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Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience?

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ABSTRACT

This study investigates the user experience to clarify what it is like to experience stories in VR (virtual reality) and how immersion influences story experiences in immersive storytelling. This study explores the immersive storytelling context, developing and testing a VR experience model that integrates presence, flow, empathy, and embodiment. The results imply that users' personal traits correlates immersion in VR: user experience in VR depend on individual traits, which in turns influence how strongly users immerse in a VR. The way users view and accept VR stories derives from the way they envisage and intend to experience them. Rather than simply being influenced by technological features, users have intentional and purposeful control over VR stories. The findings of this study suggest that the cognitive processes by which users experience quality, presence, and flow determine how they will empathize with and embody VR stories.

Virtual reality (VR) is often used in storytelling. As it is considered an effective medium for interactive storytelling, the industry seems keen to introduce an interactive element into every VR piece. VR storytelling allows the user to enter a virtually recreated scenario that represents a story. Stories are produced as computer graphic virtual environments, which can be inserted into online virtual worlds and watched either conventionally on a monitor, or via fully immersive systems such as head-tracked display. VR is redefining the rules around narrative structure, character development, and storytelling. The goal of VR storytelling is to tell a story that will stimulate emotions that will influence action (Shin, 2017). The VR and storytelling industries, taken together, expect the availability of VR devices to improve user experiences (UXs) because higher levels of immersion or presence will enable users to experience the feeling of being in another location while watching content and using services (McMahan, Lai, & Pal, 2016).

Despite high expectations and popularity, it remains unclear whether users genuinely feel presence and flow during immersive experiences, whether immersion influences cognition, and in what ways the UX is improved by new forms of heightened immersion. Although the word is widely used, "immersion" has not been precisely defined or explained with users. This term has become even more ambiguous in the emerging domain of VR storytelling. It is therefore unclear whether immersion has an impact on the degree to which users assign meaning to stories (empathy) or to objects encountered in a mediated environment (embodied cognition). To ensure a successful rollout of VR storytelling, it is critical to understand how users perceive the value of a VR story, how empathies are formed, how value perceptions influence action, and what users appreciate about their experiences at an underlying level. To ensure that a future rollout of VR is successful, it is important to understand how average users encounter VR stories and how they react overall. To address this issue, the present study tests a VR experience model on four different groups, examining how the immersion and empathy tendencies influence and/or are influenced by presence and flow in the VR story process. By exploring users' cognitive processes, this study aims to determine what it is actually like to experience a story in VR, focusing on the following research questions (RQs):

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RQ1. How does immersion relate to human traits of empathic behavior in VR stories?

RQ2. How do the human tendencies of immersion and empathy perceive presence and flow differently?

RQ3. How do users perceive immersion and how does immersion influence empathy in VR stories?

The findings in this study suggest that immersive interfaces do not necessarily enhance the sense of engagement or satisfaction (e.g., Hamari et al., 2016; Trentini, 2015). Instead, these findings highlight a new role for immersion, as redefined through user responses. The meaning of immersion depends on user traits and contexts; the function of immersion is strongly dependent on user sense-making and intention (Reinhard & Dervin, 2012). While this argument is similar to the one by Weibel, Wissmath, and Mast (2010), which confirmed the correlation of user personality and immersion in general VR, this study focuses on the specific user traits (empathy) and particular storytelling consumption context. In doing so, it examines how engagement converges and diverges, exploring the qualities that define VR and make it a uniquely engaging experience.

Users view and accept VR stories in the way they imagine and want to experience them. Although providers design VR constructs and develop stories, ultimately, it is the users who must engage with those stories. This argument highlights the active aspects of immersion and its dynamic relationship with user cognition. The importance of immersion mainly comes from user cognition, rather than being pre-embedded within technological properties or existing (separate) entities (e.g., Shin, 2016).

The results of this study contribute to ongoing research in two aspects. First, the VR model advances current immersion research and the user research by identifying key variables (immersion) and clarifying their underlying relations. As VR storytelling rapidly develops, traditional technology-based frameworks must be modified to reflect the heterogeneous and complex nature of user preferences. Although the concept of immersion is widely used to describe VR, it is not clear what immersion is—or how people actually experience it. In the VR context, a series of questions remains unanswered, regarding how users feel about the stories they experience via VR, how immersion influences performances and values, and how users react to their VR experiences. This study clarifies the cognitive processes of users, i.e., how they perceive technological properties, how immersion elicits user confirmation, and how technological cues trigger empathy and embodied experiences. It concludes that user roles are active in adopting, consuming, and experiencing VR stories. These arguments have implications for heuristic-based usability and users' cognition-evaluations, which enable us to make meaningful claims about the VR implications of UX frameworks (e.g., Bailey, Bailenson, & Casasanto, 2016).

Second, this study can provide guidance on interaction and interface design for VR and related virtual services. The findings offer practical guidelines that can help VR industries develop storytelling service evaluation frameworks capable of determining the adoption potential of new VR-related services. The industry is working to ensure that content is more enjoyable and engaging (Aronson-Rath, Milward, Owen, & Pitt, 2015). As VR content clearly represents a specific market segment (Bachen, Ramos, Raphael, & Waldron, 2016), a thorough user analysis is essential for achieving successful implementation and diffusion (Shin, 2016). The cognitive model derived from this study can be used to develop such a framework; it can be applied to services that are primarily functional, as well as to those that are specifically directed at user motivations and attitudes. The findings of this study should be useful to firms attempting to increase VR adoption and to understand the factors affecting attitudes and intentions. The results should prove valuable for market researchers engaged in VR and storytelling, as they face the challenge of developing improved immersion and empathy indicators on which to base numerous user-based interaction and interface design decisions. The key to developing great VR stories is the medium's adoption by consumers, something that may be difficult to achieve.

1. Literature review

1.1. Virtual reality storytelling

VR is a computer-generated experience that can simulate physical presence in real or imagined environments (Kerrebrock, Brengman, & Willems, 2017). The wide diffusion of VR technologies has created a trend: delivering stories through VR. VR has the potential to support incredibly complex narratives, tailored to promote complex viewer interactions. Put simply, users feel they are present in VR; they are dropped right into a scene, as if they were part of the story. Immersion and presence are terms used to describe an experience in which the line between reality and imagination is blurred. Reactions to stories are much more emotional. People get sick during fast motion videos and horror stories filmed in 360°. Yet storytelling in VR is much more than just getting out of the way when taking a 360-degree shot. With VR, users have a 360-degree canvas to step *into,* instead of passively watching a narrative unfold from *outside* the frame. This new canvas has the potential to make storytelling truly immersive—but it is no easy feat to design stories for this type of experience.

VR has become a popular means of telling stories and bringing the world closer to audiences. VR storytelling can be an effective tool for sharing experiences. In a virtual environment, viewers who are close to characters, and sharing the same space, may feel their emotions or situations more strongly. To absorb oneself in VR can stimulate empathy. Stimulated empathy with others in VR can make the virtual environment seem more realistic to users. *The New York Times*, for example, created a VR project on child refugees: *The Displaced* (Fig. 1). Paired with photographs and text were VR video portraits of three refugee children in South Sudan, Ukraine, and Lebanon. Instead of taking audience members from one place

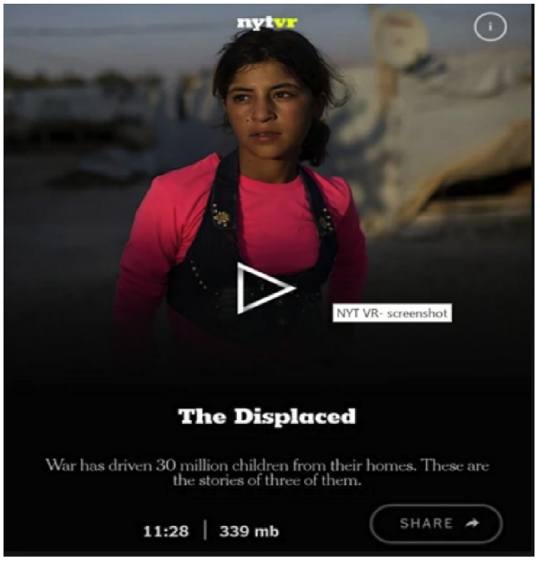

Fig. 1. *The Displaced* virtual reality film (from New York times VR).

to another along a distinct storyline, *The Displaced* grounded users in particular environments—a moment in each child's life. It was a powerful experience, triggering user empathy.

1.2. Theory of empathy

As the case of *The Displaced* illustrates, empathy appears to be the most important factor in VR. It is probable that VR can be used to make people care about groups such as refugees, the homeless, and those with physical and mental impairments. Empathy and embodied cognition are two concepts that frequently arise in discussions of VR and storytelling (Shin & Biocca, 2017). VR storytelling triggers an embodied experience in an unchangeable narrative that allows queries of the environment without altering any individual's story trajectory. Users of VR are able to embody experiences by viewing, game playing, and feeling perceptual cues linked to those experiences (Shin & Biocca, 2017). Embodied experiences create the sensation of personally having the VR experience. Users who embody avatars tend to perceive avatar actions as their own. In addition to embodiment, people can understand and empathize more when they comprehend another person's subjective experience and environment. VR content stimulates empathy, allowing people to understand others. Empathizing can help to more strongly combine VR and physical reality, thus producing higher credibility (Beadle, Brown, Keady, Tranel, & Paradiso, 2012).

VR can convey another person's experience or feelings to a viewer. In VR environments, viewers may strongly feel another person's emotions or situation by being in the same space, close to that character. Becoming absorbed by VR can stimulate empathy. Stimulated empathy in VR can increase a user's overall empathy and the perception that a virtual environment is realistic. Through empathy, users can feel a sense of embodiment or embodied cognition based on the stories. Kliteni, Groten, and Slater (2012) argue that VR users create a virtual body inside the immersive virtual environment as an analog of their own biological bodies. In other words, the embodied cognition in VR helps users feel a sense of embodiment (Hofer, Husser, & Prabhu, 2017). VR does not merely make users feel—it also changes who they are in the virtual space. Fully immersive VR offers a sense of embodiment, in which users see themselves as part of the VR environment. At the same time, users feel that VR components are parts of their own bodies (Bailey et al., 2016).

2. Study design

2.1. Participants

Participants were gathered voluntarily from different sections of various college courses related to VR, games, and new media. The number of participants was set at 200, so that four different models could be compared by 2 × 2 groups (Table 1).

The participants either watched content-based VR news while wearing a head mount display (HMD), or saw the same stories on a flat-screen TV. The news clips were approximately 10 min long; they featured a story about contemporary social issues. The news clips (*The Displaced*) were selected from contemporary news coverage. *The Displaced* is a VR story created by the New York Times. It is an 11-min long narration of the stories of three refugee children forced from their homes by tragic wars. The documentary can be readily watched on a smartphone, tablet, app, or website such as YouTube. The documentary was selected for this study as it touched on highly empathetic issues and was widely accepted and acclaimed.

Within the story clips presented via a VR headset, participants could control the news coverage sites using 360-degree controllers.

Table 1
Sample demographics of survey (N = 200).

Characteristics	Frequency	Percentage	Mean	S.D.
Age			31.17	3.19
Under 19	11			
20–30	89			
31–40	78			
41–50	22			
Gender				
Female	100	50.0		
Male	100	50.0		
Prior experience			1.7 months	4.21
1–2 months	95			
2–4 months	87			
4–6 months	13			
Over 6 months	5			

	Empathy	
Immersion	Group 1: high immersion and high empathy	Group 3: high immersion and low empathy
	Group 2: low immersion and high empathy	Group 4: low immersion and low empathy

The 3D immersive technologies created a sense of being in a different location, and gave viewers the opportunity to emotionally engage with the story. By experiencing a virtual version of the story location as a witness/participant, and by feeling the perspective of a character depicted in the story, users received specialized access to the sights and sounds (and even to the feelings and emotions) associated with the story.

A 2 × 2 between-subject survey was designed for this study; it consisted of two levels of immersion (VR-content-based and flat-screen-TV-based), and two personality traits (high empathy trait and low empathy trait). In the high immersion group, people watched the story wearing VR headsets, such as the Samsung HMD and Google Cardboard models used for VR-content-based delivery. In the low immersion group, people watched the story on normal TVs, websites, and apps. Empathy levels were divided into high empathy and low empathy groups. The trait tests were composed of five questions about tendencies and attitudes, adopted from the empathy score used by Beadle et al. (2012).

2.2. Scales and measurements

Presence was measured using items from the engagement subscale designed by Shin (2013). Flow was measured using items developed by Bachen et al. (2016). Empathy and embodiment were measured using questions drawn from Shin and Biocca (2017). Engagement was measured using items proposed by Wiebe, Lamb, Hardy, and Sharek (2014). The final scales used in this study consisted of fifteen items, with three items per factor. The initial questionnaire was developed, based on these previous studies (Shin & Biocca, 2017).

A pretest was undertaken to examine test-retest reliability and construct reliability before conducting the fieldwork. Twenty college students with some knowledge and experience of VR applications participated in the pretest within a two-week interval. After the pretest, a final sample was used for data analysis. Cronbach's alpha test was employed to identify poor item-to-total correlation measure items. After eliminating items that failed the test, retest, or alpha test phases, the remaining items were measured using Cronbach's alpha, the scores for which ranged between 0.79 and 0.89, suggesting satisfactory construct reliability (Table 2). The convergent and discriminant validity of the model was examined using a procedure suggested by Fornell and Larcker (1981). A confirmatory factor analysis (CFA) was performed to examine the

Table 2
Convergent validity and internal consistency reliability.

Variables	Cronbach's alpha	AVE	Composite reliability
Presence	0.8710	0.642	0.884
Flow	0.7995	0.631	0.854
Empathy	0.8002	0.722	0.923
Embodiment	0.8521	0.724	0.912
Engagement	0.8922	0.645	0.925

convergent validity of each construct; this analysis showed that most items had factor loadings greater than 0.8, which is considered very significant by Fornell and Larcker (1981). Other items ranged between 0.7 and 0.8, a level also considered significant by Fornell and Larcker (1981). Most items had factor loadings with greater absolute values than those of the original model. To determine validity, a test of correlation among the factors was conducted to measure the reciprocal relationships between them. A simple linear correlation (Pearson's r) was employed to determine the extent to which variable values were proportional to each other. The generally modest inter-correlations among variables indicated no significant multi-collinearity problem. In addition, the square root of the average variance extracted (AVE) from the construct was much larger than the correlation between the construct and other constructs in the model. To assess how well the model represented the data, five goodness-of-fit indices were evaluated: the χ^2 test statistic, the goodness-of-fit index (GFI), the normed fit index (NFI), the root mean square error of approximation (RMSEA), and the comparative fit index (CFI). The relative chi-square (χ^2/df) was below the desired value of 5.0. All of the goodness-of-fit indices were within acceptance levels. The internal consistency of the three scales was also strong, as indicated by the coefficient alpha.

3. The model and hypotheses

The VR cognitive model postulates two constructs that (directly or indirectly) influence empathy and embodiment, which then influence user engagement (Fig. 2). In applying this integrated model to a technology-mediated environment, flow and presence were posited as antecedents to empathy and embodiment, which were considered to be key drivers of VR experience (see Fig. 3).

3.1. Presence and flow

While some researchers consider presence and flow to be similar (e.g., Bystrom, Barfield, & Hendrix, 1999), there are clear differences between the two. Presence can be immersion into a virtual space, whereas flow can be an experience of immersion into a certain user action. In this study, presence was associated with the technological features of the medium, and flow with user task characteristics.

The concept of presence refers to the extent to which two people interacting via a technological medium feel as if they are together (Nicovich, Boller, & Cornwell, 2005). Since its initial conceptualization, presence has been defined as a technology user's awareness of another person in a mediated environment. Since the emergence of VR, the concept has been understood as a feeling of being connected to other social users. Presence can be viewed as a state of mind, whereas immersion is an experience over time (Jennett et al., 2008). Using the results of an experiment, Bracken (2005) has argued that improved image quality leads to viewers experiencing increased presence.

H1. Presence has a positive effect on the embodiment of VR.

H2. Presence has a positive effect on empathy within VR.

Flow is related to presence; it is a state of profound enjoyment and concentration experienced during activities or performances (Teng, 2010). While flow has been extensively used in game studies (e.g., Nah, Eschenbrenner, Zeng, Telaprolu, & Sepehr, 2014), it can also be a significant predictor of VR experiences and outcomes (Faiola, Newlon, Pfaff, & Smyslova, 2013). According to flow theory, people experience flow when an activity's challenges fully engage their skills, without overwhelming them. VR that promotes flow has been theorized to increase users' motivation to play and thus to increase playing (Bachen et al., 2016). In VR environments, achieving a flow experience is an important goal (McGloin, Farrar, & Fishlock, 2015). Previous studies have found that flow has a positive influence on user engagement (e.g., Hamari et al., 2016; Jin, 2012). This study posits a cognitive model to investigate the effects of flow experiences on engagement.

H3. Flow has a positive effect on user engagement in VR storytelling.

Presence will positively contribute to flow. The more users feel immersed in the simulation experience, the more likely they are to enter a state of flow, as they complete tasks (e.g., Jin, 2012). As users become more involved and absorbed, it follows that they will identify more with the main character, express greater empathy afterwards for the people in the story, and be more interested in understanding the issues those people face (Shin, 2017).

H4. Flow is influenced by presence in VR storytelling.

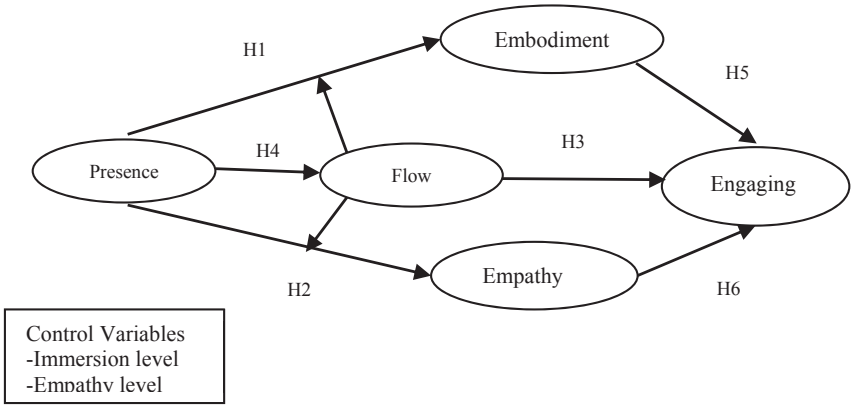

Fig. 2. Research model.

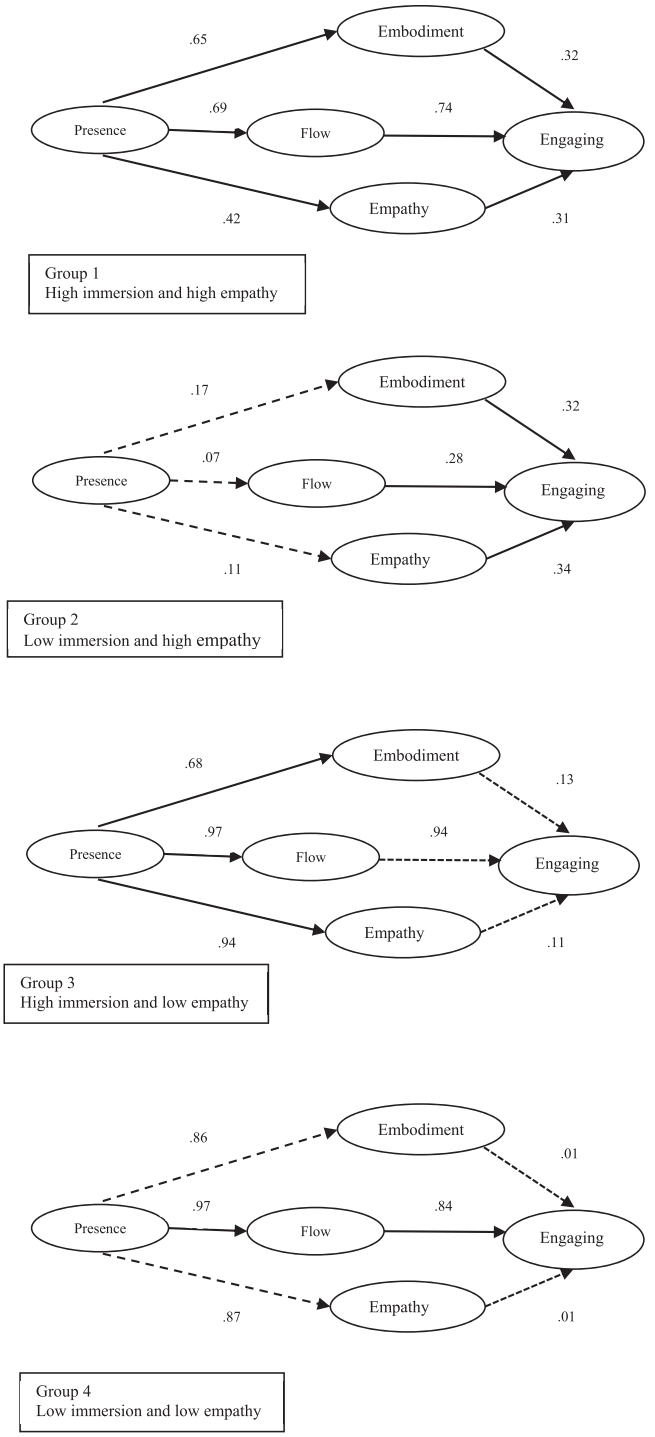

Fig. 3. Group differences in the models (dashed lines indicate non-significance and solid lines show that the coefficient is significant at a level of 0.05 or higher).

3.2. Embodiment and empathy

Arousing empathy and embodiment has almost always been at the core of storytelling (Kliteni et al., 2012). In VR, storytellers have found a new tool to give viewers an even closer physical sensation of another person's lived experience. Empathy and embodied cognition are two concepts that frequently arise in discussions of VR and storytelling (Shin & Ahn, 2013). VR stories trigger an embodied experience in an unchangeable narrative that allows the environment to be queried without altering any individual's story trajectory (Bailey et al., 2016). Users of VR are able to embody experiences by viewing, playing, and feeling perceptual cues linked to those experiences (Shin & Biocca, 2017). Embodied experiences create the sensation of personally having an experience in VR (Trentini, 2015). Users who embody their avatars tend to perceive avatar actions as their own (Hofer et al., 2017). In addition to embodiment, people can understand and empathize when they comprehend another person's subjective experience and environment. VR content stimulates empathy between people: it allows people to understand others. Embodied cognition acknowledges that the mind and body are agents working together to make meaning of VR experiences.

VR can convey another person's experience or feelings to a viewer. In VR environments, viewers strongly feel another person's emotions or situation by being in the same space, and close to that character. Becoming absorbed in VR can stimulate empathy. Stimulated empathy in VR can make users perceive a virtual environment as a more realistic and generally empathic experience. Through empathy, users can feel a sense of embodiment or embodied cognition based on the news stories. A VR user creates a virtual body inside the immersive virtual environment as an analog of his or her biological body (Kliteni et al., 2012). In other words, the embodied cognition in VR allows users to feel a sense of embodiment (Shin & Biocca, 2017). VR storytelling does not merely make users feel—it also changes who they are in the virtual space. Fully immersive VR can offer users a sense of embodiment, through which they see themselves as part of the VR environment. At the same time, users feel that the VR components are parts of their own bodies (Trentini, 2015). Thus, the following hypotheses are proposed:

H5. Embodiment has a positive effect on engagement when experiencing VR storytelling.

H6. Empathy has a positive effect on engagement when experiencing VR storytelling.

4. Findings

Table 3 describes the means, standard deviations, and correlations among all key variables in the model. These data show that the VR story successfully induced high levels of presence and flow. The means also show that the sample had high initial levels of empathy and expressed almost equally high levels of empathy for the displaced people after watching the story, as well as high levels of embodiment in the story scenes, despite substantial variation among the four different groups.

4.1. Results from the overall hypothesis testing

The results of the hypothesis tests show that all of the hypotheses were supported at relatively high levels of significance. As hypothesized, presence positively influenced embodiment and

Table 3
Means, standard deviations (SD), and correlations.

	1	2	3	4	5	M	SD
Presence	–					4.22	1.15
Flow	0.212 *	–				4.42	1.25
Empathy	0.334**		–			4.30	1.16
Embodiment	0.482***	0.524***	0.531***	–		4.45	1.13
Engagement	0.135	0.315**	0.382**	0.452*	–	4.20	1.27

Note: * = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.001$.

empathy (H1 and H2). The participants' perceived presence in the story was positively correlated with embodiment (r = 0.482, $p = 0.000$; R^2 from linear regression = 0.1345) and with empathy (r = 0.334, p = 0.000; R^2 from linear regression = 0.2924). Presence did positively contribute to flow (H4) with a positive correlation (r = 0.212, $p = 0.05$). Presence explained 21.11% of the variance in flow. The third hypothesis, that flow would positively influence engagement, showed good support (r = 0.315, $p = 0.000$, 15.36% of the variance explained). Finally, the study found strong support for H5 and H6, which proposed that embodiment and empathy would positively contribute to engagement in story. Engagement was significantly related to embodiment (r = 0.452, $p = 0.000$, 25.32% of variance explained) and to empathy (r = 0.382, $p = 0.000$, 18.9% of variance).

4.2. Results related to group differences

Structural equation modeling was used to analyze the impact of all of the variables together in the model. Given the whole sample (n = 200), the data were a good fit for the model ($X^2(3) = 2.41$, p = 0.438, RMSEA = 0.0000, SRMR = 0.019), using goodness-of-fit criteria suggested by Hu and Bentler (1999). Results showed that presence had a significant effect on flow (Std. Coeff. = 0.26, $p = 0.000$). Presence also had a significant effect on empathy and embodiment (Std. Coeff. = 0.34, $p = 0.000$). The hypothesized positive influence of empathy and embodiment on engagement was confirmed (Std. Coeff. = 0.29, $p = 0.000$; Std. Coeff. = 0.45, $p = 0.007$). Flow had a significant effect on engagement as well (Std. Coeff. = 0.37, $p = 0.0005$). For the sample as a whole, all paths were found to be significant. It is interesting to examine whether the model accounts equally well for the experiences of users at each level, and in each empathy category.

Overall, the data were a good fit for the model (Group 1 n = 50, X2(3) = 2.96, $p = 0.175$, SRMR = 0.041; Group 2 n = 50, X2(3) = 1.641, p = 0.521, SRMR = 0.014; Group 3 n = 50, X2(3) = 1.344, $p = 0.430$, SRMR = 0.013; Group 4 n = 50, X2(3) = 1.232, $p = 0.620$, SRMR = 0.020). Four major differences that emerge from a comparison of these analyses are worth noting (see Fig. 4a and b). First, in Groups 1 and 2, presence was a significant predictor of both empathy and embodiment, but only for Group 1 did it significantly influence engagement (Std. Coeff. = 0.18, $p = 0.027$). In Group 2, empathy and embodiment did not significantly influence engagement. Second, for Group 1, flow was significantly influenced by presence (Std. Coeff. = 0.59, $p = 0.000$); this was not the case for Group 2 (Std. Coeff. = 0.15, n.s.). Third, for Group 3, presence did not influence empathy and embodiment (Std. Coeff. = 0.15, n.s.; Std. Coeff. = 0.21, n.s.), whereas flow did significantly influence engagement (Std. Coeff. = 0.59, $p = 0.000$). Embodiment and empathy did moderately influence engagement (Std. Coeff. = 0.28, $p = 0.047$; Std. Coeff. = 0.29, $p = 0.036$). Finally, for Group 4, the effects of presence and flow on empathy and embodiment were insignificant (Std. Coeff. = 0.22, n.s.; Std. Coeff. = 0.19, n.s). The effects of empathy and embodiment on engagement were also not significant.

In sum, these models showed notable group differences. High immersion groups (Groups 1 and 3) generally showed immersion effects on flow; in high empathy groups (Groups 2 and 4) empathy and embodiment had a significant effect on engagement. These results suggest that, while immersion influences presence and flow to a certain level, embodiment and empathy are more dependent on the disposition of particular users.

5. Discussion

Overall, these findings show that the immersive properties of a VR story promote the perception that the story is real and live, helping to break down barriers between virtual reality and users. The findings also reveal the users' cognitive processes in the VR storytelling context, explaining the dynamic role played by immersion. The immersive experience in VR, in which viewers feel they are part of the action, is not bestowed by HMD (or indeed anything related to technological devices), but is reconstructed via user cognition. VR stories are reprocessed using user sense-making processes. Users actively create their own VR, based on their understanding of the story, their empathic traits, and the nature of the medium. In other words, VR developers propose immersion but users process it, based on their own preferences and needs.

5.1. Insights related to the group differences

The group differences that emerged through significant paths in the model relate to the users' cognitive processes in response to engagement. High immersive devices may have affected the users' perceived presence and made them feel flow, but the users' own traits ultimately determined whether they felt empathy or embodiment. Likewise, the users' own decisions and intentions determined whether such empathy and embodiment influenced engagement. Of course, high levels of immersion may have contributed to certain levels of embodiment and empathy (as shown in Groups 1 and 3, where the coefficients were larger than for Groups 2 and 4); however, the users' own traits (empathy levels) determined their levels of empathy and embodiment and aroused engagement.

Overall, the model shows that all of the paths were significant in

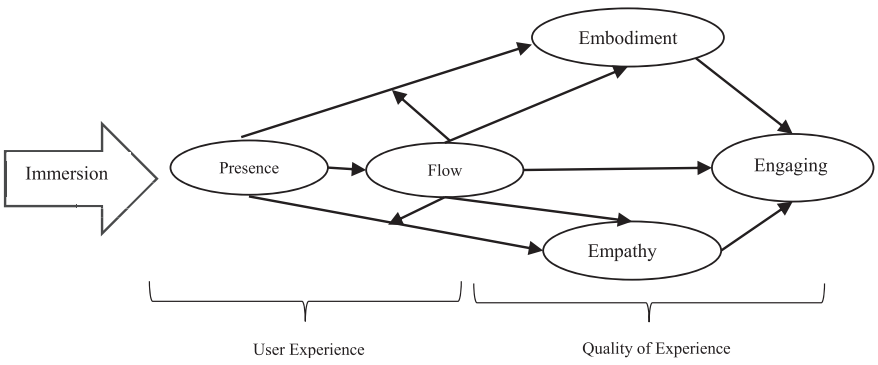

Fig. 4. A two-tiered process of immersion.

Group 1. As in the overall model, all of the paths of Group 1 were supported. This finding suggests that, by and large, people view high immersion as influencing empathy, which then triggers user engagement. However, Groups 2 and 3 reveal an important cognitive mechanism: the intrinsic empathy of users plays a key role in triggering embodiment, which then determines engagement. In other words, the immersion level is less critical in the mechanism than are users' own idiosyncratic traits. The results of Groups 2 and 3 show an interesting contrast between the first process (from presence to flow, empathy, and embodiment) and the subsequent second process (from empathy, flow, and embodiment to engagement). Group 2 was influenced by the first process, while Group 3 was influenced by the second process. This implies a two-tier process of immersion. When users receive external stimuli, those stimuli are transmitted to the user cognition where they are interpreted and processed. The stimuli are reprocessed by the users' own internal cognitive processes, which are based on previous experience, intrinsic traits, and context. This inference is also consonant with the result of Group 4, where no significant paths were found. In a less immersive environment, users with little empathy do not feel a strong sense of empathy or embodiment and thus there is weak engagement.

In VR, it might be said that technical quality does not directly influence performance, value, or experiences. In VR, immersion plays assist in eliciting the cognitive process which motivates human-media interaction, thus facilitating user experiencing processes. Note that the paths from empathy and embodiment to engagement (H5 and H6) are much higher than the path from presence to empathy and embodiment (H1 and H2). Previous research in the user study literature shows a direct or immediate relationship between immersion, flow, and presence and performance value (e.g., Jin, 2012). The results of this study indicate that such processes may be complicated or even multi-tiered, being modified by the users' own cognitive assessments. In other words, immersion and presence (as technological properties) are one aspect; how users feel about or interpret such properties is a different aspect. How such technological properties are used for eliciting empathy and embodiment is primarily dependent on user preferences and cognition. Whether users are attracted to the VR story and willing to engage with the virtually recreated environment, and the extent to which they experience presence and flow, all depend on their intrinsic cognitive motivations for engaging in and empathizing with meaningful cognitive activities. Presence is not an external factor bestowed upon users; rather, it is a fluid state that is reprocessed and redefined by users.

When presence is triggered by the level of immersion, it influences flow. Users cognitively asses such presence and flow. If they believe them to be worthwhile, they internalize those qualities by putting themselves into the VR stories. The mechanism works only when technical qualities are appropriately translated into their associated cognitive qualities. Accepting immersion is a sense-making process by which people confer some meaning upon 3D objects and related experiences. VR users play a significant role in adapting and responding to VR stories using empathy and embodiment.

5.2. The two-tiered process of VR experience

Based on the previous discussion, it can be inferred that VR experience follows a two-tiered process of immersion and empathy, although the two components are built upon one another and can be clearly demarcated (Fig. 4). The two-tiered process of immersion comprises presence and flow, which are experienced by users in the first place (user experience) and then empathy and embodiment, which are selectively experienced by users (quality of experience). Flow may link the two processes; the consequence of the two-tiered process is engagement.

The first reaction of most viewers to VR storytelling is a sense of presence: "it feels like being there." This emotional reaction to VR triggers responses that go deeper than the initial reaction, which mainly involves superficial presence. The subsequent reaction involves human emotional states: developing feelings such as empathy, compassion, and embodiment. Within the users' sense-making, two processes of different natures can be identified: the immersion quality is established explicitly and implicitly by users, and then empathy starts to kick in. A user's experience of process is simply the application of an intrinsic value to an external reality, as it has been reconstructed on the basis of cognition. Accordingly, the process is composed of cognitive and volitional acts that rely on each other. It is the user's cognition of reality that starts off the process. His or her level of empathy will determine the nature of the procedure, as well as the sense-making that results from it.

It can therefore be said that flow plays a certain role in the two-tiered process mediating presence and empathy. It is worth examining a potential underlying mechanism that might account for the effect of flow on empathy and embodiment. In this study, flow was tested as a potential mediator of this effect.

5.3. The mediating role of flow

The effect of presence had a marginal influence on flow (H4) in the overall model. As immersion and presence are the key factors in VR, these effects were expected to have the greatest influence. The marginal role played by these factors highlights the hidden role of user process. This finding somewhat contradicts previous findings, which have shown that flow is influenced by the high technology-mediated environment (e.g., Bystrom et al., 1999). It may be inferred that, in a VR context, flow works independently from technological quality, being influenced by the users' own will, mood, and disposition. Perhaps it can also be inferred that technology is now so well-developed that technological differences are commoditized, and users consider all technologies similar.

This study used Baron and Kenny's (1986) procedure to test mediating effects. First, the single order relationships among the variables were confirmed through statistically significant Pearson correlations in the expected direction. As predicted, presence and empathy were correlated ($r = 0.51$), presence and flow were correlated ($r = 0.54$), and flow and empathy were correlated ($r = 0.57$). Next, three regression analyses were performed, following the method recommended by Baron and Kenny (1986). The first equation regressed flow on presence ($F(1,97)$. 44.80, $p < 0.001$). Presence explained 31% of the variance in flow. The second equation regressed empathy on presence ($F(1,97)$. 40.93, $p < 0.001$). Presence explained 29% of the variance in empathy. The third equation regressed empathy on both presence and flow. This final equation satisfies the two requirements for a mediator effect: a) the hypothesized mediator, flow, was a significant predictor ($t.4.58$, $p < 0.001$) and explained 20% of the variance in empathy; b) the variance in empathy explained by presence was reduced from 31% in the second equation to 10% in the third equation. Thus, the reduced direct association between presence and empathy, when flow was included in the model, supported the hypothesis that flow was at least one of the mediators in the relationship between presence and empathy. Thus, flow was proven to be a mediator between presence and empathy.

Similarly, flow was found to be a mediator in the effect of presence on embodiment. The R values for flow were lower than those for empathy, suggesting that the mediating effect of flow on embodiment is weaker than the effect of empathy. This result may be partly explained by limited role played by embodied cognition in

this experiment. The 360-degree function in the experiment was weak and the time of experiment was too short for participants to feel embodied cognition.

The significant mediating role played by flow implies that VR users want to confirm performance before making the decision to adopt. It has generally been supposed that a strong presence leads to stronger empathy (Bracken, 2005). In the VR storytelling context, however, high presence does not lead to empathy; rather it is mediated by flow. Flow mediates the connection between presence and empathy. The experience of being immersed in a VR story fosters a mental state of operation in which the user is highly involved in viewing.

5.4. The interaction dynamics of empathy, embodiment, and engagement

Based on the users' cognitive processes, it can be further inferred that there is a more active role for users in VR. Many previous immersion approaches have treated users as data subjects, passive consumers of content and services, providing their data to research (e.g., Gutierrez et al., 2007). With the rise of VR technologies and services, the user's role has changed from passive consumer of technologically provided immersion to active creator of immersion. The VR user creates, adapts, and modifies immersion, depending on his or her day-to-day activities and context.

The role of the user is important in processing immersion, forming presence, and influencing user engagement. Previous theories have assumed that users are passive agents who receive immersive hallucinations (e.g., Bracken, 2005; Gutierrez et al., 2007; Huang & Liao, 2015). For example, the widely used immersion measurements (e.g., time elapsed unnoticed; being unaware of incidents or people nearby; heart rate quickening during scary or exciting moments) treat users as passive recipients of technology or content. Subjects in human experiments are inherently influenced by technological immersion. As this study and numerous others have indicated, users apply much conscious effort and intentional work toward immersion, in particular with VR content. They voluntarily initiate their intrinsic cognitive processes to engage in and enjoy effortful cognitive activities within VR, not because of the external influence of immersion, but because they decide it is worthwhile to do. For this reason, the notion of immersion should be shifted: whereas previous research has seen immersion as a strong stimulus igniting illusion, hallucination, or delusion (e.g., Bracken, 2005), future research should see immersion as a cognitive dimension alongside consciousness, awareness, understanding, empathizing, embodying, and contextualizing, which helps users understand the content and stories delivered. The concept of immersion not only takes into account the technological aspects of VR but also the emotional, motivational, and cognitive processes involved in focusing engagement. Rather than being a static entity separate from users, immersion is a dynamic fluid that flexibly exists between technology and user cognition. Following this line of discussion, immersion should be sought, not from technology, but within users' *in-situ* contexts: their cognition, interaction, and behavior.

Users are actually highly participative and intentional. VR content users are able to interact with their surroundings within the story in meaningful and purposive ways. High participation allows users to have fuller experiences of VR environments that can only suggest the full intensity of real-life experiences. This argument is consistent with the finding that immersion is, to a large extent, dependent upon personal traits (Weibel et al., 2010). More absorptive and willing-to-be-immersed personalities are able to become more immersed in VR content by triggering presence and cueing flow into the empathic process. These findings are largely consistent with those of previous studies (e.g., Burns & Fairclough, 2015; Hou, Nam, Peng, & Lee, 2012). Users become immersed because they desire to do so and have specific expectations about what the outcome should be. Users discover the most meaning where a storyline is relevant to themselves. People who are inclined toward immersion and innovativeness enjoy seeing news stories through VR; people who are aware of the news stories are more likely to experience empathy and embodiment than those who are not. In our post-experiment interviews with participants (a post-hoc analysis, carried out after the experiments), many of them talked about the importance of being aware of the story. In other words, people who understood the issues in the story, and could relate to them, found it much easier to empathize and embody the content than those who did not. This post-experiment interview finding highlights the contextual factors that interact with immersion.

In existing research, immersion has been considered a powerful determining factor that triggers users' perception of presence and influences satisfaction. Given the user's active role, an engaging experience is more about process than outcome. The immersive experience can be viewed as an interactive and ongoing procedural aspect, rather than a static or consequential factor. Immersion can be a fluid and reflective concept, rather than a fixed and isolated factor. The users' values and attitudes are represented in VR viewing processes. The majority of studies on perceived engagement have focused on discrete factors (content, services, systems, etc.), neglecting the way in which those factors are processed (e.g., how users perceive, accept, experience, and interact) or related (e.g., how a particular instance of immersion is related to specific content). Procedural and contextual views of immersion highlight the dynamic nature of users' quality of experience.

The findings in this study reveal the dynamic way in which user cognition is initiated and how it influences immersion. Immersion and users interact and co-evolve: immersion influences users, while being shaped by users. This interaction is neither one-time nor temporary; it constantly evolves and interacts with users. The immersive tendency of users seeks immersive endeavors and immersive environments, which reinforce users in their attitudes and future intentions. This phenomenon can be called a virtuous cycle of immersion, and should be the object of future studies.

6. Implications

This study has offered an integrated model showing how different levels of immersion and user empathy in VR storytelling contribute to a user's cognitive process. The experience of presence and flow emerged as a strong predictor of empathy and embodiment.

6.1. Theoretical implications

This study provides new insights into the dynamic effects of immersion on VR users' attitudes and motivation. While virtual worlds are well known as a context in which users can experience immersion, presence, and flow, the way in which these experiences are processed by users remains unexplored. Previous studies have consistently shown the importance of immersion in the adoption of VR technologies (e.g., Teng, 2010); this study clarifies the immersion factor by highlighting how it functions in a VR storytelling context. This study has confirmed that VR viewing and interaction are positively associated with engaging qualities. In turn, those perceptions are positively associated with the viewer experiences of empathy and embodiment, as well as with engagement. It has revealed the links between an experience, technology, and users' interaction with the mediated world. It has also explored the two-

tiered process of immersion that includes user experience (presence and flow) and quality of experience (empathy and embodiment).

Although the issues of immersion and presence have emerged as key factors in VR storytelling development, to date, there has been little research on this issue, especially in relation to actual UX. New factors, such as immersion, should be closely examined based on UX and interaction. Immersion should be conceptualized, measured, and examined during users' interactions with technology, instead of relying on technical features. This finding suggests that immersion is not viewed as real; an experience in a virtual world is different from one in a real environment. VR, across different platforms, challenges the concept of reality and enables us to rediscover and explore reality.

So far, there has been a tendency to view presence and immersion as technology-dependent factors. Likewise, users have been considered mere objects of such technology-dependent factors (e.g., Nicovich et al., 2005). Immersion has been studied as a direct factor triggering illusion, hallucination, and delusion. As this study has found, immersion can be a part of a cognitive dimension that includes consciousness, awareness, empathizing, embodying, and contextualizing—helping users assimilate into VR. In this light, immersion can be seen as a dynamic fluid that flexibly exists between technology and users. Immersion exists in a dormant state and becomes concrete when users experience it. Thus, instead of seeking immersion from technology, it should be sought within users' *in-situ* contexts: their cognition, interaction, and experience. Immersion is a user-dependent factor defined by and for users.

Overall, the finding constitutes a theoretical improvement on UX and the user acceptance literature. The model identifies antecedents of user engagement in VR and represents an improvement over traditional UX studies, since it integrates cognitive and affective attitudes as the primary aspects of influence. These attitudes are driven by underlying beliefs, including presence, flow, and perceived quality. Assessing these beliefs improves forecasting for VR content acceptance and the diffusion of VR storytelling in the long run.

6.2. Practical implications

The practical implications of VR storytelling include the potential for new service strategies and design guidelines. Understanding how users are immersed in VR stories will allow a VR developer and designer to work more efficiently and effectively. There are a number of challenges involved in producing VR work in a storytelling context. One practical implication is that, no matter how functional and advanced the technology, the key is to focus on the story, not the technology itself or any special 3D effects. The real challenge is not so much that things can look too real or not real enough; instead, it involves the feel of the piece, as perceived by the users of VR stories. For example, the identified group differences in the 2×2 comparison provide VR producers with important design guidelines, which show that immersion features/levels can be adjusted to reflect users' tendencies and personal traits. For example, the finding that personality traits are related to tendencies toward immersion opens up the possibility predicting engagement level in technology-mediated training programs from personality, which would potentially affect how much people learned from those environments, holding all other features constant.

VR storytelling challenges people's expectations of content quality. As more diverse platforms and services have been developed for VR, engagement has emerged as a key experience indicator. The storytelling industry should accurately estimate and follow users' quality of experience in order to evaluate the performance and quality of particular news services. Understanding user cognitive process mechanisms may thus be a valuable strategic goal for the industries developing future storytelling.

To increase the immersive experience of VR stories, engaging content should be developed. Immersion alone is not sufficient to generate the desired feeling. To fully realize such features, they must be accompanied by high quality content and enjoyable services. User engagement in VR can be significantly increased and combined with more emotional involvement, depending on the quality of the picture. These findings indicate that VR should provide both quality content and relevant, socially meaningful stories to users. VR users are more likely to experience emotions in response to relevant and engaging news stories. When providing content in VR, it may be important for the content industry (broadcasters, brands, and filmmakers) to choose the right stories and ensure that they are produced using high image quality and appropriate storytelling methods. Storytelling techniques will remain useful in VR, as numerous studies have confirmed the importance of narratives in VR. These results imply that VR stories have sense-making benefits that surpass those of traditional storytelling. VR-induced negative effects should therefore be minimized and managed. More thorough research and development are necessary, particularly into the possible connections between presence and flow, and between flow and empathy. Exploring the influence of content variables on presence will help to design narrative virtual environments and to understand the use of virtual humans in storytelling interfaces.

Finally, the two-tiered process of immersion can be particularly useful for the VR industry. In designing VR stories, presence and flow can be tailored to reflect user traits. For example, additional narratives can be provided for people who are less empathic. More sophisticated presence can be provided for highly empathic people. Empathy and embodiment can be aligned with the intended level of presence and flow. In this way, technological features and cognitive processes can be harmonized. The industry may set different marketing targets via VR storytelling: one for user experience focusing on immersion and presence and the other for quality of experience focusing on empathy and embodiment. Marketing firms may also need to come up with additional marketing tools to arouse empathy and embodied cognition.

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