided.

Role perceptions were not significantly associated with participants' experience of presence. This finding implies that one's feeling of presence in a virtual environment (*where* you are) is independent of one's role (*who* you are). Role perceptions were, however, significant predictors of narrative engagement and empathy. Participants who thought they were a character, compared to those who thought they were an observer, reported higher narrative engagement. One explanation could be that misunderstandings about one's role in the film interfered with engagement in the story. Busselle and Bilanzic [7] posit that narrative engagement in any media form can be hindered by discrepancies within the story. Understanding their role as a character in the story may have made viewers more likely to believe the events in the story and feel that the events related directly to them. Indeed, prior research demonstrates that engagement increases for viewers who have a body in the VR experience, even if the body is nonhuman [6, 14]. Although prior research has demonstrated effects on engagement for viewers who have virtual bodies, our results suggest that there may be other factors that impact viewers' overall engagement with an experience. Even when viewers in our study knew they had a body that did not necessarily result in them understanding they were a bunny nor did it necessarily impact their understanding of role.

During follow-up interviews, participants described situating themselves within the narrative by analyzing cues from one of the characters, the bunny. Participants who reported they were a character were significantly more likely to say that the bunny looked at or interacted with them. The same pattern was evident in participants' comments about the aliens, although it was not statistically significant. These comments suggest that a major cue for viewers about their role in a 360° film is their interactions with characters. Viewers may have had trouble following the gaze of the aliens, relative to the viewer's position, to know whether the aliens were looking or interacting because the bunny was situated just behind the viewer. Viewers also referenced the bunny's behavior as a cue (e.g., "It was hiding behind me!" or "It winked at me."). Participants tried to fit who they were into a pre-existing schema for how bunnies act (e.g., anxious, timid). One participant said, "I must've been some other being because the bunny was happy enough to hop up to me...most bunnies wouldn't be so inclined to come up to a biped like that." Additionally, viewers tried to figure out their size in relation to the bunny to conceptualize who they were. These cues may have contributed to viewers' understanding of their role. Blascovich and colleagues [6] noted that cartoonists have successfully created compelling characters because they understand that behavioral realism, meaning the ways that characters or objects interact with each other,

is more important than photo realism, or how characters look. Taken together, participants' comments about their interactions with the characters in the film suggest that these cues are a major part of the language that content creators need to develop to guide viewers through 360° video presented in an immersive medium.

The findings for this study highlight practical considerations for designers of 360° video content. Our findings suggest it may not be necessary to use expensive VR technology to experience empathy and strong engagement with 360° video, and that strong use of narrative techniques may be most important to make viewers understand their role and feel a part of the story. Without prior information (via trailer or description), viewers used contextual clues (e.g., character interaction) to make sense of their role. Importantly, viewers in the smartphone condition were more likely to believe they were an observer and those in the HMD condition were more likely to believe they were a character (even taking into account that some HMD users noticed their virtual body). This research prompts creators to further consider the clues, both visual and aural, that people use to understand their role in 360° content. Developers may consider ways to emphasize the viewer's role in stories where the viewer's role is less clear. Lastly, the findings of this study suggest that developers should consider narrative elements alongside their goals for the 360° content they are producing. For content where the goal is for viewers to have a role in the story, the more immersive headset may be preferable, and a smartphone or other low immersion platform may suffice for more passive content.

Limitations

Though the overall *Invasion* content was similar in both conditions, one aspect was different. In the VR headset the user could look down and see that they had a fluffy, white body. The developers' intention was that the viewer perceive themselves inhabiting a bunny body [12]. In most cases, the VR headset viewers didn't notice the bunny body and a few of those who did thought they were snowmen. However, this body cue was not available in the Smartphone/Low Immersion condition. On a smartphone, if the viewer looked down, they would simply see the virtual landscape. In order to investigate this potential confound more thoroughly we replicated the analyses after dropping the six participants in the High Immersion condition who mentioned the presence of the bunny body in their comments. None of the results with regards to presence, narrative engagement, or empathy changed. Though this is not a perfect approach, it suggests that our results were not affected by this potential confound.

Because this was an experimental study examining the contextual cues viewers use to situate themselves, it was important that viewers have no prior experience with or information about the content. The participants had to figure out what the stories were, where they were supposed

to be and who they might be in relation to the experience. In the real-world of 360° commercial content, it is perhaps less likely that this is how users would be exposed to content. Users of 360° video may read a description, even if it is just a few sentences, about the content prior to immersing themselves within it. However, there is evidence that even when viewing 360° content in which the viewer's role is intended to be relatively straightforward (i.e., passive observer), viewers struggle to make sense of their place in virtual social situations [29, 31]. Further exploration of if and how prior knowledge may impact narrative engagement and empathy within immersive experiences is warranted.

The other potential limitation of our study involves the use of a presence questionnaire (the PQ). Questionnaires assessing presence have been criticized as having flaws that render them less useful than other potential ways of measuring presence such as physiological indicators [14, 40]. Physiological measures were not appropriate for this type of content because it was unlikely to elicit strong alterations in heart rate or skin conductance, indicators most often used on more emotionally intense content [25]. Moreover, because we used a questionnaire measure for narrative engagement, it was very useful to use a parallel measure for presence. The PQ has been criticized for not being a comprehensive measure of presence [26, 35], however, it has been noted by the same researchers that questionnaires still represent an important tool for understanding presence.

Directions for Future Research

Further research is needed to look more closely at the types of contextual clues that designers of 360° video and other immersive content may provide to help illuminate viewers' roles. This study suggests that perceived interaction and gaze on the part of characters are important cues for the viewer. Indeed, *Invasion* employs state-of-the-art techniques that help make the viewer feel like they are interacting, even though true interaction is not possible. The inclusion of such effects that simulate interaction in virtual environments help to make the medium of 360° film, particularly in the advanced HMDs, a unique form of entertainment. However, more research is needed to understand these and other cues.

Relatedly, research on varying roles the viewer may have within the context of 360° film and how they impact engagement and comprehension is also needed. Is there a differential impact if a participant feels they are a character versus a passive observer? What are the possible variations within those categories? Nuances in participants' ideas about their role likely have an impact on engagement with stories and empathy for characters.

Conclusions

This study showed that, contrary to expectations, viewing a 360° video on a VR HMD with more immersive features did not necessarily encourage better comprehension of the

story, involvement with the narrative, or empathy with the characters compared to a less immersive smartphone platform. As technologies become increasingly immersive, the need for research on ways to help viewers engage with the stories and characters also increases. This research suggests that at least one criteria for engagement and empathy is for participants to have a clear grasp of their role within the experience. Immersive technology has vast potential for helping viewers experience new places and points of view. Creators of content such as 360° video viewed through immersive platforms will need to develop a set of tools that can be used to help viewers understand their intended role.

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