A User Study of Story Presence in an Immersive Narrative Experience tested with Variant Levels of Immersion

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Abstract— **Immersive narratives experienced in Head Mounted Displays (HMD's), whether involving real environments or computer generated, allow the participant to be visually immersed in the story. This study acknowledges three broad variables of immersion in narrative experiences: existence, experience, and environment. The narrowed focus of this user study is on employing perspective as a tool to test the effect of active and passive existence on the sensation of story presence. Two active permutations of a narrative story will be tested against a controlled passive experience using a subjective questionnaire to collect data and analyze the user's experience. The narrow treatment of the study is combined with a broad exploration and attempt to define the language for storytelling in immersive environments as compared to traditional cinema.**

I. Introduction

In recent years, many new emerging video formats and technologies have become available to storytellers. Each emerging technology will have a particular element that can aid a story. High frame rate, wide color gamut, and high dynamic range are prominent elements of emerging technology that are seeing increasing amounts of research and creative attention. The current study aims to bring visual immersion into the mix of emerging formats studied for cinematic content.

Immersive storytelling is a medium of expression that permits the participant to witness an enhanced sensation of "being there" in the narrative story. Immersive storytelling is not a new form of narrative expression. Rather immersive stories have existed throughout history, with their presence in theatrical production, literature, interactive web-based narratives, and within gaming. The current rise of immersive storytelling is tied to the rise of high-quality consumer-ready Head Mounted Display (HMD) technologies. These technologies are frequently considered to be virtual reality devices where *virtual reality* is a term used commonly to describe technology, content, applications, and environments. The broad usage of the term is not technically correct if following the definition of virtual reality that has existed since its origination in the mid 1900s. This study more formally classifies virtual reality as defined by Jason Jerald in "The VR Book" as "a computer-generated digital environment that can be experienced and interacted with as if the environment were real." [1]

This visual immersion provided by the HMD allows the participant to achieve a sense of presence, a sense of actually being there in a reality that is not their current reality. This general classification of presence could be achieved whether or not a narrative story is taking place. Therefore an alternate distinction is necessary to define the user's sensation of presence not only within the story environment, but also within the story narrative itself. This is called *story presence*. Story presence is a sensation that can be experienced in traditional cinema as well as immersive narratives. Traditional cinema does not use full visual immersion to induce story presence, yet rather a century of developing film language has explored and outlined composition, editorial, and other tools to emotionally immerse the viewer in the story.

Although this study was executed using 360-degree video content, the conclusions can be applicable to any immersive story experience that relies on visual immersion, which includes the spectrum of 360-degree video content to computer-generated VR content. For this study, a twelve-minute immersive story was captured and post-processed into three variations. Seventy-five participants were randomly shown one of the three variations and then answered a subjective presence questionnaire after experiencing the story in an HTC Vive. This survey collected data on general presence, and subscales of spatial presence, involvement presence, and story presence. The results of the questionnaire are used to evaluate the level to which each variation was able to induce a sensation of presence.

II. The Language of Immersive Storytelling

The purpose of immersive storytelling and the existence of immersive displays are to aid and enhance the sensation of presence. *Immersion* is an objective term related to technology that permits a sensation of presence. Contrasting to popular rhetoric, a person does not feel immersed, as immersion is not a sensation, rather it is an objective quality.

The correct alternative is a person feels present as a result of immersion. As outlined by Slater and Wilbur in 1997, "Immersion is the objective degree to which a VR system and application projects stimuli onto the sensory receptors of users in a way that is extensive, matching, surrounding, vivid, interactive, and plot informing." [2]

For each sense there is a range of quality of immersion. For example, visual immersion is measured by fidelity or vividness. [1] This originates from image resolution, dynamic range, frame rate, etc. Visual immersion is currently the most developed and accessible to creators, yet auditory, haptic, and olfactory immersive technologies are in development and will be available to creators in the future.

Presence in immersive experiences is the subjective sensation of being there as a result of the objective immersion utilized. Presence is best defined by the International Presence Research Society as "a psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience." [3]

Immersive stories have existed for years in interactive gaming and web applications. There is extensive theory on building story worlds, and recent VR evangelist Devon Dolan explores the vocabulary around immersive storytelling in his paper "Redefining the Axiom of the Story." [4] The diagram in Table 1 represents his division of experiences on a two dimensional grid based on classifications of influence and existence. A similar idea of immersive experience classification was explored by Kent Bye, host of Voices in VR podcast in the episode "The Four Different Types of Story in VR" with a similar two-dimensional approach based on classifications of impact on story and character presence. [5]

TABLE 1
REDEFINING THE AXIOM OF THE STORY BY DEVON DOLAN

INFLUENCE	EXISTENCE: OBSERVANT	EXISTENCE: PARTICIPANT
ACTIVE	OBSERVANT ACTIVE	PARTICIPANT ACTIVE
PASSIVE	OBSERVANT PASSIVE	PARTICIPANT PASSIVE

Observant vs. Participant: Defined by existence within the virtual world
Active vs. Passive: Defined by interactive influence with the story

Agency is the final term that is crucial for immersive experiences. Agency refers to the ability of the participant to interact with the story and the ability of their actions to produce a particular effect. Agency can be local or global. *Local agency* is when a participant can interact within a scene, and is able to alter minor elements of the experience. *Global agency* is when the character's actions and interactions permit them control to change the overall experience. A good metaphor is the experience of riding a train. Local agency would be if the train rider moved around within a train car to view different windows or even travel to different cars. Although the rider is changing their own perspective and experience on the train, the train is still going to its determined destination. Global agency would be if the rider on the train could ultimately alter the destination of the train. [5], [6] Only local agency to narrative storytelling is tested in this study.

III. ADAPTED CLASSIFICATION OF IMMERSION

Based upon background theory, an adapted classification of immersive storytelling experiences is illustrated in Table 2. The types of immersive experiences are outlined in three dimensions: environment, existence, and experience.

Environment relates to the visuals used to construct the experience. The environment can be divided into real and abstract. Real environments consist of live action footage or 3D generations that attempt to visually represent the real world. 3D generated, real environments follow the laws of physics and aim to achieve a heightened sense of realism. Abstract environments do not follow the physical laws of the real world and are environments that do not represent anything real.

Existence in an immersive story is either active or passive. Existence is related to the perspective provided through visual immersion. *Passive* existence is when the participant is simply a fly on the wall, an observer to the story. Passive existence in a visually immersive story is the closest equivalent to traditional cinema language, where the perspective of the story is told through various camera angles and cuts; it is a third-person perspective. *Active* existence can relate to actively perceiving the narrative from the perspective of a character in the story. This active, first-person perspective allows the participant to not just have a sense of being in a place, but a sense of being in the story as a character and a part of the narrative.

Experience pertains to agency; agency describes your ability to change your experience of the story. The description, *No Agency*, relates to an experience where the participant is given an input of sensory stimuli, yet the participant has no control over this input of stimuli. An experience with *Agency* refers to the participant's active ability to interact with the story either locally or globally.

TABLE 2
TYPES OF IMMERSIVE STORYTELLING EXPERIENCES

		EXISTENCE		
			EXPERIENCE	
		Passive	Active No Agency	Active with Agency
ENVIRONMENT	360 Video Real Environment	Fly on the Wall Perspective	Camera as Character Hoover or Mom (one stable perspective)	Camera as Character Hoover and Mom (User interaction swaps perspective)
	3D Generated Real Environment			
	3D Generated Abstract Environment			

IV. THE USER STUDY

A. *The Tested Immersive Narrative*

A key to immersive storytelling research is creating and testing with a story that benefits from and is enhanced by being told in an immersive format. The story tested was created so that variations of active and passive existence could be implemented. A full workflow for building a 360-degree narrative from pre-production to post-production was developed and implemented to create various versions of the story used for this study. The story was titled "You're My Best Friend" and is the story about a boy, Luke, and his imaginary best friend, Hoover.

The variations in existence relate directly to the placement of the camera during production. Each scene was captured from three camera perspectives shown in Figures 1-3. The three perspectives include: 1) POV of an arbitrary fly-on-the-wall, 2) POV of the imaginary friend, Hoover, and 3) POV of Luke's mom. The imaginary friend and mom perspectives are camera-as-character perspectives, which provide an active existence for the participant.

In post-production, the three captured perspectives were used to build three variations of the experience. The three variations are defined below and illustrated in Table 2 respectively.

- Passive with no agency (PNA): this variation uses only the fly-on-the-wall captured perspective illustrated in Figure 1. The participant has no agency and thus is incapable of altering the story. The participant can look around the 360-degree captured scenes but is never directly treated as a character or interacted with in the story.
- Active with no agency (ANA): this variation uses only the imaginary friend perspective from Figure 2. The perspective permits consistency so the participant can identify spatially and emotionally as the character.
- Active with agency (AA): this variation uses active perspectives of both the imaginary friend and the mom from Figure 2 and Figure 3. The participant had local agency, as they were able to switch between the two camera-as-character perspectives using a handheld remote control. Each perspective permits the participant to understand the story and the main character, Luke, in different ways.

Figure 1. Passive existence from fly-on-the-wall perspective. This perspective is invisible to the characters in the story.

Figure 2. Active existence from the Hoover (imaginary friend) perspective. In Luke's imaginary world, Hoover is an injured owl that he wheels around in his wagon. The wagon acts as a reference object and form of identity while participants view the story from this perspective.

Figure 3. Active existence from the mom's perspective.

Figures 1-3 contain screenshots of all three captured perspectives during one scene. This is a birthday party scene where simultaneous action maximizes the potential of each perspective. Luke is in a room with other children attending the party, yet he is isolated in the corner gesturing and speaking to Hoover, his imaginary friend, who he believes is in the wagon. In an adjoining room, the mother sits at a table conversing with a friend. She is having a conversation about Luke and her concern towards his attachment and belief in his imaginary friend. The PNA variation provides a central location to passively experience both conversations happening where Luke is in the corner to the right of the image in Figure 1, and the mothers are visible if the participant looks to the left. The ANA variation experiences this scene from the perspective in Figure 2, where Luke is gesturing to and engaging with the camera as Hoover. The AA variation allows the participant to experience the closeness and friendship of Luke in the Figure 2 perspective, or they may choose to switch to the mom's perspective in Figure 3, and gain understanding of her thoughts and concerns. This is just one scene layout demonstrating the differing experience for the three variations.

B. The Presence Questionnaire

Presence can be tested objectively via physical measurements such as participant heart rate or subjectively through exploratory questionnaires. [7] [8] Only subjective measurements were taken for this study.

The presence questionnaire was constructed based on various standardized and commonly used subjective scales for researching presence in virtual environments. The three primary influential and referenced questionnaires are from 1) Slater, Usoh, and Stein (SUS) [9] [10], 2) Witmer and Singer

[11], and 3) the I-Group [12]. The tested questions for the current study were either selected from these examples or created originally based on their applicability to research on storytelling. The I-Group Presence Questionnaire subcategorized its questions into spatial, involvement, and realism domains. [12] This same model was applied to the developed questionnaire for this study.

In Table 3, the structure of the study's questions is outlined. The questionnaire contains fourteen questions divided into four types of presence: general presence, spatial presence, involvement presence, and story presence. Except for general presence, the three other subcategories contain multiple questions. The *General presence* category contains a question that originated from the SUS questionnaire and asks the participant to rate their general sense of being there. *Spatial presenc*e is the sense of physically being present in the story settings/locations. *Involvement presence* relates to the involvement experienced and is a measurement of the mental attention devoted to the experience. *Story presence* is the sense of presence not just spatially in the environment, but also within the story narrative itself. This relates to emotional understanding of the story.

C. The User Study Testing

The user study was conducted with 75 participants. There were 21 participants who experienced the PNA version, 23 participants who experienced the ANA version, and 31 participants who experienced the AA version. The version was randomly assigned until at least 20 participants had completed each permutation. The entire immersive experience was twelve minutes long. Each version of the immersive story was presented to the participant with a desktop application for the HTC Vive, which was developed in Unity. The interaction of swapping perspectives in the AA version was implemented using the trigger button on the Vive hand controllers. The participants were presented the experience and upon completion were instructed to take off the HMD and to take the presence questionnaire. The participants answered each question by selecting a value on the provided Likert scale.

TABLE 3
PRESENCE QUESTIONNAIRE

Presence Type	Questions	Likert Response Scale (1-7)	p-value
General Presence	Please rate your sense of being in the story, on a scale of 1 to 7, where 7 represents your normal experience of being in a real place or location.	not at all -- very much	0.076
Spatial 1	I felt like the rooms surrounded me.	fully disagree -- fully agree	0.023
Spatial 2	When I think back to the experience, I think of the locations of the story more as images that I saw rather than somewhere that I visited.	images I saw -- somewhere I visited	0.163
Spatial 3	I did not feel present in the story setting/location.	did not feel -- felt present	0.087
Spatial 4	I had a sense of being in the scene, rather than watching it from the outside.	fully disagree -- fully agree	0.001
Spatial 5	I felt present in each scene.	fully disagree -- fully agree	0.005
Involve 1	How aware (mindful) were you of the lab room you were in while experiencing the immersive story? (i.e. sounds, room temperature, other people, etc.)?	extremely aware -- not aware at all	0.08
Involve 2	Were you involved in the experience to the extent that you lost track of time?	not at all -- very much	0.603
Involve 3	I was completely captivated by the experience.	fully disagree -- fully agree	0.014
Involve 4	To what extent were you able to ignore any thoughts that were separate from the story?	not at all -- very much	0.052
Story 1	To what extent were there times during the experience when the story was the reality for you?	at no time -- almost all the time	0.006
Story 2	How real did the events seem to you?	not real at all- - completely real	0.243
Story 3	How much did your experience of the story seem consistent with your real world experience?	about as real as an imagined world -- indistinguishable from the real world	0.384
Story 4	To what extent was your emotional response to events consistent with real world experiences	not at all -- very much	0.198

D. The User Study Results

The resultant magnitude of presence for each question is computed for all three variations. These results are visualized in the charts in Figure 4 to illustrate the similarities and differences between the PNA, ANA, and AA variant immersive experiences.

Overall, the AA variation resulted in a higher sense of presence across all delivered questions. The PNA experience resulted in a consistently lower scale of presence. This overall result is apparent in the responses to the initial general presence question summarized in Figure 4a. Table 3 is also used to summarize the results of ANOVA testing for statistical significance in mean response differences among the 3 experience variants evaluated. With a p-value of 0.076, the difference in mean response amongst the PNA, ANA and AA variants are borderline for statistical significance in general presence.

For spatial presence, the ANA and AA responses have a similar magnitude for mean spatial presence for the SP1, SP3, and SP5 questions. For SP1, the participants rated the statement 'I felt like the rooms surrounded me.' The average responses for each variation were quite high with the means equal to or above 6.0. This was the only question in the questionnaire that resulted in such high marks for all variations. The question very directly relates to visual immersion, so a high magnitude of presence speaks to the success of the immersion in yielding a sense of spatial presence. With a p-value of 0.023, these variant means are also statistically different from one another.

SP5 also yielded similar means for ANA and AA variants. In SP1, all variant results were high as they were visually immersed, and the room was in fact surrounding them visually. Contrasting to the objective nature of the SP1 question, the SP5 question asks directly about the subjective sense of presence in the scene. In SP5, the PNA response was significantly lower than AA and ANA with a mean of 5.0. It is apparent that the active existence as a character in the story, leads to an increased sense of spatial presence in the scene.

SP4 asked the participant to respond to the statement 'I had a sense of being in the scene rather than watching it from the outside.' The ANA variation had the highest spatial presence marks for this question. For the PNA variation, the participant is essentially watching the story as an outside observer, so this likely lead to the low spatial presence score for this question. For the AA variation, the participant views the story from character perspectives, but the interaction and ability to

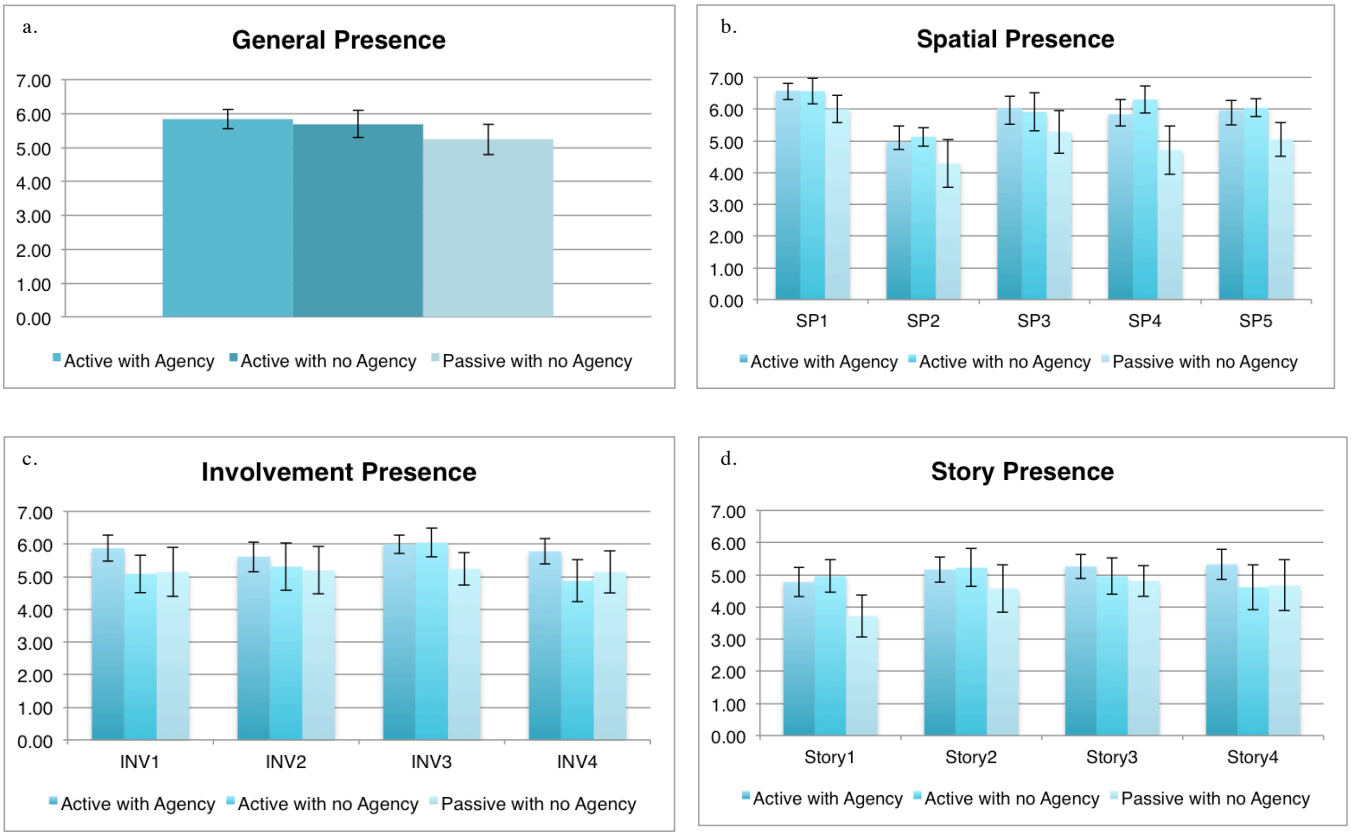

Figure 4. The visualizations of the Presence Questionnaire data of 75 participants. For each question, the mean response was computed for each variant: passive no agency (PNA), active no agency (ANA), and active with agency (AA).

transport spatial locations in the scene, could result in the sense of being an outsider choosing which window to watch the story from. For the AA version, participants commented following their experience that sometimes they felt lost or disoriented after swapping perspectives. This verbal response supports the lower spatial presence results for AA in comparison to ANA.

In the INV3 question, the participants rate their agreement with the statement 'I was completely captivated by the experience.' The ANA and AA results were equivalent for this question with mean responses of 6.0. This shows how active existence yields a higher sense of involvement presence than the passive existence in the PNA variation with a mean of 5.2. In the ANA and AA variations, characters are directly interacting with the participant, and this direct attention likely enhanced how captivating the experience was. The difference in mean response for the three variations is statistically significant with a p-value of 0.01.

Unlike SP4, where the interactivity could have negatively affected spatial presence, in INV1 and INV4, the participant responds to their ability to ignore other thoughts that were separate from the story. The interactivity in the AA variation caused the participants to be both focused on the story as well as the decision of when to switch perspectives. The focus on these two thoughts rather than just on watching the story as in PNA and ANA likely led to their increased sense of involvement and ability to lose track of time. INV1 and INV4 mean differences have borderline statistical significance with p-values of 0.08 and 0.052

For Story1, the participants rate how real the events seem to them. The ANA response of 4.96 and AA response of 4.77 are very close. This likely is related to their active existence of being a character in the story, rather than being a fly on the wall. The PNA falls short with a low response of 3.71. The PNA experience is much more similar to traditional cinema and other storytelling mediums where the participant is just a passive observer to the events. With a p-value of 0.006, the resultant difference between variants is statistically significant.

Contrasting to the significance of Story1, the remaining story questions are not statistically significant with p-values 0.198 and greater. Although Story4 resulted in in a p-value of 0.198, the results and comments from this specific sample provide an interesting insight into the potential of stories with agency. In Story4, the participant was asked 'to what extent was your emotional response to events consistent with real world experiences.' The AA mean response is higher than for both ANA and PNA. The PNA and ANA versions provide an experience that is similar to traditional film where the director controls your perspective and almost forces a certain view of the story, rather than permitting the viewer to decide for themselves. Opposing, the local agency in AA permitted the participant an ability to explore the story; this choice and greater empathy allows the participant to build their own conclusions on events in the story. Following the study, AA participants frequently stated that they enjoyed the ability to edit their own experience.

Overall, this sample of participants rated the PNA perspective with lower marks of presence than the versions with active existence (ANA and AA). These results suggest and support that approaching immersive storytelling similarly to traditional cinema, where the participant is just an outside observer, does not maximize the element of presence that makes this format different from traditional formats. Between the two active existence versions (ANA and AA), there is not sufficient data to suggest that one is a better approach to immersive storytelling. Rather the similarity of results may suggest that both are valid approaches to using visual immersion. There are stories that would benefit from agency and interactivity to explore multiple perspectives allowing the participant to direct and edit their own experience. Yet there is also validity in ANA approaches. Many stories can benefit from the consistent perspective of one character; this allows the participant to become emotionally attached to the character and this attachment can aid the story presence.

V. Conclusion

The complete language of immersive storytelling remains an evolving field of research. The remaining uncertainty in this space is paired with the unknown future and speed of developments regarding immersive technology. Thus the future of immersive storytelling will likely far surpass the 360-degree monoscopic capture utilized in this study. The focus of this study was not on the future of the technology, rather it was on executing critical thinking and well-thought research to raise more questions and hopefully provide some insight and best practices for the use of perspective in crafting visually immersive stories.

There are innumerable future studies that can be developed based off of the immersive distinctions of experience, existence, and environment. Additionally, throughout the process of this study, traditional cinema and immersive narratives were compared and contrasted. Future work should test story presence in a story told both as traditional cinema as well as an immersive narrative. This would provide insight into the type of presence experienced in each and would conclude whether the specific story used in the study is benefiting from the visual immersion technologies.

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