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Immersive documentary journalism: exploring the impact of 360° virtual reality compared with a 2D screen display on the responses of people toward undocumented young migrants to Spain

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The term 'MENA' refers to 'Menores Extranjeros No Acompañados' ('unaccompanied foreign minors') who are child immigrants to Spain who entered alone without legal documentation. Over the years, 'mena' has become a pejorative term associated with criminality, a view especially promoted by some on the political far right. In this article, we describe an experiment where virtual reality (VR) was used to place people among a group of young adults with a 'MENA' background ('ex-mena') to explore how their experience might alter their attitudes about the plight of the MENA. In particular, we were interested in the different influence of a 360 3D video or the same video on a 2D large screen, both experienced through the same VR head-mounted display. There were 51 people recruited for the experimental study, 28 of whom experienced the video in the screen condition and 23 in the 360 video condition. In addition to questionnaires, a sentiment analysis was carried out on short essays that participants wrote after their experience. The results show that sentiment was greater for the 360 video condition than the screen. Lower sentiment scores are associated with sadness, media bias, feeling bad about the conditions of the MENA, the difficulty of integration, and the utility of understanding and empathy. Higher sentiment scores are associated with empathy due to being closer to the situation, knowing the story of the migrants better, politicization, prejudging, feeling sorry for the manipulation of the migrants, and failure of action by the authorities. The 360 video approach used could be an important tool for documentary journalism.

KEYWORDS

immersive journalism, virtual reality, 360 video, MENAS, immigration, Spain

1 Introduction

The concept of "immersive journalism," introduced by de la Peña et al. (2010), "… is to allow the participant to actually enter a virtually recreated scenario representing the news story." Moreover, "An important role of immersive journalism could be to reinstitute the audience's emotional involvement in current events." Here, we describe an experiment that attempts to amplify this statement by considering the in-depth responses of participants who

used virtual reality (VR) to watch a video of a group of young people who had entered Spain alone as children without official documentation ('Menores Extranjeros No Acompañados', MENA, unaccompanied foreign minors, UFM). In particular, we consider whether emotional involvement differs between a group who experienced the video immersively as a full surrounding 360 degrees stereo VR, compared with another group who, although using the same VR equipment, watched the video on a (simulated) large 2D screen.

López-Reillo (2013) reported in 2013 an in-depth study of such unaccompanied minors who emigrated from Africa to the Canary Islands in the early 2000s. The study concentrated on the experiences of the minors, their search for work, what happened to them after they reached majority age, and their motivations and experiences. The local population was positive toward the migrants overall, understanding their motivation and wish to start a new life and integrate into society, with adults and young women, in particular, being protective and disposed toward their social integration. However, in 2021, Bordonaba-Plou and Torices (2021), partly through an analysis of a corpus of tweets, reported that the situation had drastically changed to the extent that 'mena' had come to be used as a pejorative term, driven largely by an extreme right party that used the term frequently in their public discourse, vilifying such migrants, even to the extent that the term had become associated with criminality. More recently, Martínez Lirola (2023) analyzed the portrayal of this group in the Spanish press and found overwhelmingly that the unaccompanied migrants were associated with criminality and 'problem-people', violent behavior, and generally a 'burden for Spanish society'. The author concluded that "what predominates in the corpus is not the vulnerability and necessity of protecting UFM, but the references to UFM in plural and their association with criminalization and violence."

Against this background, we investigated the responses of people to virtually being among a group of UFM who describe their own stories and situations. Specifically, we carried out an experiment to understand whether an immersive encounter, through the use of 3D stereo 360 video seen through a head-mounted display (HMD), would produce different responses compared to those who watched a large flat screen, albeit also viewed through an HMD. There has been considerable interest in the use of 360 videos for news and documentary presentation, and the New York Times produced a 360 video called 'The Displaced'[1] in 2015 that portrayed three children who had been driven from their homes by war as a way to tell the story of the 30 million children who had suffered this fate. It can be displayed using Google Cardboard, a very low-cost device that can display 360 videos. The cardboard arrangement is designed to hold a smartphone, which serves as the display and processing unit. The smartphone screen is divided into two sections to provide a separate image for each eye, creating a stereoscopic 3D effect, and the two screen sections are seen through lenses that attempt to focus the images for each eye. The phone's built-in sensors can detect rotational motion and linear acceleration, forming the basis for 3 degrees of freedom head tracking.

Following this, the NYT started 'The Daily 360' in 2016,[2] and in 2018, it reported that they had 'made 435 videos in 426 days.'[3] Their 360 videos can be viewed on a flat screen, using a mouse or trackpad to rotate the view around the fixed point of the camera. They can also be viewed through an HMD, so that viewers can turn their heads around and look around the scene as if they were there. However, 360 videos only support 3 degrees of freedom head tracking (roll, pitch, and yaw), so that head translations in any direction are not reflected in updates to the displayed images. This can be a cause of simulator sickness due to changes in the vestibular and sensorimotor systems without accompanying visual update. The 360 videos featured many different types of stories, ranging from simple interest ones (such as 'Daybreak Around the World', January 1, 2017)[4] to deadly serious content such as 'The Atomic Bombing of Hiroshima' (August 7, 2017)[5] and the 2017 'We Who Remain'[6] about the war in Sudan, in conjunction with Nonny de la Peña's Emblematic Group, who have produced several immersive documentary news stories but using graphics based VR rather than video (De La Peña, 2017). However, the NYT seems to have discontinued production of 360 videos in 2018. The Guardian newspaper also supported 360-degree videos[7] with similar content to the NYT, and their last posting seems to have been in August 2021 with the story 'How racist propaganda inspired riots in America's biggest cities'.[8] Again, this can be viewed on a normal computer screen, tablet, smartphone, or through an HMD. For example, with the Meta Quest HMD it can be immersively viewed through the YouTubeVR application. Note that both the NYT and Guardian videos are 2D, even though they are 360-degree video, since they were filmed from a single camera (although that camera was typically moved through the scene while making the video). The BBC has also produced 360-degree content,[9] some of it in 3D, and it has also mixed video with computer graphics, such as a documentary that depicted a computer graphics constructed dinosaur combined with video of a famous natural history broadcaster.[10] It should be noted that many videos from these news sources make a fundamental error of moving the camera, which causes simulator sickness for the viewer due to the resulting sensorimotor conflict—the visual system registering movement, whereas the vestibular and sensorimotor systems, indicating that the head is stationary in comparison (this point is taken up further in the Discussion section).

The European Commission, in partnership with Euronews, has produced a range of documentary 360 videos[11] about climate change and other related issues. There have also been several famous examples of 360 videos for news produced by individuals or smaller groups rather than large news organizations. Gabo Arora produced a documentary called 'Waves of Grace'[12] about a survivor of Ebola in Liberia. 'Clouds over Sidra' is set in the Syrian war about a child

1 https://www.youtube.com/watch?v=ecavbpCuvkI&t=4s
2 https://www.nytimes.com/2016/11/01/nytnow/the-daily-360-videos.html
3 https://www.youtube.com/watch?app=desktop&v=iWyQqwNAMdA
4 https://www.youtube.com/watch?v=m9SeJ0XT810
5 https://www.youtube.com/watch?v=Hgp6ZH-by-E
6 https://www.youtube.com/watch?v=d04n6aE8FOk&t=391s
7 https://www.youtube.com/playlist?list=PLa_1MA_DEorE_Qwa-4uURxeOvRxYfqA-6
8 https://www.youtube.com/watch?v=8pvZmfzWW90&list=PLa_1MA_DEorE_Qwa-4uURxeOvRxYfqA-6&index=1
9 https://www.youtube.com/watch?v=8A63jbyk4bM&list=PL5A4nPQbUF8Bc6Z3bCRyC1Wb1kZ8jFNO4
10 https://www.youtube.com/watch?v=rfh-64s5va4
11 https://www.euronews.com/tag/360-video
12 https://www.youtube.com/watch?v=0lwG6MfGvwI

refugee.[13] Louis Jebb and Edward Miller used 360-degree video to cover unrest in Hong Kong.[14]

Such 360-degree videos place the viewer in the midst of the content but do not allow the viewer to move around nor actually interact in any way, though see the study of Landau et al. (2020) and Hasler et al. (2021), who attempt to overcome this limitation. However, it is possible to give the viewer the impression that they are involved in the scenario by using techniques such as players in the video occasionally looking toward or even talking to the camera (i.e., the viewer) as if drawing them into the action. In the BBC's 'Damning the Nile in 360 video, Episode 1', the viewer (you) is sitting around a table in a restaurant with the presenter and others, and suddenly the presenter turns to look toward you and says, "Well you are joining us for a traditional evening meal in Addis Ababa. I know you are only virtually here, I'm going to pour you a glass of water anyway" and continues to fill glass just in front of you.[15] This can be highly compelling, leading to strong plausibility, the illusion that these events are really happening right now (Slater, 2009; Slater et al., 2022). So, while 360 video is not interactive, there can be a strong illusion of 'being there' based on the ability to perceive the scene using normal sensorimotor contingencies for vision (provided that there is no head translation), and plausibility can be fostered to some extent, by drawing viewers into the scenario by glances, and addressing them directly. However, since a 360 video is not interactive, plausibility can break if the viewer does something that requires a response (e.g., asks a question to one of the people on the video), and place illusion, the illusion of being there, can break because head translation does not lead to corresponding image updates. Place illusion and plausibility, although orthogonal, can be considered as two dimensions of the illusion of presence (Held and Durlach, 1992; Sheridan, 1992, 1996; Sanchez-Vives and Slater, 2005; Slater, 2009; Slater et al., 2022).

There has been growing interest in 'immersive journalism' since the de la Peña article that introduced this term in 2010. As an approximate indication of this, for the years 2010–2011, there are 26 articles in Google Scholar that appear under the search term "immersive journalism." For 2018–2019, there are 516; for 2020–2021, there are 705; and more than 877 in the period 2022–2023. There has been some research into how people respond to the immersive presentation of documentary-style news stories. Sundar et al. (2017) carried out a study where participants observed two different news stories in one of three media. Their study with 129 participants was between-groups across three methods of delivery (text, 360 on a screen, and 360 VR using a cardboard headset) and within groups over two different videos, both available from the NYT—one more emotionally arousing ('The Displaced', as discussed above) and 'The Click Effect' about communications between dolphins and whales.[16] The results showed that the 360 VR method resulted in a greater sense of presence (being there, interaction, and realism) than the 360 screen, which in turn was greater than the text presentation. Both of the 360 methods resulted in greater empathy than the text method.

Schutte and Stilinović (2017) investigated the impact on the empathy arising from viewing 'Clouds Over Sidra' (mentioned earlier) through 360 VR, with a headset compared with a screen that was also viewed through the same headset, but which contained one-third of the 360 view, n = 24 in a between-groups design. They found that the VR 360 format evoked greater empathy. Bujić et al. (2020) also studied empathy using a similar strategy where participants experienced a news story related to human rights in 360 VR (n = 31), 360 on a 2D screen (n = 29), and a text-based article (n = 27). Their interest was in how 'stepping into another's shoes' would influence participants' attitudes toward human rights, which were measured pre and post the experience, using a human rights. The overall conclusions were that viewing the content using 360 whether VR or on a monitor screen led to a greater change toward positive attitudes toward human rights than a normal text article displayed on the monitor.

Van Damme et al. (2019) considered a number of delivery methods for a 360 video: a single viewpoint on a laptop display, a condition where viewers on the laptop could rotate their view direction, display of the 360 video on a cardboard device, and the final method was to use an Oculus Rift HMD to view the same 360 video. This was a between-group experiment with n = 153 assigned at random to the four conditions. The experiment assessed presence, enjoyment, topic engagement, and the extent of distant suffering. The video was a news story about a man's experiences during the civil war in Syria, involving fleeing his hometown to work on an oil field to escape the war. The results showed that the more immersive methods led to greater presence and enjoyment, but there were no effects on involvement or distant suffering.

Another study by Frechette et al. (2023) with a similar design examined the effects of the degree of immersivity on the attitudes of people toward the homeless. The conditions were as follows: static photos and text (n = 79), 2D video (n = 89), 360 video on a screen (n = 73), and 360 VR—video using an Oculus Quest headset (n = 56). There was also a control group (n = 172) who watched a 360 video that was unrelated to the issue of homelessness. Participants in the VR condition had the most change in positive attitudes toward the homeless compared to the other conditions and the control group, and generally, the level of immersion was associated with more positive attitude changes toward the homeless.

Overviews and reviews of immersive journalism can be found in Bujić and Hamari (2020) and Kang (2023) and reports from a focus group of experts are reported by Herrera Damas and Benítez de Gracia (2022). A framework was developed by Hardee and McMahan (2017) to assist journalists in understanding the fundamentals of immersion and common immersive technologies and to aid developers in grasping the essentials of journalism and the various types of journalistic stories. This consisted of the fundamentals of immersion and presence, the technology, journalistic principles, and types of stories that might be appropriate.

Given the background of largely negative attitudes toward UFM in Spain, we explored the extent to which a 360-degree video documentary that immersed participants among a small group of young migrants might influence their attitudes about this group. In particular, as with some of the studies described above, we focused on the issue of whether 360 videos displayed in 3D stereo and viewed through an HMD would produce results different from viewing the same content on a 2D screen. However, to make the conditions as similar as possible, participants also

13 https://www.youtube.com/watch?v=FFnhMX6oR1Q

14 https://www.youtube.com/watch?v=39_JlqGj_0Y

15 https://www.youtube.com/watch?v=Un0LWhH-9CI (second 8.38).

16 https://www.youtube.com/watch?v=P_Da5w4UxBo

viewed the 2D video through the HMD on a large simulated screen. We were not interested in studying general reactions such as the sense of presence, or even empathy, but directly assessing the attitudes of participants in open-ended questions that could then be analyzed to extract their feelings about the life situation of the UFM and to compare these among the two groups (screen, 360 video) and also within each group, and in particular how political affiliation may affect these. Anti-MENA feeling is typically stronger among more right-wing individuals. We investigated whether the impact of the exposures was different among people with more left-leaning views, different age groups and other demographic factors.

2 Materials and methods

2.1 Ethics

The study was approved by the Commissió de Bioètica of the Universitat de Barcelona. Participants gave written and informed consent and were free to leave the study at any time without giving reasons. Exclusion criteria were being less than 18 years old, taking psychoactive medicine, having epilepsy, having any pathology that causes nausea, and planning to drive a motor vehicle or work with complex machinery within 3 h after the exposure. All ethical guidelines were adhered to. All people who appeared in the video gave written consent to publication.

2.2 Experimental design

This was a between-group design with one binary factor with levels '360 video' or 'screen'. Both conditions were experienced through the HMD (see Materials). There were 51 participants: 28 were arbitrarily assigned to the 360 video condition and 23 to the screen condition.

2.3 Materials

All participants used an Oculus Quest 1 display. This has a resolution of 1,440 × 1,600 per eye, with a refresh rate of 72 Hz. It has 6 degrees of freedom in head-tracking using an insight tracking system using cameras mounted on the HMD, so that no external sensors are required. It has integrated spatial audio. It weighs approximately 570 g.

The scene was captured with an Insta360 Pro camera. This supports video resolution up to 7,680 × 3,840 with six fisheye lenses. It supports 3D video (as well as 2D) with frame rates up to 100 fps for 4 K video and 30 fps for 8 K.

The Sennheiser EW 112P G4 wireless microphone system was used for audio recording, which operates in the Frequency Range (C-Band): 734–776 MHz, with a transmission range of up to 100 meters and signal-to-noise ratio ≥ 110 dBA.

The video was edited using Premiere Pro. For the '360 video' condition, the scene was played using the 'Meta Quest TV' application. This places the participant in a first-person perspective, seeing in stereo through the eyes of the cameras used for the filming. For the 'screen' condition, the application DEO VR[17] was used. This application was set up so that the video was displayed on a large flat screen. Figure 1 illustrates the difference between the screen and 360 video conditions, although it is not possible to appreciate the 360 video in a static picture.

2.4 Video recording

The video was recorded one day at various locations in Barcelona: the beach area at Port Olympic, on the Montjuic mountain where MENAS has a camp, the Born neighborhood, an apartment and a rooftop, and Plaça de Catalunya. See Figure 2 and the full 360 video, which can be viewed at https://www.youtube.com/watch?v=1c-_XbQqaG4.

At the beginning of the video, three of the ExMenas association volunteers introduce themselves and tell their stories about their journey arriving illegally in Spain from Morocco or their experience as migrant teenagers growing up in Barcelona. There is then an invitation to the viewer/participant of the VR experiment to follow them on a journey through different locations in Barcelona.

All the stories and participants who appear in the video are members and volunteers of the ExMenas association in Barcelona. The stories told, and conversations were real and not scripted but improvised based on a briefing about the theme and objective. The video participants were told that they had to talk to the camera as if they were talking with the viewers of the video.

2.5 Experimental participants

Participants were recruited at the University of Barcelona and through online advertisement in order to recruit people from different ages, ideologies and backgrounds. Of the 51 participants 25 were University students, and 26 were recruited online and directly in Barcelona and Sabadell with an approximate balance of ages and political ideologies.

2.6 Procedures

Participants read an information sheet describing the experimental procedures and then signed a consent form. They then answered a pre-questionnaire concerning demographic information and political orientation (Table 1). They then donned the HMD and watched the video, which lasted for 18:48 min. Then, there was a post-experience questionnaire (Table 2) aimed at assessing their reactions to the experience. This also included a short essay. The questionnaires were accessed online through the Qualtrics interface.[18] Finally, participants were compensated €10 for their time.

17 https://deovr.com

18 qualtrics.com

FIGURE 1
Comparison of screen and 360 video viewing experiences. (A) The initial view in the screen condition shows the full frame. (B) Rotated view in the screen condition, demonstrating a limited field of view. (C) The initial view in the 360 video condition shows user interface elements. (D) Rotated view in 360 video condition, illustrating the immersive experience where the entire environment is visible regardless of viewing direction. The 360 video condition allows participants to explore the entire scene by changing their viewing direction, while the screen condition presents a fixed perspective.

2.7 Response variables

Immediately after the participants had watched the video, they returned to the Qualtrics interface to answer the second questionnaire, and the first question was open ended:

> *essay*: "Please can you write about your experience, mentioning how you felt at the beginning and at the end, anything interesting or unusual that you noticed. Summarize your general feelings."

The answers were used for sentiment analysis, described in the next section. The remaining questions are shown in the first column of Table 2. Some of these questions are simply to ascertain the degree of attention (*allvideo*, *numexmenas*, *numscenes*, *numscarf*, and *finalplace*), while the rest are to assess attitudes toward the situation of the MENAS and the portrayal of a news documentary in this way.

2.8 Sentiment analysis

Sentiment analysis (Bakshi et al., 2016; Liu, 2022) is based on a multitude of classifications of words in dictionaries, which have been assigned positive or negative valence through the use of natural language processing, text analysis, and computational linguistics. A score is derived for each piece of text, for example, as the average score over all the relevant words in the text, though modified by natural language analysis to take account of negations and other grammatical constructs. The response variable was derived for each participant from the essay that they were asked to write immediately after their experience. We used the Hugging Face system (Wolf et al., 2020) in Python with the model 'bert-base-multilingual-uncased-sentiment'.[19] This model "… is intended for direct

19 https://huggingface.co/nlptown/bert-base-multilingual-uncased-sentiment

FIGURE 2
Key scenes from the MENAS experience video. (A) The opening scene at the Barcelona waterfront introduces the ExMENAS members. (B) Montjuïc hill location, depicting challenging living conditions. (C) Group discussion in the Born neighborhood of Barcelona. (D) Concluding scene in Plaça de Catalunya.

use as a sentiment analysis model for product reviews in … [six] languages …, or for further finetuning on related sentiment analysis tasks." In particular, it works with Spanish. All answers, except for one, were in Spanish (Castilian), and the one in Catalan was translated into Castilian. The model estimates sentiment expressed as a number of 'stars'—i.e., scores between 1 (lowest) and 5 (highest) sentiment. For each level, it includes a probability that the predicted score is correct (i.e., a confidence level). However, since there is no ground truth, we do not use these confidence levels in our analysis. We refer the resulting variable as *stars*, which are therefore the sentiment scores for *essay*.

2.9 Statistical methods

All the response variables are either ordinal, such as *stars,* and the answers to the questions in Table 2 are 1–7 Likert scores or are binary, such as *objective*. Therefore, the appropriate statistical models to use are ordinal or binary logistic regression, where *condition* is the primary independent variable of interest. Also, since attitudes toward migrants are likely to be highly influenced by political views, we also consider the influence of *politics_bin* (which henceforth we abbreviate to *politics*). Since there are several response variables, the use of frequentist statistics would be problematic due to the fact that with multiple null hypothesis significance tests, control is lost over the overall significance level, unless *ad hoc* methods such as Bonferroni Corrections are used. Therefore, we use a Bayesian model where all response variables are considered in one overall model from which we can derive multiple probability statements without any diminution of validity.

Suppose that y is an ordered response variable with k levels (e.g., $k = 5$ in the case of *stars*, $k = 7$ in the case of *different_information*), and y_i is the observation for the ith individual, then the ordered logistic model is as follows:

$$\log\left(\frac{P(y_i < j)}{P(y_i \geq j)}\right) = c_j - \eta_i$$

$$= c_j - \left(\beta_1 C_i + \beta_2 P_i + \beta_3 \left(P_i \cdot C_i\right)\right),\ j = 1,2,\ldots,k;\quad i = 1,2,\ldots,n(=51) \tag{1}$$

Here, $P(\ )$ are parameters representing probabilities, and the β shows how the explanatory variables influence the linear predictor η_i.

$$C_i = \begin{cases} 0, Screen\ condition \\ 1,360\ Video \end{cases}$$

$$P_i = \begin{cases} 0, NotLeft \\ Left \end{cases}$$

for the ith individual. $\left(P_i \cdot C_i\right)$ is the interaction term.

The c_j are an ordered sequence of parameters, referred to as cut-points. The interpretation is that there is a latent, unobservable, continuous random variable y_i^*, such that whenever the value of y_i^* crosses a cut point, so the observed y_i increments or decrements a level. In particular: $y_i = j$, when $c_{j-1} < y_i^* \leq c_j, j = 1,2,\ldots,k$ where $c_0 = -\infty$ and $c_k = \infty$. The cut-points are parameters whose values are unknown and estimated from the data.

Rearranging Equation 1

TABLE 1 Summaries of the questionnaire responses prior to the exposure.

Variable	Category	Screen (n = 28)	360 Video (n = 23)
Gender	Male	11 (39.3%)	11 (47.8%)
	Female	17 (60.7%)	12 (52.2%)
Age (years)	Mean ± SD	35.3 ± 14.2	35.4 ± 13.5
Country of origin	Spain	23 (82.1%)	17 (73.9%)
	Other	5 (17.9%)	6 (26.1%)
Education	Undergraduate	20 (71.4%)	15 (65.2%)
	Masters	4 (14.3%)	6 (26.1%)
	Secondary	4 (14.3%)	2 (8.7%)
Employment	Student	10 (35.7%)	10 (43.5%)
	Employed	0 (0%)	1 (4.3%)
	Self-Employed	1 (3.6%)	1 (4.3%)
	Retired	10 (35.7%)	7 (30.4%)
	No Answer	7 (25.0%)	4 (17.4%)
VR experience[1]	Median (IQR)	2 (2)	3 (2)
Video game frequency (last year)[2]	Median (IQR)	2.5 (3)	3.0 (5)
Video game hours (last week)[3]	Median (IQR)	1 (1)	1 (2)
Knows meaning of "MENAS"	Yes	24 (85.7%)	17 (73.9%)
Political ideology	Left	14 (50.0%)	9 (39.1%)
	Not-left (a)	14 (50.0%)	14 (60.9%)
MENAS meaning response	Correct	20 (71.4%)	17 (73.9%)
	Partially correct	1 (3.6%)	1 (4.3%)
	No answer	7 (25.0%)	5 (21.7%)
Interest in MENAS issue[4]	Median (IQR)	4 (2.5)	4 (3.0)
Concern about MENAS impact[4]	Median (IQR)	4 (3)	2 (4)
Frequency of MENAS news exposure[4]	Median (IQR)	4 (1)	4 (1)
Main news source	Social Media	16 (57.1%)	13 (56.5%)
	Television	5 (17.9%)	5 (21.7%)
	Newspapers	4 (14.3%)	3 (13.0%)
	Radio	3 (10.7%)	2 (8.7%)
Opinion on MENAS news coverage	Politicized	19 (67.9%)	17 (73.9%)
	Superficial	8 (28.6%)	5 (21.7%)
	Neutral	1 (3.6%)	0 (0%)
	Objective	0 (0%)	1 (4.3%)

(a) "Not-left" combines indifferent, center, and right responses. The distribution is as follows:		
Indifferent	4	3
Center	0	5
Left	14	9
Right	10	6

1. VR experience scale: 1 (never) to 7 (many times).
2. Video game frequency scale: 1 (0 times) to 7 (>25 times).
3. Video game hours scale: 1 (0 h) to 7 (>10 h).
4. Scale: 1 (not at all) to 7 (a lot).

TABLE 2 Summaries of the questionnaire responses after the exposure.

Variable	Description	Screen (n = 28)	360 Video (n = 23)
allvideo	Watched the whole video	100%	100%
different_information[1]	New information provided	5 (3)	6 (2)
firstperson[1]	Effectiveness of first-person narration	7 (2)	7 (1)
comprehension[1]	Change in understanding of MENAS issue	5 (2)	5.5 (2)
interestvr[1]	Interest in future 360/VR news	5 (3)	5 (1.5)
numexmenas[2]	Number of ExMENAS members identified	3.9 ± 0.26	4.0 ± 0
numscenes[2]	Number of settings identified	6.9 ± 1.34	7.3 ± 1.07
numscarf[2]	Number of members with head scarf	2.0 ± 0.19	2.0 ± 0.2
finalplace	Correct identification of final location	100%	100%
correctly[3]	MENAS treated correctly upon arrival	0%	4%
objective[3]	Media presents objective information	21%	13%
moreinfo[3]	Interest in learning more about MENAS	100%	96%
more360[3]	Interest in more 360 news/documentaries	82%	83%
worry360[1]	Concern about manipulation in 360/VR	4 (2)	5 (3)

1. Reported as Median (IQR). Scale: 1 (not at all) to 7 (a lot).
2. Reported as Mean ± SD.
3. Reported as percentage answering 'Yes'.
Correct answers:
- numexmenas: 4 members
- numscenes: 6 settings
- numscarf: 2 members.

$$P(y_i \geq j) = \frac{1}{1+\exp(c_j - \eta_i)} \tag{2}$$

Hence, the interpretation of each β is that it indicates the increment in the probability of being at any level j or higher, for a unit change in the corresponding explanatory variable, or from Equation 1 the change in log odds.

Binary logistic regression is a special case when there are only two outcomes (e.g., 'No' (0) or 'Yes' (1) in the case of *objective*). In this case:

$$\log\left(\frac{P(y_i=1)}{P(y_i=0)}\right) = \eta_i = \gamma_0 + \gamma_1 C_i + \gamma_2 P_i + \gamma_3 (P_i \cdot C_i)$$

or,

$$P(y_i=1) = \frac{1}{1+\exp(-\eta_i)} \tag{3}$$

Hence, the γ represents the change in log odds in favor of 'Yes' compared to 'No' for a unit increase in the corresponding variable.

We use weakly informative prior distributions for all the parameters (Lemoine, 2019) in the sense that these are proper probability distributions but with wide variance. In this case, we use the normal distribution with mean 0 and standard deviation 10, so that all:

$$\beta, \gamma, c_j \sim normal(mean = 0, standard\ \ deviation = 10)$$

with the addition that the c_j are ordered $c_1 < c_2 \ldots < c_{k-1}$. Therefore, the 95% equal interval credible intervals for all parameters are −20 to 20.

Table 2 shows that some response variables are not worth further analysis, such as *correctly* and *moreinfo*, so we analyze only the ordinal variables *stars*, *different_information*, *comprehension*, *interestvr*, *worry360*, and the binary variable *objective*. All of these are contained simultaneously in one overall model, with each individual variable modeled according to the discussion above.

We use the Stan probabilistic programming language (Stan Development Team, 2011-2019; Carpenter et al., 2017) through the RStudio interface with rstan.[20] Stan uses a Monte Carlo method to estimate the posterior distributions of the model, which converged without problems with 2000 iterations. Some graphs and basic statistics were produced using Stata 16.1.[21]

3 Results

3.1 Participant characteristics

Table 1 shows that the two groups (screen and 360 video) are similar across most of the pre-questionnaire variables. The one with seemingly the greatest difference is *knows_menas*, where it appears that more people in the screen condition (24/28) knew what MENAS meant than those in the 360 video condition (17/23). However, Cohen's h is 0.29, indicating a small to moderate effect size for the difference between the two proportions. It is interesting that the principal news media for both groups is social media (57% for both conditions) and that both groups reported that the main sources of communication were politicized.

20 https://mc-stan.org/users/interfaces/rstan
21 www.stata.com

TABLE 3 The first five essays in Spanish with an English translation.

Spanish text	English translation	Stars
1. La verdad que me he asustado al principio viendo a las personas del video, pero me ha gustad mucho. Realmente es mucho mas cercano cuando te lo explican así, empatizas mas con estas personas. Por otro lado, pienso que el poder ver la realidad que viven en "primera persona," ayuda mucho a ver como es. no es lo mismo verlo en una foto que mediante realidad virtual. me ha gustado mucho. Como critica constructiva, se veia un poco pixelado y eso puede hacer que no lo sientas como real.	The truth is that I was scared at first seeing the people in the video, but I liked it a lot. It really is much closer when they explain it to you like this; you empathize more with these people. On the other hand, I think that being able to see the reality they live in "first person" helps a lot to see what it is like. It is not the same to see it in a photo than through virtual reality. I liked it a lot. As constructive criticism, it looked a bit pixelated, and that can make it not feel like real.	4
2. El video me ha generado un sentimiento de tristeza, ya que no tiene nada que ver cómo se habla de los menores extranjeros en televisión o en los medios de comunicación con lo que en realidad son; niños.	The video has generated a feeling of sadness in me since it has nothing to do with how foreign minors are talked about on television or in the media with what they really are: children.	2
3. La verdad es que mi visión ha cambiado de forma radical ya que, des de un inicio no sabia que significaba el concepto de MENA. Una vez he sabido el significado sí que sabía que lo había visto miles de veces por las noticias, medios de comunicación e incluso en partidos políticos que o bien defienden este colectivo o bien van en su contra. Me he sentido muy mal por ellos ya que, es verdad que muchas veces no nos preguntamos el por qué la gente está aquí, como ha llegado, como se siente y prejuzgamos en función, no de haber visto su situación real sino en función de lo que escuchamos, de gente que no sabe o de medios que intentan conducirnos hasta un terreno que les interesa. Me sabe muy mal que haya gente en estas condiciones, creo que está muy bien que personas como los que han gravado e vídeo lo hayan hecho porqué ver el donde duermen, donde viven, el frío que deben pasar, hace empatizar muchísimo con este grupo de gente. mis sentimientos: me he sentido engañada por los medios, muy afortunada de la vida que me ha tocado vivir, y he sentido mucha pena por la gente que tiene que vivir así y que pasa por situaciones que nadie en el mundo debería de pasar, para encontrar un mundo mejor que no encuentran.	The truth is that my vision has changed radically since, from the beginning, I did not know what the concept of MENA meant. Once I knew the meaning, I knew that I had seen it thousands of times on the news, in the media and even in political parties that either defend this group or go against it. I have felt very bad for them because it is true that many times we do not ask ourselves why people are here, how they have arrived, how they feel, and we prejudge based not on having seen their real situation but on what that we hear, from people who do not know or from the media that try to lead us to a field that interests them. I feel very bad that there are people in these conditions; I think it is very good that people like those who have recorded the video have done it because seeing where they sleep, where they live, and the cold they have to go through, makes you empathize a lot with this group of people. My feelings: I have felt cheated by the media, very lucky for the life I have had to live, and I have felt very sorry for the people who have to live like this and who go through situations that no one in the world should go through, to find a better world that they do not find.	2
4. Tanto al principio como al final del vídeo comprendo que la situación que viven los MENAS no es nada sencilla, ya que nunca es fácil irte a otro país y menos siendo menor. me ha sorprendido el escenario del piso de okupa que estaba en muy buenas condiciones, ya que las veces que he podido presenciar una casa ocupada siempre las he visto en pésimas condiciones. Evidentemente, creo que hace falta más empatía hacia estas personas.	Both at the beginning and at the end of the video, I understand that the situation that the MENAS are experiencing is not easy since it is never easy to go to another country, especially if you are a minor. I was surprised by the scenario of the squatter flat that was in very good condition; since the times that I have been able to witness an occupied house, I have always seen them in terrible condition. Obviously, I think more empathy is needed toward these people.	3
5. Me ha gustado mucho. Me ha parecido muy interesante. Es necesario que la gente empatice para poder entender situaciones a las que por suerte muchos no hemos estado. Este vídeo ayuda a poder ver a estas personas de una manera más próxima y personal, te da la oportunidad de verlos de una manera más cercana (ya que mucha gente no daría la oportunidad ni de tener una conversación).	I liked it a lot. I found it very interesting. It is necessary for people to empathize in order to understand situations that, luckily, many of us have not been to. This video helps to be able to see these people in a closer and personal way; it gives you the opportunity to see them in a closer way (since many people would not even give you the opportunity to have a conversation).	4

The variable *stars* is the sentiment analysis output from the hugging face model on the integers 1 (low sentiment) to 5 (high sentiment).

The variable *politics* is divided into four categories, some with frequencies that are too low for viable statistical analysis. However, it is likely that there is a social desirability bias that leads some to report themselves as 'center' or 'indifferent' rather than 'right', especially in a face-to-face interview (Rinken et al., 2021). We, therefore, simplify this category into the new variable *politics_bin* (binary) with categories 'left' and 'not-left' as shown in the table.

3.2 Sentiment analysis

Table 3 shows examples of the essays and corresponding stars (sentiment scores). The essays of the first five participants are given in the original Castilian and with the English translation.

Table 4A shows the means and standard deviations of the number of words in the essays, and Table 4B shows the frequency distributions

TABLE 4 Sentiment analysis results by condition.

(A) Mean ± SD of the number of words in the essays.			
	Screen	360 Video	Overall
Number of words	74.2 ± 47.98	65.6 ± 40.40	70.3 ± 44.06

(B) Frequency distribution of the number of stars.					
No. of stars	Screen	%	360 Video	%	Total
1	1	3.6	1	4.3	2
2	10	35.7	2	8.7	12
3	5	17.9	6	26.1	11
4	9	32.1	11	47.8	20
5	3	10.7	3	13.0	6
Total	28	100.0	23	100.0	51

over the number of stars by condition. The greatest difference is that the number of '2-star' scores (low sentiment) is much greater for the screen condition than the 360 video. The percentage of 4 or 5 stars is 60.8% for the 360 video and 42.8% for the screen. Figure 3 shows the histograms of the number of stars for the screen and 360 video conditions. The distribution of the scores for 360 video is weighted more toward higher values than the distribution of the scores for the screen condition.

3.3 Statistical analysis

In the following, we first use the statistical model to analyze these data together with the questionnaire scores and then carry out a further analysis to understand the meaning of the sentiment scores.

Table 5 shows the posterior distributions of the parameters of interest based on Equations 1, 2 for the ordinal scores and Equation 3 for the binary response score *objective*. The 95% posterior credible intervals are much narrower than the prior intervals ±20, which shows the impact of the data. We will consider as strong inferences cases where the probability of the parameter being positive is at least 0.9 (or equivalently, at most 0.1 for negative associations). Moderate inferences are based on probabilities at least 0.8 (or equivalently, at most 0.2).

The number of *stars* (sentiment) is positively associated with the 360 video condition compared to the screen condition (prob = 0.935) and also positively influenced by being politically left (prob = 0.909). The 360 video and politics left contribute approximately equally. The extent of *different_information*, obtaining information from the exposure that was not known before, is less for the screen condition than the 360 video condition (prob = 1–0.004 = 0.996). Correspondingly, the change in understanding of the MENAS issue (*comprehension*) is less for the 360 VR condition (prob = 1–0.052 = 0.948) and for those with left attitude (prob = 1–0.022 = 0.978). There is moderate evidence that comprehension is greater for those in the 360 video condition with left attitudes (prob = 0.849). There is moderate evidence that those with left attitudes and who experienced the 360 video condition (*interestvr*) had a greater interest in viewing future news this way (prob = 0.826). Those with left political attitudes were less likely to be worried that the level of manipulation would be greater through the method that they experienced than conventional media (*worry360*) (prob = 1–0.037 = 0.963). Those who experienced the screen condition and with not-left attitudes were less likely to consider that conventional media is objective toward the MENAS (objective) with prob. = 1–0.013 = 0.987. A moderate inference is that irrespective of political views, those who experienced the 360 video condition were less likely to believe in the objectivity of conventional media (prob = 1–0.117 = 0.823).

3.4 Interpretation of the texts

The interpretations of the questionnaire scores are derived from the meanings of the questions. However, the sentiment scores, apart from being ordered with respect to sentiment, have no intrinsic meaning without more information about the texts that gave rise to them. Here, we carry out further analyses of the essays in order to throw greater light on this and look more deeply into the relationship between the experimental conditions and the essays written by participants.

For text summarization, we employed the BART model (Lewis et al., 2019) as implemented in the Hugging Face Transformers library (Wolf et al., 2019) using Python. The summarizer allows a maximum of 1,024 tokens for text input; therefore, we had to split the text into segments. If the total number of tokens exceeded 1,024, we split the text into 2, 3, … pieces so that each piece had approximately an equal number of tokens, and none exceeded 1,024. The aim was to obtain a summary of between 50 and 100 words for each individual segment; however, this is not strictly under control since the method works on tokens rather than words. We then combined the summaries of the segments together. This BART model supports English best, so we used the translations.

The results are shown in Table 6. Lower sentiment scores are associated with sadness, media bias, and feeling bad about the conditions of the children—pointing out that they are indeed children, the difficulty of integration, and the utility for understanding and empathy. Higher sentiment scores are associated with empathy due to being closer to the situation, knowing the story of the migrants better, politicization, prejudging, feeling sorry for the manipulation of the migrants, and the authorities not doing enough. The higher sentiment essays discuss the root causes of why the minors are in their situation, mentioning the roles of mafias, corrupt regimes, stringent religious practices, and poverty in their countries of origin. It also explicitly critiques the authorities for not doing enough to both control illegal immigration and integrate these young people.

Table 7 shows the summaries for the screen and 360 video conditions, irrespective of *politics*. The screen condition text evokes feelings of sadness, fear, and helplessness, whereas the 360 video is focused more on clarity and anger, specifically regarding misconceptions about MENAS. The screen condition highlights the disparity between media portrayals and the actual lives of foreign minors, whereas the 360 video condition refers to the value of the experience in offering a truer understanding of MENAS and correcting misconceptions. Overall, the screen condition emphasizes the maltreatment of children, the ineffectiveness of the childcare

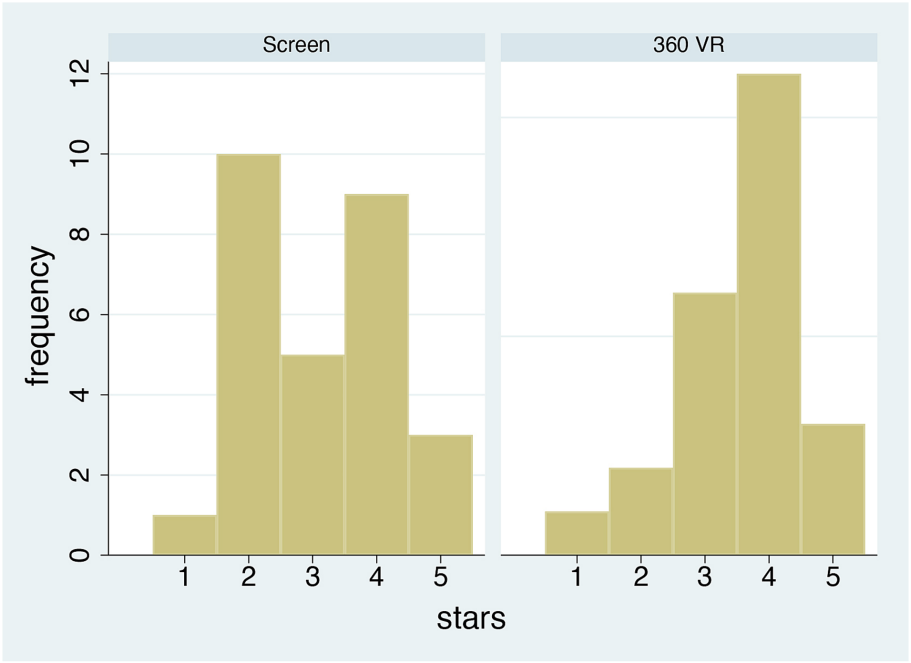

FIGURE 3
Distribution of the number of stars by condition.

system, and the powerful impact of this mode of viewing, whereas the 360 video focuses more on its potential as an educational tool, correcting misperceptions about MENAS and promoting empathy and understanding.

Table 8 shows the summaries for the not-left and left essays. In the not-left essays, there is an emphasis on the disparity between media portrayal and the reality of foreign minors, whereas the left essays focus on the broader concept of MENAS and the situation behind it. While the not-left essays show stronger reactions about the conditions these minors live in, including shock that such situations exist in Spain and criticism toward the government's action, in the left essays, the sadness seems more related to the broader issue of illegal immigration.

4 Discussion

Participants watched a video where they were addressed by young members of an immigrant community, specifically those who had arrived in Spain undocumented as children. The youngsters gave the participants an account of their lives as if they were directly talking to them. In one condition, participants saw this on a large fixed flat screen (screen), as if at a cinema, and a different group saw the video in full 360-degree surround in stereo (360 video). Both groups saw the video through a head-tracked stereo HMD, but the head tracking was effectively limited to 3 degrees of freedom (rotation but no translation) due to the inherent limitations of 360 videos. For those in the screen condition, head movements would only alter their view of the screen but not influence the presentation of the video, whereas those in the 360 video condition could rotate their heads and look around as in reality (except that head translation would have no effect). Our major question of interest was whether there would be differences between these two conditions, but also considering the fact that the issue is controversial, and typically immigration is viewed differently by those with a left political viewpoint compared with others; therefore, we also took this into account.

A clear finding is that sentiment was greater overall for those in the 360 video condition than those in the screen condition. While both screen and 360 video essays express compassion and a desire for better understanding and treatment of MENAs, the screen essays show a more personal and emotional reaction, while the 360 video essays take a broader societal viewpoint, touching on deeper causes and the role of authorities. The not-left group gained different information compared to their prior knowledge (compared to the other conditions) (*different_information*), and specifically, those not-left who experienced the screen condition had the greatest *comprehension*. Those with left views in the 360 condition expressed the greatest interest in following up with this way of presenting news (*interestvr*). Those with not-left views in the 360 video condition were more likely to be worried about this technology being used for manipulation, but they were also most likely to agree that current media were not *objective*, although this was true for all groups.

Previous studies have shown that 360 VR leads to greater presence (place illusion), enjoyment, and credibility. Vettehen et al. (2019) compared 360 video to a 2D screen, both presented through an HMD. Here, we wished to equalize the plausibility aspect of presence since the video itself was deliberately designed to heighten plausibility, the illusion that the depicted events were really happening. The protagonists spoke to the camera as if they were directly talking to the participant. One of the requirements for plausibility is that there should be events that directly address the participant, and this was accomplished in this way. For example, Bergström et al. (2017) found that plausibility was higher when members of a virtual string quartet looked toward the participants than when they did not. However, unlike the study reported by Vettehen et al. (2019), we have concentrated

TABLE 5 Summaries of the posterior distributions of the parameters showing the means and standard deviations, the 95% credible interval, and the probability of the parameter >0.

Response variable	Coefficient of	Mean	SD	2.5%	97.5%	Prob > 0
stars						
β_1	*condition*	1.09	0.69	−0.25	2.46	0.935
β_2	*politics*	0.98	0.74	−0.43	2.45	0.909
β_3	*condition×politics*	−0.36	1.09	−2.45	1.81	0.370
different_information						
β_1	*condition*	−0.41	0.69	−1.77	0.91	0.277
β_2	*politics*	−1.82	0.72	−3.24	−0.47	0.004
β_3	*condition×politics*	0.62	1.07	−1.42	2.76	0.715
comprehension						
β_1	*condition*	−1.08	0.68	−2.41	0.25	0.052
β_2	*politics*	−1.44	0.71	−2.83	−0.08	0.022
β_3	*condition×politics*	1.16	1.12	−1.06	3.37	0.849
interestvr						
β_1	*condition*	−0.24	0.67	−1.60	1.05	0.367
β_2	*politics*	0.34	0.72	−1.07	1.70	0.684
β_3	*condition×politics*	0.98	1.04	−1.03	3.04	0.826
worry360						
β_1	*condition*	−0.03	0.65	−1.29	1.22	0.474
β_2	*politics*	−1.21	0.71	−2.67	0.14	0.037
β_3	*condition×politics*	0.83	1.04	−1.18	2.89	0.797
objective						
γ_0		−1.43	0.69	−2.97	−0.18	0.013
γ_1	*condition*	−1.63	1.45	−4.79	0.81	0.117
γ_2	*politics*	0.43	0.92	−1.37	2.27	0.683
γ_3	*condition×politics*	1.18	1.80	−2.21	5.04	0.742

on the effects of the different formats for the presentation of news—in particular, on attitudes and information changes, the potentiality of the manipulation: whether the presentation of news leads to changes in attitudes when presented in 360 stereo form compared to a 2D screen, whether participants want to have further experience of this for news presentation, and how it might influence their attitudes toward a controversial issue. Related to this Kang et al. (2019) found that watching a news presentation in 360 with a headset (Google Cardboard) or on a Smartphone, where the view could be manipulated by rotating the phone, resulted in higher news credibility than watching it on a standard 2D screen. This is an important issue because if the credibility is greater and 360 also produces attitude changes, as we have found, then this does raise the ethical issue of the potentiality for manipulation.

However, attitude changes are not inherently manipulative—since they could simply mean that participants have gained new information on which those changes are based. This seems to have occurred, for example: "The 360 video experience in VR has made me reflect and change my perspective and opinion on the situation of MENAS," and "The video has helped me to understand their situation and not to prejudge so much. I feel very bad that there are people in these conditions," also "A video has helped me understand the concept of MENAS and what is really behind it. It is necessary for people to empathize in order to understand situations that luckily many of us have not been to." Beforehand, the issue of the MENAS was abstract and about unknown, faceless people. The screen format presents information, and the 360 video format not only does this, but it is also apparently directly presented to the participants by people who are in the same (virtual) space as them. It is more like being with someone who explains their issues than learning about them from a more distant perspective (Kross and Ayduk, 2017).

The issue of "empathy" was raised by some of the participants, although it was never a goal of our documentary to induce empathic feelings. The concept of empathy has been quite controversial, with various different definitions, but a recent review by Eklund and

TABLE 6 Summaries of low and high sentiment of the essays using the BART hugging face model.

Lower sentiment stars ≤ 3, n = 25	*Higher sentiment stars* ≥ 4, n = 26
The video has generated a feeling of sadness in me, since it has nothing to do with how foreign minors are talked about on television or in the media with what they really are; children. I feel very bad that there are people in these conditions, I think it is very good that people like those who have recorded the video. I disagree with the child care system as it really is not an effective system. I could not feel how they really feel on a daily basis but I can understand it. It is intolerable to allow the bad treatment that is given to children. As an immigrant, I feel a lot of empathy and understanding for the situation of unaccompanied minors (MENAs) I arrived in Spain when I was a minor, and despite being with my family and doing it legally, integration was, and continues to be, very difficult. VR videos like the one I just saw could be a useful tool to improve empathy, understanding, and integration.	It really is much closer when they explain it to you like this, you empathize more with these people. I have had mixed feelings, since indirectly the media have made me have a friend that is totally different from what it is. We really cannot judge any of their decisions or acts until we know their story. I believe that the issue of the MENAS is highly politicized and objective information has never reached us. I've tried to empathize but I'm aware that I cannot feel the same as them. It makes me very angry that minors are prejudged by linking them to crime. The story gives a human, supportive and positive version of the reality of unaccompanied minors (MENAs) I feel very sorry for these minors who are deceived by the mafias and the problems of the country of origin: corruption, radical and intransigent religion, dictatorships, poverty. The authorities are not doing enough to stop illegal immigration and integrate these people.

n refers to the number of participants in the cell.

TABLE 7 Summaries of screen and 360 video essays using the BART hugging face model.

Screen, n = 28	*360 Video*, n = 23
The video has generated a feeling of sadness in me, since it has nothing to do with how foreign minors are talked about on television or in the media with what they really are; children. The truth is that I was scared at first seeing the people in the video, but I liked it a lot. It really is much closer when they explain it to you like this, you empathize more with these people. I think I have learned a lot on the subject. For example, that many children leave the centers and live on the street, and it would be necessary to see why that happens. I disagree with the child care system as it really is not an effective system. In the end I felt helpless due to the lack of help. It is intolerable to allow the bad treatment that is given to children. It is definitely more impressive to see this story in VR and told by its protagonists. I have seen part of the reality of the MENAS that I did not know and it has made me very sad.	Virtual reality has helped me understand the concept of MENAS and what is really behind it. I felt anger knowing that many people only see the MENAS as problems and do not stop to think that if they are here in this situation, it is for a reason. It seems to me a very good awareness campaign and a good use of technology. VR videos like the one I just saw could be a useful tool to improve empathy, understanding, and integration. The video has helped me understand the problems of these young minors, it creates empathy, you realize that these young people are not criminals or radical Islamists.

n refers to the number of participants in the cell.

TABLE 8 Summaries of not-left and left essays using the BART hugging face model.

Not-left, n = 28	*Left*, n = 23
The video has generated a feeling of sadness in me, since it has nothing to do with how foreign minors are talked about on television or in the media with what they really are; children. The video has helped me to understand their situation and not to prejudge so much. I feel very bad that there are people in these conditions. I never thought that in Spain there could be minors living on the street, let alone in those conditions. I am surprised that the government does not really do everything it could do in these situations with more empathy and citizen responsibility. The video has helped me understand the problems of these young minors. The 360 video experience in VR has made me reflect and change my perspective and opinion on the situation of MENAS. The main problem is that a minor should not have to travel alone to seek a better life in another country. I would never allow my children to make this dangerous journey and have to survive on the streets.	A video has helped me understand the concept of MENAS and what is really behind it. It is necessary for people to empathize in order to understand situations that luckily many of us have not been to. Both at the beginning and at the end, I felt sad since illegal immigration is something that happens continuously in our country. VR videos like the one I just saw could be a useful tool to improve empathy, understanding, and integration. I could not feel how they really feel on a daily basis but I can understand it. The fact that it's a made-for-VR video projected onto a flat screen is disconcerting.

n refers to the number of participants in the cell.

Meranius (2021) suggested that the various conceptualizations are similar. The emerging consensus is that empathy involves understanding the mental state of another person, feeling and resonating with their emotions, while maintaining a differentiation between themselves and the other person (or group). There is a strand of thought where VR is thought of as an 'empathy machine' (Bevan et al., 2019), the idea being that placement of people in the situations of disadvantaged or discriminated-against groups using VR would result in an increase in their empathy toward those groups. However, in the MENAS documentary, there is no hint of the placement of participants in the situation; instead, the idea is that the young people just explain and demonstrate their stories, i.e., provide information. In an important article on this issue Sánchez Laws (2020) pointed out that the original article that introduced 'immersive journalism' (de la Peña et al., 2010) did not, and was not designed to induce empathy toward Guantanamo Bay prisoners, and that

subsequent immersive journalism pieces, although aimed at inducing empathy, did not do so.

Bloom (2018) has argued convincingly, and with associated empirical evidence, that empathy may not be a desired outcome for prosociality but instead argues for rational compassion: caring for others and wanting to help them, but without necessarily adopting their emotional state. For example, Schutte and Stilinović (2017) exposed people to 'Clouds Overs Sidra' (mentioned earlier) in a headset with 360 video, or in the same headset but on a simulated 2D screen, and found that empathy was greater in the first. Lee et al. (2023) examined the impact of presenting disaster news through 360 video versus a two-dimensional laptop screen on empathy and fear. The results showed that the 360 video condition resulted in greater cognitive empathy and presence, but not affective empathy or fear. However, it is not known if these types of effects lead to any enhanced information, understanding or changed attitudes on the part of the participants. Nevertheless, Frechette et al. (2023) did find that participants who experienced a 360 video through an HMD were more likely to display prosociality toward the homeless than those in other experimental conditions. Although empathy was mentioned as a possible explanation, it was not actually measured. We have shown elsewhere that the very attempt to induce empathy, by putting people 'in the shoes' of others and subjecting them to adverse conditions that those people face, can actually lead to an increase of implicit bias against them (Banakou et al., 2020). Although the concepts of empathy, sympathy and compassion are distinct (Singer and Klimecki, 2014), they can be confused in everyday language. Hence, we cannot conclude that participants in the scenario became empathic with the protagonists; indeed, there is one comment that illustrates this: "I could not feel how they really feel on a daily basis but I can understand it." It is the understanding that is crucial.

de Bruin et al. (2022) analyzed 189 immersive journalistic productions and found that the actual level of user immersion is limited, with many productions offering minimal interaction and technical inclusion possibilities. This may go along with the possible decline in the use of 360 videos by major outlets—they seem to have been abandoned by the NYT, The Guardian and the BBC, for example. Another important reason for this decline in the use of 360 videos may be the impact of simulator sickness—which would occur if the camera were moved during the filming so that the participant would have the visual illusion of movement while the somatosensory and vestibular feedback contradicts this.

People may argue that VR could be akin to other media, that over time, its impact will diminish—referring to the often reported incident where people ran out of an early cinema because the film depicted a fast approaching train, even if there is some doubt about whether this incident actually occurred (Loiperdinger and Elzer, 2004). However, VR is quite different to cinema. In the cinema, people very quickly learn that they are not in the same space as the train; they just turn their heads away from the screen, and they are perceptually back in real-world space. But in VR, if they turn their heads, they are still in the VR. Our sensory systems provide very strong evidence about where we are and what is happening through our perception of the VR world through natural sensorimotor contingencies. Moreover, plausibility operates through events in the virtual world responding to the actions of the participants, and when there are contingent actions that refer personally to the them (such as a virtual character smiling at or looking toward them). This does not happen in the cinema.

The study presented in this article attempts to throw further light on the possible use of immersive 360 video for immersive documentary journalism. Compared to watching a large 2D screen, it can lead to a deeper understanding of a controversial issue, lead to greater sentiment, greater anger at a perceived injustice, and change attitudes based on new information. It is not a substitute for traditional video journalism but offers another technology for journalists to exploit in order to present the news.

There are many other aspects to consider with respect to the deployment of immersive journalism beyond the scope of what is covered in this article. For example, in earlier work, we noted that immersive journalism might have a different objective in its presentation of news since "the goal is not so much the presentation of 'what happened' but to give people experiential, non-analytic insight into the events, to give them the illusion of being present in them" (Slater and Sanchez-Vives, 2016). This can lead to a different understanding of events compared to traditional formats, and even though it may have problems with objectivity, so do presentations with other forms of media; this is inevitable since even what is selected as 'news' in any media depends on the decisions of editors and reporters.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Commissió de Bioètica of the Universitat de Barcelona. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

Author contributions

RG: Writing – review & editing, Visualization, Software, Investigation, Data curation, Conceptualization. CT: Writing – review & editing, Investigation, Data curation. MS: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

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Conflict of interest

RA is a video journalist who works for the Catalan TV Channel TV3. MS is a Founder of the company Virtual Bodyworks, which specializes in using VR in the context of DEI.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2024.1474524/full#supplementary-material

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