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The Stigma Machine: A Study of the Prosocial Impact of Immersive VR Narratives on Youth in Spain and Canada

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Abstract

Virtual reality (VR) is increasingly employed to create immersive, interactive audiovisual narratives that accentuate emotion, storytelling, and user engagement. By harnessing the potential of VR, these avant‐garde narratives aim to instill values of equity, justice, and fairness. This article critically examines the largely unsubstantiated assertion that VR is the ultimate tool for fostering empathy by means of a qualitative evaluation of the influence of prosocial VR audiovisual narratives. The study involved the production of the first episode of *The Stigma Machine*, a VR short film series in both traditional 2D and immersive VR formats, in a two‐pronged production approach designed to examine the effects of the film on a sample of 44 university students from Spain (n = 22) and Canada (n = 22). The participants were segregated into two groups: Group 1 (1st VR Condition) viewed the VR experience first, followed by the traditional version, while Group 2 (1st Video Condition) viewed the two formats in reverse order. Data was collected before, during, and after viewing, using standardized questionnaires (interpersonal reactivity index, basic empathy scale, and Igroup presence questionnaire) and electroencephalogram devices to monitor brain activity. The dependent variables included: empathy, assessed using the interpersonal reactivity index and basic empathy scale surveys; electroencephalogram brain activity measures, indicating engagement, excitement, focus, interest, relaxation, and stress; presence, evaluated using the Igroup presence questionnaire; and various outcome variables. The results reveal no significant differences in presence and no significant changes to the empathy scores. The findings point to a need to focus more on narrative design and audiovisual content creation strategies than on VR technology itself.

Keywords

electroencephalogram; immersive narratives; prosocial impact; virtual reality; VR short film

1. Introduction

Extended reality technology enables users to interact with immersive stories and environments. The use of virtual reality (VR), mixed reality, and augmented reality technology has increased dramatically in recent years due to the buzz surrounding the Metaverse. Though research on VR has focused mainly on video games, there is a burgeoning interest in the use of these technologies as prosocial instruments, with the creation and assessment of immersive VR experiences designed to elicit positive social behavior. A substantial body of research has examined the impact of VR experiences as tools for eliciting positive social outcomes (Canet & Sánchez-Castillo, 2024; Martínez-Cano et al., 2023; Nikolaou et al., 2022; Tassinari et al., 2022). VR devices are also becoming increasingly affordable, opening up the possibility of "a full integration of VR technology with movies, which is progressively leading to a significant advancement in traditional screen cinema" (Tian et al., 2022, p. 1).

Immersive media make it feasible to place users in scenarios and settings that could be hard to reproduce in the real world. VR enhances the audience-storyteller relationship by empowering users to participate actively in the narrative they are witnessing, placing them inside the story, and giving them a sense of presence (Lombard & Ditton, 1997). Place illusion is one of the keys to achieving this sensation of "being there," as "it helps to create the effect of presence" (Martínez-Cano et al., 2023, p. 3).

Immersive audiovisual content may therefore foster positive attitudes and emotions such as empathy, compassion, and teamwork, justifying Milk's (2015) description of VR as the "ultimate empathy machine." Such content can provide users with the opportunity to adopt the perspective of another person, in so-called "perspective-taking" experiences (Herrera et al., 2018) or social modeling activities, in which they observe and imitate the actions of others in a VR setting, leading to embodiment.

According to Barsalou's (2008) theory of grounded cognition, our ideas and behaviors are shaped by our physical experiences, which include interacting with others and our surroundings. Because VR is so engrossing, users may experience a sense of presence in a VR environment. This experience can influence the user's beliefs, attitudes, actions, and social interactions. An embodied experience in a VR environment can exert considerable influence over various cognitive and emotional mechanisms. For instance, VR simulations of physical activity, such as walking, can improve cognitive functioning among elderly individuals (Riva et al., 2007). Similarly, VR scenarios depicting intergroup encounters have been harnessed to promote prosociality by encouraging empathetic responses while reducing stress and prejudicial attitudes (Banakou et al., 2016; Gonzalez-Franco et al., 2016; Stelzmann et al., 2021; Tassinari et al., 2022).

In opposition to these arguments, Robertson (2017) questions Milk's description of VR as an empathy machine based on the lack of empirical evidence to support the assertion. Moreover, research on the psychology of immersive experiences suggests that users may occasionally find it challenging to handle the many inputs of immersive content effectively (Bowman, 2021), which may undermine their emotional responses to the stories or have the effect of distancing them from the characters (Barreda-Ángeles et al., 2021). Some studies also suggest that VR may encourage "false empathy," contradicting the idea that first-hand accounts and immersive experiences alone can elicit empathy (Bender & Broderick, 2021; Bloom, 2017). Based on such criticisms, Lisa Nakamura (2020) argues that VR empathy experiences encourage a kind of "identity tourism," whereby a VR user pretends to be a member of a marginalized group or to share a group experience, usually for voyeuristic purposes. This results in false embodiment, in the sense of occupying an identity completely different from our own, which in turn leads to false empathy (Nakamura, 2020).

1.1. The Impact of Immersive VR Narratives vs. Traditional Media Formats

In one of the various studies that have compared the effectiveness of VR and linear 2D screen formats, Barreda‐Ángeles et al. (2020) measured the impact of 360° nonfiction content in both immersive head‐mounted display and non‐immersive 2D screen formats, exposing half of the participants first to four VR videos followed by four videos presented on screen, and the other half with the opposite order of media exposure. They found that the immersive content had no notable impact on empathy, possibly due to a potential offsetting mechanism between indirect positive and direct negative effects. This constitutes a case of "competitive mediation," suggesting that immersive presentations may elicit reactions from viewers related more to their personal immersive adventure than to spatial presence or the events depicted, thus hindering empathy and emotional engagement. While enjoyment negatively mediated the spatial presence effect on the empathic concern dimension, no negative effect was found for perspective‐taking (Barreda‐Ángeles et al., 2020, p. 686).

Research conducted by Zhang et al. (2020, p. 6) concluded that VR gives its audience a variety of aesthetic experiences through its immersiveness, real‐time interactivity, and user conception, and that the various aesthetic sensations produced by VR visuals challenge the conventional definition of what constitutes good visual design, as virtual experiences and content are starting to take on a personality of their own. Based on this perception, a study by Szita et al. (2018) hypothesized that highly immersive experiences may impact information intake and how storytelling events are understood. Some years earlier, Mateer (2017) was already arguing that although VR content could be impressive and convincing, thereby enhancing the immersive experience, it is important to take into account viewers' point of view, position, body, and agency of movement, as these elements may affect their access to narrative content. In their research, Szita et al. (2018, p. 414) used two versions (VR and screen formats) of the same animated short film, *Pearl* (Osborne, 2016), as independent variables to examine "whether cinematic virtual reality and screen‐based viewing would evoke different experiences in terms of engagement, presence, emotions, memory characteristics, and recollection accuracy." When they used VR headsets to watch the movie, participants exhibited a higher level of engagement with the film and a decreased awareness of the outside world. They also reported experiencing a heightened sense of immersion within the narrative's fictional environment compared to participants viewing the content on traditional screens. At the same time, there were no appreciable differences in emotional engagement with or empathy for characters between 2D screen and VR viewers. Conversely, Carpio et al. (2023) compared the emotional and cognitive impacts of VR and traditional screen formats on a sample of 60 participants, in a multimodal experiment where one group watched the movie *Gala* (Carpio, 2022) in VR and the other group viewed it in 2D, concluding that the VR movie had a substantially stronger effect on viewer emotions and elicited higher levels of immersion and engagement than the 2D version. The study combined self‐reports and questionnaires—the positive and negative affect schedule and the self‐assessment manikin—with heart rate variability and electroencephalogram (EEG) brain activity data, thereby confirming "the value of using a multidisciplinary method for analyzing audience impacts" (Carpio et al., 2023, p. 3188).

Ding et al. (2018) also compared traditional 2D films with VR in terms of their emotional effects, with a sample of 40 participants separated into two groups, VR and 2D, both shown the same content: *The Jungle*

Book (Reitherman, 1967). None of the participants had prior experience with VR. The study used positive and negative affect schedule, skin temperature, electrocardiogram, respiration signal, and photoplethysmography measures. The results indicated a more pronounced emotional impact among VR viewers than 2D viewers, corroborating Riva's findings that "confirmed the efficacy of VR as an affective medium in eliciting specific emotions of anxiety and relaxation" (Riva, 2007, as cited in Ding et al., 2018, p. 9). A study by Tian et al. (2022) sought to determine whether the variance in emotional arousal between 2D and VR stimuli consistently manifests as statistically significant by testing a sample of 16 participants using different questionnaires (self-rating anxiety scale, self-rating depression scale, self-assessment manikin) combined with EEG-based trials. The researchers developed a series of virtual scenarios designed to elicit positive, negative, or neutral emotions, and participants were separated into two groups: one viewing the scenarios in VR and the other viewing them in 2D. The study found that VR environments "can trigger increased emotional arousal" (Tian et al., 2022, p. 13). On the other hand, a study by Wang et al. (2018) that examined the power of 360-degree VR news videos for enhancing engagement demonstrated that VR videos exhibited inferior performance compared to 2D screen videos. This study did not test any particular content on users; instead, a series of data analyses were conducted based on popularity indicators on a sample of content that included 299 VR videos and 299 screen-based videos produced since 2015.

1.2. Objectives and Hypothesis

Clearly, more research is needed to explore the differences between VR and 2D screen narratives in terms of their effects on viewers. While some studies assert that immersive narratives foster a stronger emotional bond with narrative content than a traditional linear format, others conclude the opposite. Some make optimistic claims about the potential benefits and trade-offs for the user's social and ethical awareness. To fill the research gap in this area, this study proposes an experimental design that integrates a range of approaches used in earlier research in an effort to compare the prosocial impact of the two media formats.

In view of the above considerations, this study postulates the following hypothesis: Exposure to immersive VR prosocial audiovisual narratives will have a greater impact on fostering empathy, engagement, and positive emotional responses in viewers compared to traditional 2D screen formats. This hypothesis will be tested by comparing the cognitive and emotional responses of participants who view the same narrative in both VR and 2D screen formats.

2. Methodology

2.1. Design

This study used a pre/during/post design. Participants were exposed to both versions of the stimuli but were divided into two groups: Group 1, or 1st VR Condition, watched the VR film stimulus first and the video format of the film second; and Group 2, or 1st Video Condition, watched the traditional video content first and the VR stimuli second. A within-subjects design, frequently used in media psychology research, was employed to investigate whether immersive VR and screen viewing evoke different responses in terms of empathy, sense of presence, and emotional involvement. This design was chosen primarily due to the need to control for individual variability of the results, thereby reducing the likelihood of genuine differences between conditions going undetected or being obscured by random fluctuations. Moreover, within-subjects designs can use smaller sample sizes to identify statistically significant differences between two conditions. The independent variable was the viewing order condition, determined by the format that was viewed first (2D screen or VR). The stimuli were two iterations of the same movie and there were two subconditions—the “initial” (basal) and “boo” (post) moments—that corresponded to two distinct points in the story where EEG brain activity data was collected while participants were viewing the stimuli in VR and screen-based formats.

2.2. Film Stimulus

In order to study the prosocial impact of VR immersive narratives compared to traditional linear 2D screen content, we produced the first episode of a VR short film series titled *The Stigma Machine* (Martínez-Cano, 2022) in both formats (Figure 1). *The Stigma Machine* is an experimental VR story that attempts to put the spectator into another person’s shoes while addressing the issue of social stigma. The aim is to use this technology as a prosocial input to encourage supportive behaviors in relation to sensitive topics in today’s society, such as respect and tolerance for the diversity of the LGBTIQA+ community. The first episode is a hybrid immersive movie created for VR devices, produced by combining volumetric filmmaking and 3D CGI, with a duration of 2 minutes and 30 seconds.

Volumetric video capture is a growing trend in immersive content production (augmented reality/VR/mixed reality). It provides VR experiences based primarily on 3D scanned images taken by depth sensors such as Microsoft Azure or Kinect 2. With the help of gaming engines such as UDK and Unity, the technologies of photogrammetry and volumetric video allow the viewer to enter realistic virtual worlds that are recreated by combining artificial 3D elements with real actions captured in volumetric video format (Figure 2). A Microsoft Kinect 2 sensor and 3D reconstruction of the areas and objects that serve as the story’s settings were used to create this first episode. The resulting non-interactive, immersive audiovisual experience can be described as having two layers, as the sets for the action were reconstructed in 3D CGI, while the actors’ performances were captured on film sets with chroma backgrounds using volumetric video recording with 4k DSLR cameras, Kinect sensors, and Depthkit software. The sound production for the stimulus was captured for both formats using a stereo system display and subsequently edited to create an immersive auditory experience for the VR format. This was achieved by means of spatial sound design, which enables users to perceive sound more realistically based on their distance and spatial position relative to the observer.

The film tells the story of a student who is bullied in a classroom because of their gender identity. Over the course of two days, the actors’ performances were filmed on a set using a chroma background (Figure 3). Since

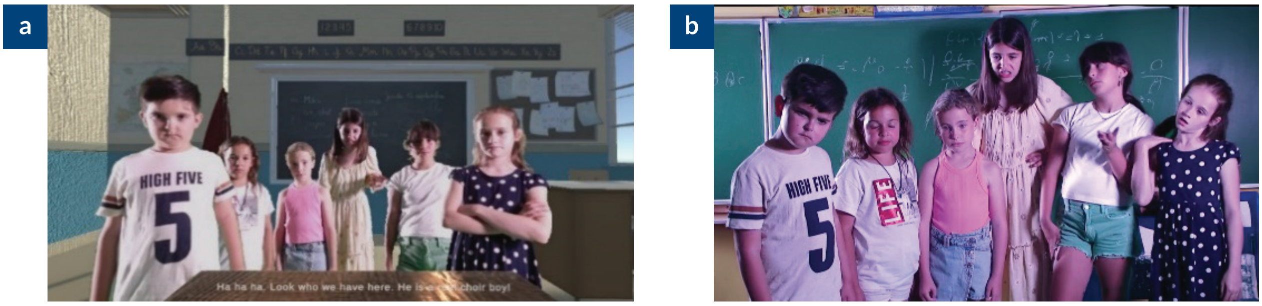

Figure 1. Screenshots of the film stimuli in VR format (a) and in video format (b). Source: Martínez-Cano (2022).

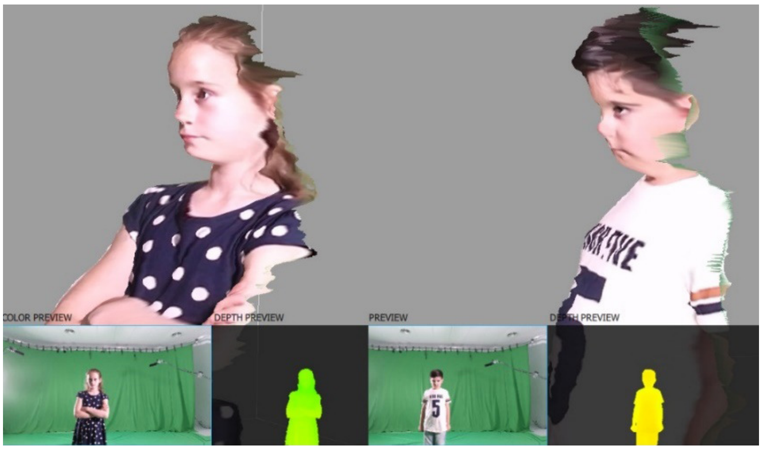

Figure 2. Screenshot during the volumetric video recording using Depthkit software.

Figure 3. Shooting process for the VR experience *The Stigma Machine*.

the furniture and props were made later and added in 3D, they did not need to be built for the scene. Autodesk Maya was used to create the classroom set, which the user can visually explore as the narrative progresses. In order to be able to insert each actor into the virtual setting later and to create the ideal composition for communicating the intended message to the audience, the performances were first recorded with the entire group and then with each actor separately. The sensor was placed at the user's eye level so that it was in the same position as the child who was being bullied by his peers during the story. Afterward, the group recording was edited for the conventional linear screen-based version of the short film. There are two specific events in the storyline: the "initial" point where one of the girls starts to yell at the viewer (who is in the position of the main character in a sort of perspective-taking narrative strategy); and a second moment near the end where the kids jeer at the spectator (the "boo" subcondition). Since both formats follow the same script, there is no difference in storytelling between the immersive and non-immersive modes. The film was shot in Spanish and subtitled in English.

2.3. Participants

Initially, 50 young university students from Spain (n = 23) and Canada (n = 27) took part in the study. Six participants were removed from the sample at the end of the experiment either because they did not complete all phases of the experimental design or because the signal used to record their brain activity while viewing was of insufficient quality to measure the various research variables. The final sample thus included 44 participants, 22 from each country. A total of 88.2% of the participants were between 18 and 25 years old, 7.8% were between 25 and 30 years old, and 3.9% were older than 30. Participants were recruited through online advertisements and by word of mouth at two universities: Toronto Metropolitan University and Universidad Miguel Hernández de Elche. Participants received no compensation apart from a five-dollar voucher for a coffee shop franchise. The study forms part of the research project titled The Role of Virtual Reality Audiovisual Narratives in Social Inclusion and the Perspective of Prosocial Models: Analysis of Their Characteristics, Effects and Impact on Young University Students, which was reviewed and approved by the Toronto Metropolitan University Research Ethics Board (REB 2022–376) and by the Miguel Hernández University Research Ethics Board (DCS.FMC.01.21).

2.4. Apparatus, Setup, and Procedure

The participants were invited to attend the lab installed at The Catalyst at Toronto Metropolitan University and at the Atzavares building at Universidad Miguel Hernández de Elche, where the two conditions were set up in a neutral environment. For the 1st VR Condition ($n = 19$), participants viewed the VR version of the short film first using an OCULUS Rift S device, while for the 1st Video Condition ($n = 25$) participants watched the 2D format film first on a 17-inch screen laptop.

Data was collected before, during, and after the viewing stages. On their arrival at the lab (pre-viewing stage), participants were asked to fill out two online questionnaires: Form 00 with demographic data; and Form 01, which included the interpersonal reactivity index (IRI; Davis, 1980, 1983) and the basic empathy scale (BES; Jolliffe & Farrington, 2006). Subsequently, participants in both conditions watched the two versions of the short film in the order assigned to their group, and their brain activity was recorded during both viewings using an EMOTIV EPOC X EEG device. Stimulus exposure in both formats lasted 2 minutes and 30 seconds, with a 5-minute break between each exposure. After viewing, participants were asked to complete online Form 01 (IRI and BES) again, as well as Form 02 (outcome variables) and Form 03, which included the Igroup presence questionnaire (IPQ; Schubert et al., 2001). At the end of the study, participants were debriefed. Including the instructions, viewing the two formats, and completing the pre- and post-viewing surveys, the entire procedure took about 30 minutes.

2.5. Measures

Participants were asked to answer a set of pre-viewing and post-viewing surveys that included standardized questionnaires (IRI, BES, and IPQ). The internal consistency of these questionnaires in our study was moderate, with Cronbach's alpha values ranging between 0.5 and 0.7. The outcome variables survey was specifically created for this study. Additionally, while the participants were viewing both formats, an EEG device was used to monitor brain activity. The measures taken were as follows.

The dimensions of empathy were assessed using the IRI and BES surveys. The IRI measures were obtained based on Table 6 in Pérez-Albéniz et al. (2003). Perspective-taking was measured based on items 3, 8, 11, 15, 21, 25, and 28; fantasy based on items 1, 5, 7, 12, 16, 23, and 26; empathic concern based on items 2, 4, 9, 13, 14, 18, 20, and 22; and personal distress based on items 6, 10, 17, 19, 24, and 27. The BES was calculated using the authors' guidelines (Jolliffe & Farrington, 2006). The cognitive BES variable was obtained by adding the scores of items 3, 6, 9, 10, 12, 14, 16, 19, and 20 of the BES questionnaire. Affective BES was calculated by adding the scores of items 1, 2, 4, 5, 7, 8, 11, 13, 15, 17, and 18 of the BES questionnaire, and the BES total score was obtained by adding up all the scores of the items of the BES questionnaire, i.e., the sum of the scores of items 1 to 20.

EEG brain activity measures were captured using an EMOTIV EPOC X device. Recordings were made using 14-channel electrodes, continuously recorded at a sampling frequency of 1,000 Hz. Engagement, excitement, focus, interest, relaxation, and stress were measured using the EmotivPro software performance metrics during the "initial" (basal) and "boo" (post) subconditions. Performance metrics are recorded on a scale from 0 to 100. Engagement is characterized by alertness and the conscious focus on task-relevant stimuli, measuring the degree of immersion, which combines attention and concentration. Excitement reflects positive physiological arousal, indicated by activation of the sympathetic nervous system, and it provides output scores showing short-term changes in excitement, even within seconds. Focus measures the intensity of attention on a single task. Interest measures the level of attraction or aversion to the stimuli, environment, or activity. Relaxation measures the ability to disengage and recover from intense concentration. Stress indicates the comfort level with a stimulus.

Presence was measured using the IPQ questionnaire (Schubert et al., 2001). The variable of spatial presence was calculated by adding the scores of items 3, 6, 9, 10, and 13 of this questionnaire. Involvement was determined by adding the scores of items 1, 7, 11, and 14, and experienced realism was calculated by adding the scores of items 2, 4, 5, and 12. The general score was obtained by adding the scores of item 8.

Regarding outcome variables, a combination of different types of questions and prompts were used in order to assess the VR experience. The first was a "yes or no" question: Did you feel comfortable with the interactive systems proposed? To measure the level of emotional involvement, we used a 9-point Likert scale adapted from Batson et al. (1997), asking participants to rate the extent to which they felt moved, sympathetic, and/or compassionate. To measure negative emotional response, we added a 9-point Likert scale adapted from Batson et al. (1997), asking participants to rate the extent to which they felt uncomfortable, worried, anxious, or upset. To measure social presence, we used two 5-point Likert scales based on the social presence scale (Nowak & Biocca, 2003), asking participants to rate how strongly they felt that characters were present and how strongly they felt that characters were aware of their presence. To measure the participants' relationship of "otherness" with the main character, we used the inclusion of the other in the self scale (Aron et al., 1992), utilized predominantly in social science research to assess social connectedness. This scale has a valence score range from 1 to 7 (Figure 4), whereby a higher number indicates a stronger connection with the main character of the story. These results were split into four ranks: 1; 2 to 3; 4 to 5; and 6 to 7. Participants responded to the prompt: "Please select the image number (in red) that best describes your relationship with the main character of the narrative you have seen." We also used three 5-point Likert scale prompts to measure participants' degree of comfort with the first-person narrative perspective, with diverse sexual orientation kissing, and with collaborating with team members of a different race or sexual orientation. Finally, to assess the image quality of the VR experience, we added two questions with the following single-answer options: sublime, marvelous, strange, beautiful, realistic, confusing, artificial, impressive, surrealistic, and other. The two questions were "what do you think of the image quality of the classroom in this VR?" and "what do you think of the image quality of the children in this VR?"

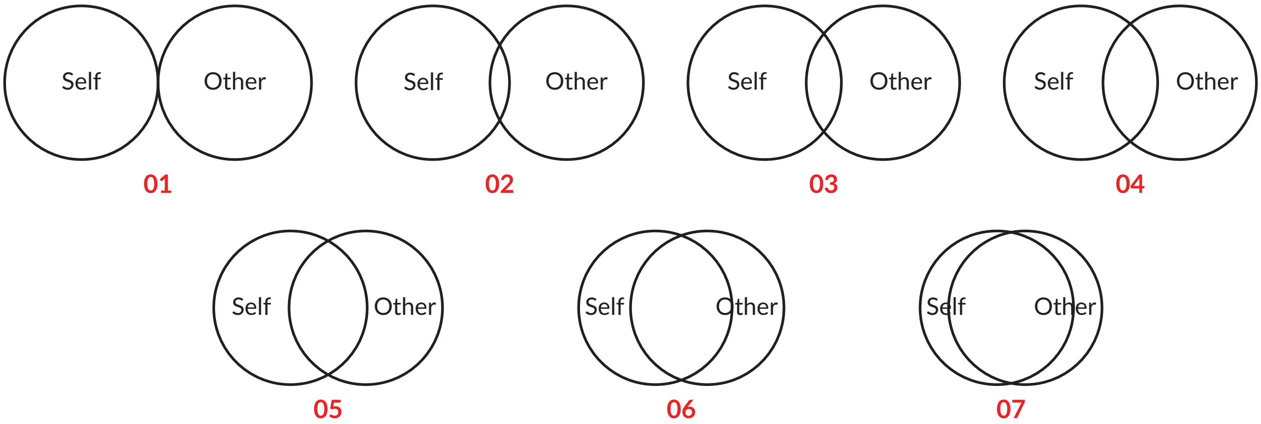

Figure 4. The inclusion of other in the self scale, a unidimensional visual instrument for assessing social connectedness. Source: Aron et al. (1992).

2.6. Statistical Analysis

The statistical analysis was performed using R software version 4.2.0 (R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org). All statistical tests were bilateral, and the significance level was established at 0.05. Before conducting the analysis, we checked whether the continuous variables followed a normal distribution by applying the Kolmogorov-Smirnov test.

Variables that follow a normal distribution are described using means and standard deviations, while those that do not are analyzed using medians and interquartile ranges. On the other hand, qualitative variables are described using frequency (n) and percentage (%). To compare quantitative variables across intervention groups, the Student's t-test for independent samples was used for normally distributed variables, or the Mann-Whitney U test for non-normally distributed variables. For qualitative variables, the Fisher's exact test was used with two categories, and the Chi-square test was used for variables with more than two categories.

To evaluate quantitative variables before and after the intervention, the Student's t-test for paired samples was used for normally distributed variables, and the Wilcoxon test for non-normally distributed variables. Finally, to analyze changes in quantitative variables between intervention groups, the Student's t-test was used for normally distributed variables, and the Mann-Whitney U test was used for non-normally distributed variables. In addition, effect sizes were determined using Cohen's d for variables with normal distribution and Cliff's Delta for variables without normal distribution. Effect sizes can be classified as small, medium, or large based on Cohen's d values of 0.20, 0.50, and 0.80, and Cliff's Delta values of 0.147, 0.330, and 0.474, respectively.

3. Results

The sample included 44 participants, 19 of whom viewed the short film in VR first, while the other 25 viewed it first on a 2D screen. Table 1 shows the participants' sociodemographic characteristics both for the total and broken down by viewing group. Fifty percent of participants were ≤ 25 years old, 50% were from Spain, and the other 50% were from Canada. A total of 68.2% had previous experience with VR audiovisual content but only 6.8% considered themselves regular users of VR headsets, while 63.6% reported that they were regular video game players and 70.5% preferred viewing fictional audiovisual content. Most participants (86.4%) had

Table 1. Participant characteristics overall and broken down by group (1st VR and 1st Video).

	Total ($n = 44$)	1st VR ($n = 19$)	1st Video ($n = 25$)	p-value
Age				0.761
≤ 25y	50% (22)	52.6% (10)	48% (12)	
> 25y	50% (22)	47.4% (9)	52% (13)	
Country				0.761
Spain	50% (22)	52.6% (10)	48% (12)	
Canada	50% (22)	47.4% (9)	52% (13)	
Do you have experience with VR audiovisual content?				0.495
Yes	68.2% (30)	73.7% (14)	64% (16)	
No	31.8% (14)	26.3% (5)	36% (9)	
Do you consider yourself a regular user of VR headsets?				0.721
Yes	6.8% (3)	5.3% (1)	8% (2)	
No	93.2% (41)	94.7% (18)	92% (23)	
Do you play video games regularly?				0.565
Yes	63.6% (28)	68.4% (13)	60% (15)	
No	36.4% (16)	31.6% (6)	40% (10)	
What type of audiovisual content do you prefer?				0.797
Fiction	70.5% (31)	68.4% (13)	72% (18)	
Non-Fiction	29.5% (13)	31.6% (6)	28% (7)	
Are you a volunteer for a pro-social NGO or charity?				0.378
Yes	13.6% (6)	21.1% (4)	8% (2)	
No	86.4% (38)	78.9% (15)	92% (23)	
Do you consider yourself an active participant in improving your community?				0.900
Yes	43.2% (19)	42.1% (8)	44% (11)	
No	56.8% (25)	57.9% (11)	56% (14)	

Note: p-value estimated from the Fisher's Exact Test or Chi-square test.

never volunteered with any NGO, although 43.2% considered themselves to be actively involved in improving their community. A comparison of the audiovisual content and sociodemographic characteristics between the two groups found no significant differences.

Table 2 shows the data for each group at the two key points of the storyline, i.e., the "initial" (basal) and "boo" (post) subconditions. No changes were observed between basal and post moments of the short film for IRI or BES for either the group that viewed the VR movie first or the group that watched the video first. On the other hand, a decrease in EEG parameter scores was observed when viewing the VR film in the group that watched the video first, while no significant changes were observed in the group that viewed the VR first. When viewing the video, a significant decrease in the engagement and relaxation scores was observed in both groups. Moreover, the group that viewed the VR version first also experienced a significant decrease in

Table 2. Description of IRI, BES, EEG in VR, and EEG in video between basal and post moments for each study group (1st VR and 1st Video).

	1st VR (*n* = 19)			1st Video (*n* = 25)		
	Basal	Post	*p*-value	Basal	Post	*p*-value
IRI, median (IR)						
Perspective taking	19 (16; 23.5)	19 (17; 22.5)	0.334	20 (18; 22)	20 (17; 22)	0.633
Fantasy	18 (16.5; 20)	19 (16.5; 21)	0.061	22 (19; 23)	21 (17; 24)	0.572
Empathetic concern	21 (17; 24.5)	21.5 (18.3; 26.8)	0.173	22 (20; 25)	24 (19; 27)	0.053
Personal distress	10 (8.0; 14)	10 (8.5; 16)	0.701	13.5 (10.8; 15.3)	15 (10; 16)	0.955
BES, mean (*SD*)						
Cognitive	30.3 (3.5)	30.9 (3.8)	0.459	32 (3.1)	31.7 (4.2)	0.633
Affective	33.5 (7.3)	34.4 (7.4)	0.148	35.5 (4.9)	36.8 (6.2)	0.080
Total	64 (9.6)	65.3 (8.7)	0.207	67.4 (6.4)	68.5 (9.2)	0.353
EEG in VR, median (IR)						
Engagement	74 (65; 91)	72 (63.5; 81)	0.052	71 (66; 73)	64 (57; 67)	0.001
Excitement	23 (16; 45.5)	25 (13.5; 32.5)	0.314	39 (24; 46)	20 (16; 28)	< 0.001
Focus	37 (25; 42.5)	34 (28.5; 38)	1.000	43 (33; 50)	35 (26; 39)	< 0.001
Interest	45 (42; 50)	44 (42.5; 49.5)	0.586	50 (48; 64)	44 (41; 49)	< 0.001
Relaxation	32 (28.5; 42)	32 (28.5; 42)	0.266	45 (32; 66)	35 (22; 59)	0.004
Stress	35 (33; 39)	36 (33.5; 44)	0.218	43 (35; 68)	35 (34; 41)	0.003
EEG in Video, median (IR)						
Engagement	71.0 (65.5; 80.5)	65.0 (61.0; 70.5)	< 0.001	87.0 (73.0; 84.0)	67.0 (63.0; 73.0)	< 0.001
Excitement	17.0 (11.0; 36.0)	13.0 (6.0; 18.0)	0.003	24.0 (10.0; 40.0)	20.0 (12.0; 32.0)	0.882
Focus	38.0 (29.5; 43.0)	31.0 (24.0; 33.0)	0.004	33.0 (24.0; 36.0)	34.0 (26.0; 41.0)	0.241
Interest	48.0 (43.0; 53.0)	43.0 (38.5; 48.5)	0.042	51.0 (45.0; 60.0)	47.0 (41.0; 53.0)	0.065
Relaxation	37.0 (25.5; 55.5)	20.0 (17.0; 37.5)	0.031	52.0 (35.0; 64.0)	31.0 (23.0; 47.0)	0.007
Stress	36.0 (32.5; 58.5)	34.0 (29.0; 37.5)	0.098	40.0 (34.0; 59.0)	35.0 (32.0; 39.0)	0.288

Notes: IR = interquartile range; *p*-value obtained from paired t-students (parametric) and paired Wilcoxon (non-parametric).

the excitement, focus, and interest scores between the two key points of the storyline while viewing the film in video format. A drop in excitement, focus, and interest scores was also observed during VR viewing in the group that viewed the short film in video format first.

The drop in engagement between the two key moments while viewing the VR film was greater in the group that watched the video first. Participants who viewed the video version first also had a higher initial engagement when viewing the video, while the group that viewed the VR version first showed no significant variation in engagement levels while viewing the immersive narrative, and only a slightly bigger drop between the two key moments of the story when viewing the video format, although the engagement levels in both formats were fairly regular for this group.

Table 3 presents the changes to the results for IRI, BES, EEG in VR, and EEG in the video between the basal and post moments for both groups. Significant differences were observed between the two groups in the changes to the parameters of focus, interest, and stress while viewing the VR version, as the group that viewed the video format first experienced an 11-point drop in focus, while in the group that viewed the VR version first this parameter decreased by only one point. The 1st Video Group also experienced a 16-point drop in excitement and a 10-point drop in interest while viewing the VR version, compared to much smaller decreases for these parameters in the group that viewed the VR format first (−1 and −2, respectively). In addition, an eight-point decrease in stress was observed in the 1st Video Group while viewing the VR version, while the 1st VR Group experienced a two-point increase for this parameter. On the other hand, while viewing the video version, significant differences were observed between the two groups in the changes to excitement

Table 3. Differences in IRI, BES, EEG in VR, and EEG in video between basal and post moments for each study group (1st VR and 1st Video).

	1st VR (*n* = 19)	1st Video (*n* = 25)	*p*-value	Effect sizes
	Post-Basal	Post-Basal		
IRI, median (IR)				
Perspective taking	1 (−1.5; 2.0)	0 (−2.0; 1)	0.250	0.204
Fantasy	1 (0.0; 2.5)	0 (−2.0; 2)	0.109	0.287
Empathic concern	0.5 (−0.8; 2.0)	1 (−1.0; 3)	0.709	−0.069
Personal distress	0 (−1.0; 1.0)	0 (−2.0; 1.3)	0.643	0.086
BES, mean (*SD*)				
Cognitive	0.5 (3.1)	−0.3 (2.9)	0.371	0.280
Affective	0.9 (2.6)	1.3 (3.6)	0.666	−0.132
Total	1.4 (4.5)	1 (5.5)	0.826	0.068
EEG in VR, median (IR)				
Engagement	−3 (−12; 0.5)	−7 (−11; 0)	0.448	0.137
Excitement	−1 (−24.5; 6.5)	−16 (−26; −6)	0.072	0.322
Focus	−1 (−3.5; 11)	−11 (−19; −3)	0.013	0.422
Interest	−2 (−4; 2.5)	−10 (−12; −1)	0.003	0.539
Relaxation	−2 (−11; 6.5)	−9 (−20; −3)	0.104	0.291
Stress	2 (−2; 8)	−8 (−26; 0)	0.002	0.568
EEG in video, median (IR)				
Engagement	−5 (−14.5; 0)	−8 (−15; −3)	0.245	0.208
Excitement	−8 (−19; −4.5)	2 (−8; 8)	0.031	−0.385
Focus	−6 (−10.5; 0)	2 (−4; 13)	0.006	−0.486
Interest	−4 (−10; 1)	−3 (−10; 2)	0.812	−0.044
Relaxation	−9 (−23.5; 2.5)	−8 (−25; 1)	0.924	−0.019
Stress	−2 (−23.5; 2)	−2 (−14; 4)	0.538	−0.112

Notes: IR = interquartile range; *p*-value obtained from t-students (parametric) and U de Mann-Whitney (non-parametric); the effect size was calculated using Cohen's *d* for the BES, and Cliff's Delta for the remaining variables comparing 1st VR versus 1st Video.

and focus. Specifically, the group that watched the video first experienced a median two-point increase in excitement and focus, while an eight-point decrease in excitement and a six-point drop in focus was observed in the group that viewed the VR first. No significant changes were observed in the interpersonal index or empathy scores.

Cohen's *d* values below 0.3 suggest minimal differences between groups in the BES. The remaining variables show small to moderate effect sizes, except for the EEG values for interest and stress in VR and for focus in video, which were all above 0.474, suggesting significant differences between the groups.

The data collected on presence reveals no significant differences between participants who viewed the VR format first (1st VR) and those who viewed the video format first (1st Video) for any of the dimensions assessed in the IPQ (Table 4).

Table 5 outlines the main characteristics of the VR experience perceived by participants. In general, it was observed that participants in both groups felt comfortable with the interactive systems offered (interface; 89.5% and 88%). Furthermore, no significant differences were observed in emotional response (either positive or negative) between the two groups, or in the perception of the presence of characters. Although the two groups reported similar levels of connection with the characters, the group that viewed the VR version first identified less with the main character than the group that viewed the video version first. In relation to comfort with the first-person narrative perspective and with sexual and racial diversity, no significant differences were observed between the two groups.

Participants' perceptions of the image quality of the virtual classroom in the VR experience for both groups (Figure 5a) were varied in some respects. For example, while participants who saw the VR version first rated the "artificial" category higher than the 1st Video Group (42.1% vs. 32%), the latter group rated the "surrealistic" category higher (0 vs. 12%). The 1st VR Group also rated the "strange" category higher (10.5% vs. 4%), while there was no significant difference between the two groups in the "impressive" category (21.1% vs. 20%). Finally, the 1st VR Group rated "beautiful" and "cartoonish" higher than the 1st Video Group (5.3% vs. 0% for both categories). Perceptions of the image quality of the children (Figure 5b) also revealed some differences between the two groups. For example, while members of the 1st VR Group were more likely to describe the images as "realistic" (26.3% vs. 16%), the perception that they were "artificial" was more common among members of the 1st Video Group (28% vs. 0%). In addition, perceptions of the images as "surrealistic" and "confusing" were more prevalent in the 1st video group than in the 1st VR group (12% vs. 5.3% and 12% vs. 5.3%, respectively).

Table 4. Results of IPQ for each study group (1st VR and 1st Video).

	1st VR (*n* = 19)	1st Video (*n* = 25)	*p*-value	Effect sizes
IPQ, median (IR)				
Spatial presence	4 (1; 6)	4 (1; 7)	0.739	−0.061
Involvement	2 (0.5; 5)	1 (−2; 3)	0.278	0.194
Experienced realism	−2 (−2.5; −1)	−2 (−5; −1)	0.290	0.187
General presence	1 (1; 2)	2 (0; 2)	0.626	−0.086

Notes: IR = interquartile range; *p*-value obtained from U de Mann-Whitney; the effect size was calculated using Cliff's Delta for the remaining variables comparing 1st VR versus 1st Video.

Table 5. Post-viewing description of the characteristics of the VR experience by each study group (1st VR and 1st Video).

	1st VR ($n = 19$)	1st Video ($n = 25$)	p-value
Feel comfortable with the interactive systems offered			0.730
Yes	89.5% (17)	88% (22)	
No	10.5% (2)	12% (3)	
Extent of positive emotional response (e.g., moved, sympathetic, compassionate), median (IR)	7 (4.5; 7)	6 (3; 7)	0.185
Extent of negative emotional response (e.g., uncomfortable, worried, anxious, upset), median (IR)	6 (3.5; 7.5)	6 (3; 7)	0.867
Perceived awareness of presence by character, median (IR)	4 (3; 4)	4 (2; 4)	0.709
Perceived awareness of characters towards participant presence, median (IR)	4 (2; 4)	4 (3; 4)	0.126
Selection of image number (in red) reflecting relationship with narrative characters			0.445
1	15.8% (3)	28% (7)	
2–3	47.9% (9)	40% (10)	
4–5	26.3% (5)	12% (3)	
6–7	10.5% (2)	20% (5)	
Degree of comfort with first-person narrative perspective, median (IR)	3 (2; 3)	4 (2; 4)	0.167
Degree of comfort with diverse sexual orientation kissing, median (IR)	5 (5; 5)	5 (4; 5)	0.443
Degree of comfort in collaborating with team members of different race or sexual orientation, median (IR)	5 (5; 5)	5 (5; 5)	0.168

Notes: IR = interquartile range; p-value obtained from U de Mann-Whitney (continuous variables) and Fisher's exact test or Chi-square test (categorical variables).

Tables 6–10, in the Supplementary File, present results broken down by country, consistent with the findings described above, as no significant deviations were observed in the cross-country comparison.

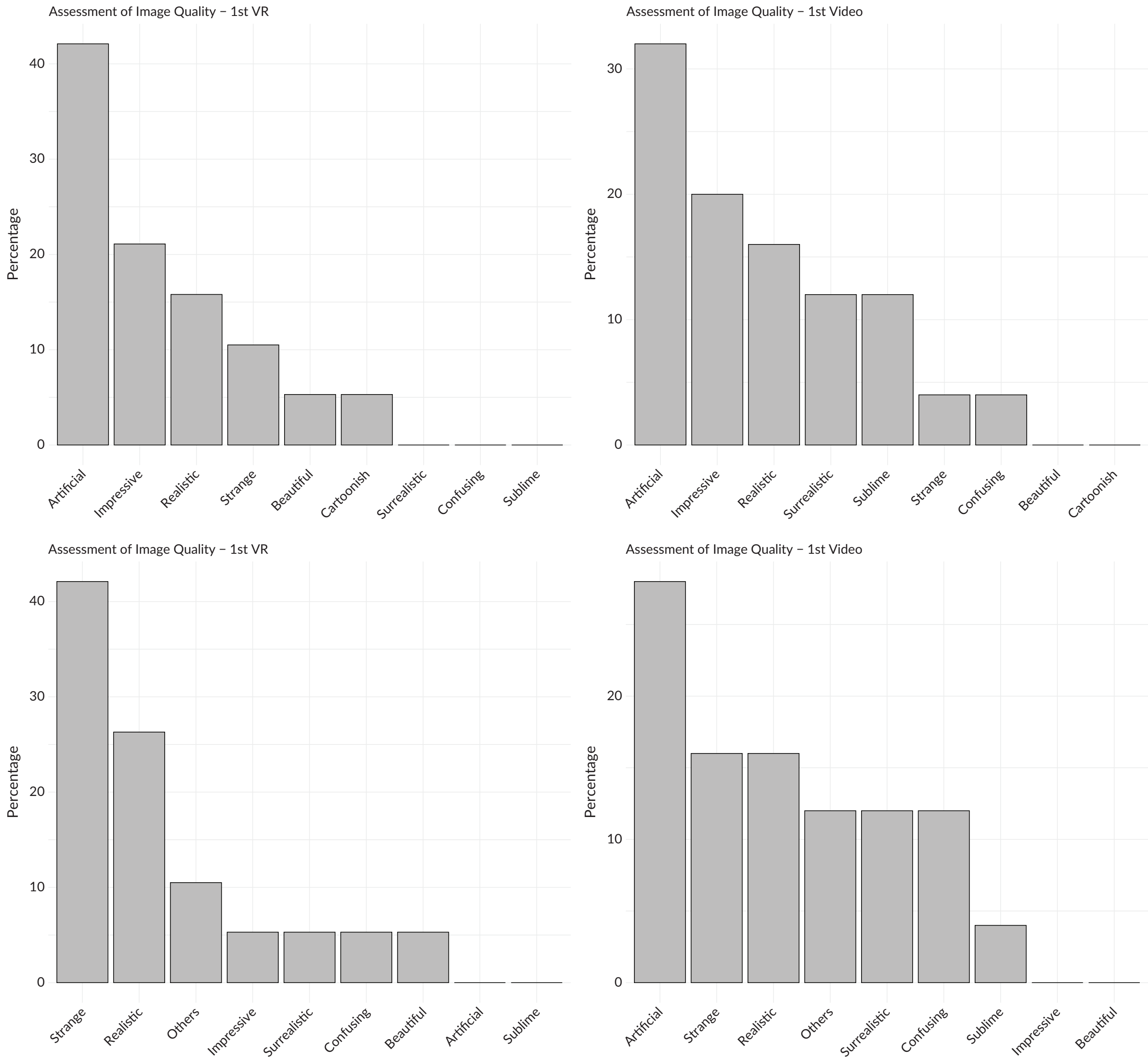

Figure 5. Assessment of image quality of virtual classroom in VR experience (a), and assessment of image quality of children in VR environment (b).

4. Conclusion and Discussion

The results of this study do not establish that the use of a VR narrative is more effective at promoting prosocial behavior than the use of the same narrative in video format, or that the use of VR instead of a traditional screen-based narrative enhances the audience's emotional connection to the narrative content. The drop in the level of engagement between the two key moments of the VR short film was greater in the group that watched the video first, which showed a higher initial level of engagement with the video format, while the group that watched the VR first exhibited no significant change in the level of engagement between the basal and post moments while watching the VR version, and a slightly bigger drop between the two key moments when viewing the video, but the engagement levels in both formats were fairly stable. Although sense of presence has been identified in other studies as one of the key factors behind promoting prosocial behavior using VR experiences, in this study, the VR experience did not show higher levels of presence than the video format, a result that may be associated with the nature of the stimulus itself. Although the immersive stimulus involves 3D recordings of actual actors using volumetric capture, the characteristics of this digital method might induce an uncanny valley effect in participants, thereby impacting the findings related to empathy and engagement. The age disparity between the film's characters and the participants may also have contributed to a sense of detachment, as they no longer relate to the stage of life represented in the film. Sound design, particularly the "boo" subcondition, may have also influenced the level of engagement. This auditory stimulus could have triggered the participants' defensive mechanisms, leading to a subconscious disengagement.

The results also reveal no differences in either positive or negative emotional response between the two groups, suggesting that the prosocial impact of the VR short film was not weaker for the group that viewed the video first, as similar results were obtained for both groups. Thus, in terms of emotional response, the VR narrative had the same impact on both groups. In addition, in the group that watched the video first, the levels of excitement and focus increased by two points between the two key moments of the storyline, while in the group that watched the VR version first, both levels dropped by one point during the VR experience. This finding could be interpreted as indicating that the video format has a greater potential to promote excitement and focus than VR, possibly due to the conditioning of the participants, who have grown up watching audiovisual narratives in 2D formats and are still more accustomed to watching fiction films this way. It is also consistent with the conclusions of Barreda-Ángeles et al. (2020), who contend that immersive media can have the opposite effect of the aim of the narrative due to competitive mediation.

On the question of interpersonal connection and "otherness" in the immersive VR experience, the group that viewed the video format first reported feeling connected to the main character, while the group that viewed the VR version first identified less with that character. This suggests that the order in which formats are viewed may affect audience responses and the impact of narrative content. In this case, viewing the VR version first conditioned the effect of the narrative less than viewing the video format first.

The fact that VR did not have the impact identified in previous studies may also be due to the fact that users are now more familiar with the medium. As Bosworth and Sarah (2018, p. 12) point out, VR has a greater impact on viewers unfamiliar with the technology. In view of these results, it would be advisable to give priority to the narrative over the technological device in order to elicit emotional involvement and prosocial responses from the audience. VR may offer an innovative and more immersive way of storytelling, but it is the story itself that determines the impact on the audience.

Finally, it is important to highlight certain potential limitations of this study. Firstly, although the sample comprises participants from two countries, which may pose an issue in relation to possible cultural differences, the comparative analysis of the data collected by country reveals no significant variations. Secondly, given that participants in both countries might have different linguistic backgrounds, the languages of the stimulus film—shot in Spanish and subtitled in English—could represent a limitation, potentially influencing how participants interpreted the narrative and responded to the stimulus based on their proficiency in Spanish or English. Finally, despite efforts to reduce and shorten the number of survey questions, the extensive use of questionnaires in the study may have induced a fatigue effect in participants, which in turn may have affected the results.

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Conflict of Interests

The author declares no conflict of interests.

Data Availability

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding author.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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