



Virtual reality versus classic presentations of mass media campaigns: Effectiveness and psychological mechanisms using the example of environmental protection

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ABSTRACT

Virtual reality (VR) and 360° VR videos are increasingly important for media advertising campaigns due to their immersive potential. This particularly applies to topics many recipients find difficult to grasp, including environmental protection issues. However, previous research on the effects of 360° VR videos on users' environmental attitudes and behavioural intentions, compared to more traditional media, came to mixed results and lacked a consistent approach regarding the considered presentation modes and mediating mechanisms. To address this circumstance, we compare the effects of 360° VR videos with 2D video, audio, and printed text, and examine the potential roles of spatial presence, narrative transportation, and affect. We presented three environmental protection documentaries in one of the four presentation modes to the participants, who then rated their experiences as well as their environmental protection and donation intentions. We analysed data from 128 participants and examined the main effects of presentation mode (360° VR video vs. 2D video vs. audio vs. text) on spatial presence, narrative transportation, and positive and negative affect as well as indirect effects of presentation mode on participants' environmental and donation intentions via these four psychological mechanisms. Results revealed that the 360° VR video condition evoked significantly stronger feelings of spatial presence, narrative transportation, and positive affect than the other conditions. We also found significant indirect effects of presentation mode on environmental protection and donation intentions via narrative transportation. These results emphasise the relevance of the narrative for virtual marketing campaigns and the need to consider mediators in VR research.

1. Introduction

With the increasing popularity of affordable devices, Virtual Reality (VR) – defined as a “three-dimensional, computer-generated, lifelike environment” (Vallance & Towndrow, 2022, p. 1) – is gaining popularity with private consumers. As a result, VR is increasingly adopted as presentation media. The spreading availability of affordable VR devices such as Head Mounted Displays (HMDs) has made VR increasingly vital in marketing and advertising campaigns. Companies try to influence consumer attitudes and purchase intentions by allowing them to ‘be’ at the scene of an advertisement and to experience products directly in VR (Dietrich et al., 2019; Pala et al., 2022; van Kerrebroeck et al., 2017). Consequently, VR has already become a popular medium in fields like tourism (Adachi et al., 2022; Chen & Yao, 2022; Huang et al., 2016) and education (Au & Lee, 2017; Han et al., 2022; Markowitz et al., 2013).

VR has lately gained increasing significance as a tool for promoting

charitable purposes. Many famous non-profit organisations have cooperated with technology companies in recent years to use VR in their fundraising campaigns (e.g. Amnesty International, 2017; International Rescue Committee, 2016; UNICEF USA, 2015) due to its potential to generate donations more effectively than more traditional media (Kristofferson et al., 2022). Convincing people to engage with issues and problems that seem geographically and emotionally distant is one of the most significant challenges for these organisations (Orgad & Seu, 2014; Zheng & McKeever, 2016). Immersive media content can create the impression of being physically present in a distant, problem-ridden location. This experience can enhance compassion and ultimately encourage prosocial behaviour (Ahn et al., 2013; Fonseca & Kraus, 2016; Frechette et al., 2023; Nikolaou et al., 2022), underlining the potential of VR to support charitable causes.

With the urgent discussion about environmental protection and climate change, 360° videos – omnidirectional videos that enable

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viewers to look around a 360° view of a scene from a specific point (Mendes et al., 2020) – are particularly receiving attention from non-profit environmental organisations for charity, fundraising, and advertisement. These organisations aim to motivate consumers to donate and invest time or money in environmental protection behaviour (Kandaurova & Lee, 2019) by letting them experience 360° videos through HMDs (subsequently called 360° VR videos). Consequently, studies on the effectiveness of 360° VR videos to increase environmental protection and donation intentions have come into focus of recent research.

Previous studies have revealed mixed results, though. On the one hand, research has shown that 360° VR videos positively influence environmental protection behaviours (Breves & Heber, 2020; Hofman et al., 2022) and donation intentions (Kandaurova & Lee, 2019; Kristofferson et al., 2022; Nelson et al., 2020; Nielsen, 2017; Yoo & Drumwright, 2018), especially when compared to 2D videos. On the other hand, various studies have found no additional benefits of 360° VR videos over 2D videos (Breves, 2020; Martingano et al., 2023; Thoma et al., 2023), illustrating the need for clarification by further research. Additionally, most of these studies have compared 360° VR videos with 2D videos, but studies varied in the way they integrated videos, which other modes of content presentation they included, and whether and which mediating variables and mechanisms they considered.

To address these empirical gaps, the present study investigates the effects of 360° VR videos on the attitudes of recipients towards the content of environmental protection campaign videos and the recipients' intention to engage in environmental protection, namely by their intention to participate in environmental protection efforts and to donate money. The research objectives of the present study are three-fold: First, we investigate to what extent the type of audio-/visual presentation of information influences the three psychological mechanisms assumed to be central experiential processes in the context of media-related information processing. These include the experience of spatial presence, narrative transportation, and affect. Secondly, it will be investigated whether these three mechanisms mediate the assumed influence of the form of information presentation on environmental attitudes and behavioural tendencies or whether direct effects can be observed. Thirdly, in this context, we contrast the respective effectiveness of four different audio-/visual forms of presentation, namely 360° VR videos, 2D videos, audio files, and printed text. To achieve these research objectives, we implemented a single-factorial experimental design in which we showed three environmental documentaries in one of four presentation modes to the participants who rated their experience as well as their environmental protection and donation intentions after each documentary.

1.1. Why 360° VR videos for charity advertising? – the promising mechanisms of spatial presence, narrative transportation, and affect

Spatial presence (subsequently called presence) and narrative transportation are critical factors in the persuasion of consumers through marketing and advertising in virtual environments and VR. Understanding these factors is essential for understanding the broader impact of VR marketing (Barnes, 2016). Since presence and narrative transportation are distinct constructs (Cummings & Bailenson, 2016), it is important to consider both concepts when examining the effects of 360° VR videos on recipients' attitudes and intentions. In addition to presence and narrative transportation, affect is a crucial aspect of persuasion (Fox et al., 2009; Girard et al., 2009; Skalski et al., 2009). Especially donation appeals and narrative charity video messages seem to be particularly effective in eliciting affect (Liang et al., 2016; Rodriguez et al., 2014). Thus, we investigate the underlying roles of the psychological mechanisms of presence, narrative transportation, and affect for the potential effects of 360° VR videos in the context of environmental protection campaigns. We will present these three constructs in detail in the following three subsections, focusing on the constructs'

definitions, their dependence on audio-visual presentation formats, and their potential role as mediating mechanisms.

1.1.1. Spatial presence

Presence (also known as spatial presence or telepresence) pertains to the subjective feeling of being physically present in the depicted scene. According to Steuer et al. (1995), the vividness (realism), i.e. the sensory richness of the environment produced by the medium, and the interactivity of the medium, i.e. the degree to which recipients can influence the form or content of the medium, determine presence. Thus, immersive technological properties like improved user tracking, stereoscopic imagery, multimodality, and extended fields of view in displays mainly generate presence (Biocca, 1997; Li & Lee, 2019; Slater & Wilbur, 1997; Sundar et al., 2017), such as given with current HMDs and 360° VR videos (Cummings & Bailenson, 2016; Slater & Sanchez-Vives, 2016; Vettehen et al., 2019).

Presence plays a pivotal role in VR advertising (Barnes, 2007, 2016). Cummings and Bailenson (2016) conducted a meta-analysis to assess how varying levels of immersive technology influence the sense of presence. Overall, they found a moderate effect on spatial presence. Highly immersive environments and presentation modes within environmental and humanitarian campaigns elicit stronger feelings of presence compared to less immersive environments (e.g., Breves & Heber, 2020; Kang et al., 2019; Ma, 2020; Moriuchi & Murdy, 2022; Nelson et al., 2020; Sundar et al., 2017; Vettehen et al., 2019; Walewijns et al., 2023). Accordingly, Ma et al. (2023) more recently reported a large effect of the immersion level's impact on presence in their meta-analysis, underlining the impact of immersive presentation modes on the feelings of presence.

Several studies in the fields of VR marketing and advertising have shown that presence is a key aspect of the persuasive effects of immersive environments and technology, as it is already extensively examined as a mediating mechanism for the persuasive effects of VR on users (for a current literature review, see Breves, 2023). For example, presence plays a crucial role in consumer persuasion (Fox et al., 2014). Sundar (2008) posits in the Modality-Agency-Interactivity-Navigability (=MAIN) model that three cues related to presence serve as heuristics for evaluating message quality and credibility: the feeling of being there (i.e., the users' feeling of being located in the virtual environment), interaction (i.e., the possibility of intuitive actions in the virtual environment), and realism (i.e., the closeness of the virtual environment to physical reality). Furthermore, based on an extensive literature review on the mediating role of spatial presence for persuasion, Breves (2023) describes how immersive media can have a persuasive or less persuasive effect through presence in the four-step model of persuasion through spatial presence: In step 1, spatial presence elicits an illusion of a direct experience. In step 2, this experience changes the perception of the media content and can have an impact on affect and emotion, message evaluation (e.g., credibility and media involvement), and enhances personal involvement and engagement. Consequently, in step 3, cognitive processing of the media content can be biased by generating more thoughts that are consistent with the message and fewer thoughts that are inconsistent with the message (i.e., reduced persuasive resistance). Finally, in step 4, this can affect attitudes and behavioural intentions so that persuasion is consistent with the message. Importantly, immersive media can also lead to inconsistent persuasion due to negative side effects such as cybersickness and cognitive load (Breves, 2023).

In a study on immersive journalism, Sundar et al. (2017) had already examined the effects of VR videos, compared to 360° videos on a traditional computer and text with pictures, on the three presence heuristics of the MAIN model. The authors found that the feelings of being there, interaction, and realism were higher for the VR videos and 360° videos on a traditional computer compared to the texts, and that the feeling of being there was even higher for the VR videos compared to the 360° videos. Importantly, all three heuristics played a significant (but inconsistent) role in the indirect effects of presentation mode on

outcome variables such as story-sharing intentions and perceived source credibility (Sundar et al., 2017). In the context of advertising, presence influences consumers' attitudes and behavioural intentions in favour of the advertised message (e.g. Griffin et al., 2017; Tussyadiah et al., 2018; van Kerrebroeck et al., 2017). Lee and Li (2023) found that presence mediated the relationship between immersive technology and the intention to volunteer and donate. Ma (2020) found that stories told in immersive virtual environments, compared to traditionally mediated environments, led to higher levels of presence, which in turn increased narrative transportation and identification.

All in all, previous research successfully demonstrated the potential of experienced presence as a mediating mechanism for the persuasive effect of immersive technologies, both in general and in the field of news stories and advertising.

1.1.2. Narrative transportation

Weibel and Wissmath (2011) differentiate between *presence* (see above) and *flow*. Flow refers to the sensation of being mentally engaged in the narrative. In this context, Green and Brock (2002, 2000) characterize this mental engagement into a narrative as *narrative transportation*, the "integrative melding of attention, imagery and feelings [...] where all mental systems and capacities become focused on events occurring in the narrative" (Green and Brock, 2000, p. 701). This state can occur in response to both fiction and non-fiction. Intense participation in a narrative causes individuals to construct vivid mental images, experience intense emotions, and lose awareness of their real surrounding as they immerse themselves in the alternative reality of the story (Ma et al., 2023). Green and Brock (2002, 2000) describe in their Transportation-Imagery Model that this immersion in the narrative's story leads to its persuasive potential by reducing cognitive resistance and narrative-inconsistent cognitions. So, real-world events and facts become less accessible due to the transported participants' mental focus on the mediated world, which also results in a reduction of the individual's cognitive capacity. Consequently, individuals who are narratively transported lack the ability or motivation to critically analyse the narrative content and to form counterarguments against it. Thus, narratives can impact the real-world beliefs of those who experience narrative transportation (Green & Brock, 2000, 2002). For the present study, mental immersion and transportation into the narrative of the audio-/visually presented environmental protection campaign may be a mechanism through which the presentation mode influences users' attitudes and behavioural intentions. It is conceivable that people who feel immersed in the narrative of the environmental protection campaign may be less likely to create counterarguments against it and ultimately show higher protection and donation intentions. Hence, it is also important for the present study to examine narrative transportation in addition to presence, as distinct constructs (Cummings & Bailenson, 2016).

Indeed, in contrast to research on presence, few studies have explored the effects of presentation modes on narrative transportation. Nevertheless, there is reason to believe that narratives within highly immersive environments have a positive impact on narrative transportation, with technical and narrative immersion being positively connected (Elmezeny et al., 2018). For instance, Walter et al. (2017) showed that audio-visual narratives, in contrast to printed media, enhanced narrative transportation due to richer sensory input. Similarly, 360° VR videos offer increased sensory input, which encourages more natural interactions and reduced external distractions (Ma et al., 2023), thereby enabling the viewer to focus on the narrative and resulting in stronger narrative transportation into the story (Pianzola et al., 2019). Conversely, in their meta-analysis, Ma et al. (2023) did not find any effects of immersive environments on narrative transportation, attributing this to the limited number of studies included, which again underlines the need for further research on the effects of immersive presentation modes on narrative transportation.

Regarding narrative transportation, Van Laer et al. (2014) extended

Green and Brock, 2002, 2000) Transportation-Imagery Model by describing the influence of narrative transportation on beliefs, affects, and behaviour, known as *narrative persuasion*. They emphasise that the characteristics of the storyteller, such as identifiable characters and plot, and the story-receiver, like familiarity, attention, and transportability, are positively related to narrative transportation, which in turn impacts the users' affective responses, critical and narrative thoughts, beliefs, attitudes, and intentions. There is already evidence that narratives and narrative transportation are associated with message perception and an increased likelihood of donating (Correa et al., 2015; Morgan et al., 2009). Ma (2020) found that narrative transportation mediated the influence of presentation mode on participants' prosocial attitudes. Chen and Yao (2022) corroborated these findings by showing that narrative-induced transportation can reinforce viewers' positive attitudes towards an advertised object.

All in all, these findings suggest that narrative transportation is also a potentially crucial aspect of persuading consumers in environmental protection campaigns and is therefore worth considering when investigating the effects of presentation mode and 360° VR videos on consumers.

1.1.3. Affect

Regarding affect, we refer to Watson and Tellegen (1985) and Watson et al. (1988), who defined positive and negative affect as distinctive dimensions that describe peoples' emotional states. Positive affect (PA) describes "the extent to which a person feels enthusiastic, active, and alert. High PA is a state of high energy, full concentration, and pleasurable engagement, whereas low PA is characterized by sadness and lethargy" (Watson et al., 1988, p. 1063). Negative Affect (NA) describes subjective distress and negative mood states including, for example, anger, fear, and nervousness. People with high negative affect are feeling irritable, nervous, and anxious, while low negative affect is characterized by calmness (Watson et al., 1988; Watson & Tellegen, 1985). Thus, we investigate both positive and negative affect as potential mechanisms for the use of 360° VR videos for charity.

There is evidence suggesting that 360° VR videos can elevate the recipients' affect due to their immersive qualities compared to 2D videos in general (Diemer et al., 2015; Visch et al., 2010; Juan & Pérez, 2009) and specifically in the domain of environmental protection campaigns (Nelson et al., 2020). Notably, Nelson et al. (2020) found that 360° VR videos, compared to 2D videos, not only increased positive affect but also elevated negative affect. However, a comparison of the effect of 360° VR videos with various presentation modes on positive and negative affect is missing, and especially negative affect has been neglected in the context of VR advertising and charity. Thus, we now close this research gap by also examining the effects of 360° VR videos on positive and negative affect as well.

In the context of affect, donation appeals and narrative charity video messages are particularly effective in eliciting the experience of positive affect, which, in turn, can enhance donation intentions (Liang et al., 2016; Rodrigue et al., 2014). Given that positive affect is linked to increased perceived credibility and decreased reactance against persuasive messages (Fox et al., 2009; Girard et al., 2009; Skalski et al., 2009), the heightened positive affect experienced when watching 360° VR videos could lead to greater agreement with the environmental protection campaign and, consequently, leading to an increase in environmental protection intention and donation intention. Importantly, experienced negative affect can be as effective, or even more effective, than positive affect in positively influencing donation behaviour and motivating environmental protection behaviour (Baberini et al., 2015; Bennett, 2015; Erlandsson et al., 2018; Liang et al., 2016). This indicates that positive and negative affect may also prove to be important factors in the effects of 360° VR videos in the context of environmental protection campaigns.

In summary, we understand presence as the subjective feeling of being physically at the scene, narrative transportation as the subjective

experience of mental engagement in the narrative, and affect as peoples' emotional states comprised of positive and negative affect. Previous research suggests that especially 360° VR videos have the potential to impact viewer opinions and behaviours as they affect the sense of presence, narrative transportation, and affect, which in turn seem to be related to viewer persuasion.

1.2. 360° VR videos versus other presentation modes in the fields of charity and environmental protection campaigns: state of research and the present study

Previous research already compared the effects of 360° VR videos with other various presentation modes on consumers' attitudes and perceptions regarding charity and fundraising. Table 1 provides an overview of relevant studies, including the modalities that were compared, the topic, dependent variables, and whether they already conducted mediation analyses. We identified five studies which had already compared 360° VR videos with other presentation modes in the context of environmental issues. The rest of the studies in the field of charity focused on the areas of health, humanitarian, or social issues. In general, previous research on the effects of 360° VR videos on recipients' attitudes and behavioural intentions in the context of charity focused on examining the impact of such videos on attitudes towards the charity goal, donation behaviour, presence, and emotional and empathetic responses of the recipients.

1.2.1. Review of previous research

Previous research (see Table 1) has come to mixed results. On the one hand, watching 360° videos via an HMD or a VR device resulted in higher hypothetical donation intentions (Moriuchy & Murdy, 2022; Walewijns et al., 2023; Yoo & Drumwright, 2018), actual donations (Kristofferson et al., 2022), intentions to spend effort (Lee & Li, 2023; Yoo & Drumwright, 2018) and time (Kandaurova & Lee, 2019) on charity, and environmental commitment (Breves & Heber, 2020) compared to watching it on a 2D screen. In addition, 360° video watched via HMD led to a higher percentage of donors and higher donation amount compared to a written donation appeal (Gürerk & Kasulke, 2021). Furthermore, attitudes towards homeless people and the intention to help them were also highest when participants saw a video about them via an HMD in a VR condition than when they experienced it through an interactive 360° video where they could manually influence the perspective, a 2D video, and a text with images, all three via the screen of a self-selected device such as smartphones, tablets, and laptops (Frechette et al., 2023). Nelson et al. (2020) found that 360° videos increased donations for environmental protection and fundraising campaigns than unidirectional videos, especially when the video's message was negatively framed compared to positively framed messages. Presence (Walewijns et al., 2023), narrative engagement (Pressgrove & Bowman, 2021), and emotional responses like empathy (Kandaurova & Lee, 2019; Walewijns et al., 2023), guilt, and responsibility (Kandaurova & Lee, 2019) mediated the relationship between presentation mode and behavioural intentions. Furthermore, Breves and Heber (2020) showed that immersive videos elicited a stronger commitment to the environment and that the need for affect moderated this effect. Thoma et al. (2023) demonstrated that exposure to both 360° VR and traditional media – such as 2D videos, images with text, and plain text – increased participants' environmental awareness, but this was only significant in the VR condition. In summary, these studies highlight the potential of 360° VR videos and the potentially important role of presence, narrative transportation, and affect to positively influence attitudes towards the charity causes depicted in the campaign videos.

On the other hand, though, there are studies that could not find any added value of 360° VR videos. For example, Martingano et al. (2023) found no significant effects of 360° VR videos on donations when the content was presented using an HMD compared to other modalities like

audiobooks and computer desktops. Similarly, Breves (2020) could not find any significant differences in donation amounts between 360° VR videos viewed via HMDs and passively watching it via a flat screen. Gürerk and Kasulke (2021) also found no significant differences in donation amounts between 360° videos watched via HMD compared to watching and interacting with the video content on a flat screen. Walewijns et al. (2023) demonstrated that though 360° VR videos positively impacted donation intentions, this did not transfer into actual donations. In addition, Fonseca and Kraus (2016) found effects of 360° videos via HMD (compared to watching it on a tablet) on pro-environmental attitude, but not on pro-environmental behaviour. Finally, Pressgrove and Bowman (2021) could not find any effects of 360° VR videos, compared to watching the 360° video on a flat screen and in 2D, on narrative engagement which in turn would have been related to behavioural intentions. Kristofferson et al. (2022) and Pressgrove and Bowman (2021) also found no mediation roles of presence for the effect of presentation mode on attitudes and behavioural intentions. These studies therefore raise the question of the actual impact of 360° VR videos compared to other presentation modes, and why these studies have come to such different conclusions.

1.2.2. The present study

Some of the reasons for the mixed results of previous studies presumably lie in the way they operationalized the modes of presentation, i. e. at the level of the independent variables. Other reasons lie at the level of the dependent variables, both for the outcomes under consideration and for the potential mediating variables. In the following, we therefore classify the present study in this respect and derive the specific hypotheses.

To further clarify the benefits of 360° VR videos for environmental campaigns, we compare 360° VR videos with a set of different presentation modes. First, we compare them to 2D videos and printed text, as those comparisons have already been done. However, results were mixed. To broaden the focus of previous studies, we additionally include an audio condition. Surprisingly, no study has implemented audio in this field to date. Only Martingano et al. (2023) included a combination of audio and text in the form of an audiobook. However, the investigation of audio appears to be relevant due to the increasing popularity and use of podcasts. For example, 45 % of respondents in Germany stated that they occasionally listen to podcasts, compared to 33 % before the COVID-19 pandemic (Bitkom, 2024). Podcasts are already used for education about environmental protection and awareness (Kurniawati et al., 2024; Mulki & Ormsby, 2022; Strickland et al., 2021), thus it is interesting to examine whether they may have potential for environmental protection campaigns too.

The literature review above highlighted the particular importance of the concrete implementation of the presentation modes. A guiding concept for the present study is that of mental imagery, which is strongly related to the quality of different presentation modes (e.g., Alyahya & McLean, 2022; Wu & Lai, 2023). This concept has been often and very similarly defined so far: Finke (1989) has defined it as the mental invention or reformulation of an experience that is in some respects similar to the experience of actually experiencing an event, either in conjunction with or without direct sensory stimulation. Drigas et al. (2020, p. 18) defined it "as the blend of all the senses that are designed to create or reformulate a picture or mental condition in the mind", and MacInnis and Price (1987, p. 473) postulated that it is "a processing mode in which multisensory information is represented in a gestalt form in working memory". In this sense, the type and comprehensiveness of audio-visual information should play a key role in the process of media consumption. The 360° VR videos and their 2D versions are identical in terms of the visual and auditory content presented, although the immersive potential is much more pronounced in 360° VR videos. The audio and text conditions, on the other hand, require recipients to mentally generate suitable images themselves to a larger degree. While the audio condition replicates the original audio track of the videos and

Table 1

Overview of previous studies that compared 360° VR videos with other presentation modes regarding their effects on recipients' attitudes and intentions in the context of charity.

Reference	Topic	Compared presentation modes					Measured variables	Analysis of mediation effects
		360° VR video	2D video	audio	text	special feature		
Breves and Heber (2020)	Environmental issues	yes	yes	no	no		Spatial presence; environmental connectedness; need for affect (moderator)	no
Breves (2020)	Health issues	yes	yes	no	no	Additional condition: 360° VR video viewed with cardboard HMD	Spatial presence; empathic parasocial interaction; issue involvement; request for information; willingness to donate; amount of money donated	Spatial presence mediated the effect on empathic parasocial interaction; Empathic social interaction mediated the effect on issue involvement
Fonseca and Kraus (2016)	Environmental issues	yes	yes	no	no		Presence; narrative engagement; presence in narrative and empathy/sympathy for the character; pro-environmental attitude; pro-environmental behaviour	no
Frechette et al. (2023)	Social issues	yes	yes	no	no	Additional condition: text with photos	Attitudes towards the homeless; intent to help	no
Gürerk & Kasulke (2021)	Humanitarian issues	yes	yes	no	yes	Interaction (moving camera) was enabled in the 2D condition	Presence; attitudes towards refugees; empathy; donation amount; percentage of donors	Empathy did not mediate the effects of presentation mode
Kandaurova & Lee (2019)	Environmental issues	yes	yes	no	no		Study 1: Immersion (manipulation check); empathy; responsibility; Study 2: immersion (manipulation check); willingness to donate money; willingness to volunteer time; Study 3: immersion (manipulation check); empathy; guilt; responsibility; time donation; money donation	Study 1: Empathy mediated the effect of presentation mode on responsibility; Study 3: Empathy, guilt, and responsibility serially mediate the effect of presentation mode on time and money donation
Kristofferson et al. (2022)	Social issues	yes	yes	no	no	Interaction (moving camera) was enabled in the 2D condition.	Study 1: donation amount and percentage of donors; downstream support measures; Study 2: donations: donation amount and percentage of donors; Study 3: donation amount and percentage of donors; downstream support measures; physical presence	Physical presence did not mediate the effects on donations
Martingano et al. (2023)	Social issues	yes	no	no	no	Additional conditions: 360° footage with perspective-taking instructions; audiobook on virtual whiteboard (text and audio combined); 360° video of a waiting room (control condition)	Dispositional empathy; familiarity with technology; emotional empathy; cognitive empathy; self-efficacy; presence and interactivity; emotional arousal; emotional responsiveness; prosocial behaviour: donation amount and percentage of donors	no
Nelson et al. (2020)	Environmental issues	yes	yes	no	no	Both types of videos (360° and 2D) viewed with HMDs.	Donations: contribution amount; and percentage of donors; emotional responses; presence	no
Pressgrove & Bowman (2021)	Humanitarian issues	yes	yes	no	no	Additional condition: 360° video on standard monitor	Narrative engagement; presence; attitudes; perceived norms; perceived behavioural control; behavioural intentions	Narrative engagement, not presence, was related to attitudes and behavioural intentions
Thoma et al. (2023)	Environmental issues	yes	yes	no	yes	Additional condition: images with text	New ecological paradigm; climate change scepticism; nature relatedness; implicit association test for environmental awareness; presence; suspension of disbelief; enjoyment (manipulation check)	no
Walewijns et al. (2023)	Humanitarian issues	yes	yes	no	no	Additional condition: 2D-360° (2D screen, rotating camera angle possible)	Spatial presence; empathy; responsibility; guilt; issue involvement; donation intentions; donation behaviour	Presence and empathy mediated the relationship between VR on donation intentions
Yoo & Drumwright (2018)	Humanitarian issues	yes	yes	no	no		Perceived vividness; perceived interactivity; donation intention; social presence; sensation seeking tendency	Social presence mediated the effect of the presentation mode on donation intentions

thus depicts the temporal relationship of events identically to the videos, the text-based condition offers a visual representation of information that is, however, fundamentally different from the predefined images of the video conditions and at the same time eliminates the original tempo of the sequence of events. This condition thus offers the greatest degree of freedom for the recipients concerning the generation of mental images of the scenes and sequence of events described.

With regard to the outcome side, it is noteworthy that of the five studies in the field of environmental issues, only one study has examined mediation at all (see Table 1). Thus, in the present study, we focus particularly on indirect effects of the presentation mode through the vital mechanisms of perceived presence, narrative transportation, and affect. This combination of possible mediation variables, although intensively discussed in the literature and studied in isolation so far, has not yet been realised. With respect to the dependent variables, we focus on environmental protection intention and donation intention of the recipients, as most of the previous studies in the field of environmental issues and charity included those dependent variables. We expect main effects of the presentation mode on perceived presence (H1a), narrative transportation (H1b), positive affect (H2a) and negative affect (H2b). Moreover, we expect significant indirect effects of the presentation mode on environmental protection intentions (H3a) and donation intentions (H3b) through presence, narrative transportation, and positive and negative affect. To sum up, we hypothesized.

H1a. There is a significant effect of the presentation mode on the recipients' subjective feeling of presence.

H1b. There is a significant effect of the presentation mode on the recipients' subjective feeling of narrative transportation.

H2a. There is a significant effect of the presentation mode on recipients' positive affect.

H2b. There is a significant effect of the presentation mode on recipients' negative affect.

H3a. There are indirect effects of the presentation mode on environmental protection intentions through presence, narrative transportation, and positive and negative affect.

H3b. There are indirect effects of the presentation mode on donation intentions through presence, narrative transportation, and positive and negative affect.

2. Methods

To examine the (indirect) effects of presentation mode on the dependent variables, we employed a four-levelled, between-participants independent variable for the presentation mode (360° VR video vs. 2D video vs. audio vs. text). We preregistered the experimental protocol and analysis plan on Open Science Framework prior to its realisation (<https://osf.io/p6qze/>). We performed all procedures in accordance with the ethical guidelines of the German Psychological Society (DGPs) and with the 1964 Helsinki declaration. Additionally, the Ethics Committee of the Faculty of Human Sciences at the University of Cologne assessed our experiment as uncritical and approved the present study (September 27, 2019, registration number: KKHF0036).

2.1. Sample

We conducted an a priori power analysis with G*Power (Faul et al., 2009) to determine the required sample size for an ANOVA (with fixed effects, omnibus, one-way: testing the effect of the presentation mode on presence, narrative transportation, and affect). We estimated an effect size of $f = 0.3$ which was based on previous work that found medium effects of 360° VR videos on recipients' attitudes and behavioural intentions (cf. Vettehen et al., 2019). We set the error probability at $\alpha = .05$ and aimed for a test power of 0.8. The analysis indicated a required

sample size of 128 participants, which corresponds to 32 participants per presentation mode. Consequently, we collected the data of 128 participants (71.9 % female, 27.3 % male, 0.8 % diverse; $M_{\text{age}} = 25.23$; $SD_{\text{age}} = 8.10$), forming the basis for all analyses. The sample consisted primarily of students (71.9 %), followed by full-time employees (12.5 %), pupils (6.3 %), part-time employees (5.5 %), and self-employed persons (3.9 %).

We focused on young academics as especially this group perceive climate change and environmental protection as a serious threat and is concerned about these issues (e.g. D'Uggento et al., 2023; Poortinga et al., 2023), thus they are the main target groups for 360° VR videos on environmental protection. We deliberately refrained from assessing pro-environmental attitudes, as an assessment after the experiment would mean that they had already been influenced by the manipulation, and a survey before the start of the experiment would have run the risk of sensitization and thus a possible influence on the effectiveness of the manipulation. Campbell and Stanley (1966) already described such sensitizing effects as a methodological challenge. Hoeken (1994, p. 76) accordingly concluded that "results show that pretesting leads subjects to stick to their initially expressed attitude thereby obscuring persuasive effects". Therefore, our participant acquisition strategy focused on young academics whose pro-environmental attitudes have already been demonstrated at the group level. Please also note that we conducted a real experiment, so inter-individual differences in pro-environmental attitudes should have been evenly distributed across the experimental groups and thus should not have had a significant impact on the results.

Participants were recruited through social network groups, internal university mailing lists, and personal contact. The only inclusion criteria were a minimum age of 18 and proficiency in the German language. All participants provided their informed consent and were randomly assigned to one of the four experimental conditions. Some students were able to earn credit points for their participation depending on their field of study.

2.2. Procedure

At the beginning of the 45-min experiment, we welcomed the participants and randomly assigned them to one of the four presentation modes: 360° VR videos, 2D videos, audio tracks, and texts. We then briefed participants with background information on the documentaries' topics and the tasks. Depending on the condition, we presented three environmental protection documentaries in a balanced order to the participants, either as printed texts, as audio tracks, as a 2D video on a TV, or via 360° VR video using an HMD. In the 360° VR video condition, we adjusted the HMD to fit the participants' head size before the presentation to ensure visibility. Like the other conditions, we seated the participants in the 360° VR video condition during the presentation to prevent loss of balance. After each documentary, the participants completed questionnaires to assess the dependent variables related to the documentary they just got. Upon getting all presentations, the participants provided demographic information (age, gender, and occupation). At the end of the experiment, the participants received compensation in the form of course credits, if needed, and were dismissed afterwards.

Importantly, after careful consideration, we decided not to implement an attention check into the experiment for three reasons: Firstly, we were interested in the holistic effect of the entire documentary and not the effect or memory of a specific scene or detail. Thus, the selection of the content of an attention check would have been rather arbitrary and not a precise indicator of the depth of perception of the entire documentary. Second, several studies have shown that although immersive VR elicited higher feelings of presence than a 2D presentation (Makransky et al., 2017), higher motivation, interest, and engagement than a self-directed PowerPoint slideshow on a desktop computer (Parong & Mayer, 2018), and more positive attitudes towards the experience than a 360° video playing on a flatscreen computer (Chen &

Yao, 2022), immersive VR led to reduced learning outcomes (Makransky et al., 2017; Parong & Mayer, 2018) and reduced recall performance (Chen & Yao, 2022). Accordingly, the validity of an attention check, in which specific content of the documentaries is queried, would be fundamentally questionable regarding the target variables of the present study. Thirdly, it was a laboratory study in which the participants had little opportunity to engage in activities other than stimulus processing in individual sessions and under the observation of an experimenter.

2.3. Material and measurements

2.3.1. Stimulus material: documentaries

To achieve generalizability and validity of our results, we implemented several thematically related stimuli, as suggested by Pressgrove and Bowman (2021). We presented a total of three nature documentaries as environmental protection campaign videos and assessed the dependent variables after each video. The German and international divisions of Greenpeace produced and published the original videos on YouTube. These videos report on specific environmental issues in various natural regions, such as pollution, and directly appeal to the consumers at the end of the presentation to assist in protecting these areas. The documentary “On board the Beluga II” (3 min, 21 s) addresses the severe plastic waste pollution around the Inner Hebrides, a group of islands off the west of Scotland, which threatens marine habitats. “Discover the Arctic” (3 min, 22 s) discusses the threat to Arctic wildlife posed by diminishing ice due to global warming and the interest of oil companies in drilling for oil. “Amazon” (3 min, 30 s) explores the imminent destruction of the Amazon rainforest due to the planned construction of more than 40 dams, threatening biodiversity, the homeland of the indigenous Mundurucu people, and an essential ecosystem crucial for oxygen production and climate regulation. We obtained prior consent in writing from Greenpeace to use the videos for scientific purposes.

For the text and audio conditions, we made sure that the original video material was designed in such a way that the transcription of the audio track (i.e., texts) and the audio track itself could be used meaningfully independently of the images in the videos and that the narrative could be conveyed regardless of the form of presentation. This was an important prerequisite for the stimulus material, as the visual images of the videos only visualise content that reflects the audio tracks of the videos (and thus their transcription) since the narrative is conveyed exclusively via the audio track. This ensures that the content and narrative remain comparable regardless of the form of presentation.

2.3.2. Hardware

In the text condition, participants read the transcription of the audio tracks on paper (Din A4, Times New Roman, 12 point, 1.5 spacing). In the audio condition, the participants listened to the audio tracks of the videos on a Motorola z2 Play smartphone through noise-cancelling headphones (Sony WH-1000 XM2). Each participant set the volume individually beforehand. In the 2D condition, participants viewed the documentaries on a 55-inch Sony Bravia TV. The videos were played on a Sony PlayStation 4 Pro via the corresponding YouTube app. For the 360° VR video condition, we used the HMD Meta Quest and the corresponding YouTube app to present the documentary videos to the participants. The app enabled immersive viewing that encompassed the participants' entire field of vision, which could be adjusted by head movements.

2.3.3. Questionnaire

We implemented several paper-pencil questionnaires and scales, described in the following paragraphs.

2.3.3.1. Presence. To assess the experience of spatial presence, we used the MEC-Spatial Presence Questionnaire (MEC-SPQ, Wirth et al., 2008;

Cronbach's $\alpha \geq 0.930$ for each of the three documentaries). This questionnaire in German language consists of eight items measuring the subjective feeling of presence experienced by the participants. For this, participants indicated on a five-point scale ranging from 1 (*not at all*) to 5 (*very much*) to what extent they agree with different statements about the experienced spatial presence (e.g., “I had the feeling of being in the middle of the action instead of just following it from the outside”).

2.3.3.2. Narrative transportation. To measure the subjective feeling of narrative transportation, we adapted and translated Green and Brock's (2000) eleven items of their Transportation Scale ($\alpha \geq 0.754$ for each of the three documentaries). Since this scale was originally developed to assess the experienced narrative transportation in texts, we modified the items to match each of the four experimental conditions accordingly (e.g., “I was mentally involved in the scene during the report” instead of “I was mentally involved in the narrative while reading it”). Participants indicated the extent to which they agreed with the different statements about their experienced narrative transportation on a seven-point scale ranging from 1 (*not at all*) to 7 (*very much*).

2.3.3.3. Positive and negative affect. We implemented the German version of the Positive and Negative Affect Schedule (PANAS; Krohne et al., 1996) to assess the affective impact of the documentaries on the participants. This questionnaire contains two different scales, one for positive affect ($\alpha \geq 0.720$ for each of the three documentaries) and one for negative affect ($\alpha \geq 0.873$) with ten items respectively adjectives each. The items for the positive affect are *active, interested, joyful, strong, excited, proud, enthusiastic, awake, determined, and attentive*. The items for the negative affect include *grieved, angry, guilty, scared, hostile, irritable, ashamed, nervous, upset, and anxious*. Participants indicated the extent to which they experienced these reactions during the report on a five-point scale ranging from 0 (*not at all*) to 4 (*very much*).

2.3.3.4. Environmental protection intention. We assessed environmental protection intention using an adapted version of the Environmental Movement Activism scale from the Environmental Attitude Inventory (Milfont & Duckitt, 2010; $\alpha \geq 0.891$ for each of the three documentaries). We translated the ten items of the scale into German using a translate-translate-back method and matched the items to the presented scenes in the documentaries. In this questionnaire, participants specified the extent to which they agreed with different statements about their intention to assist Greenpeace in protecting the natural areas featured in the documentary (e.g., “I would like to join Greenpeace in actively contributing to the protection of the presented natural area”) on a scale ranging from 1 (*not at all*) to 7 (*very much*).

2.3.3.5. Donation intentions. We assessed donation intention with three different measures. First, we measured the participants' general donation intention by asking how willing they would be to donate money for environmental protection following the documentary (“In general, how willing would you be to donate a sum of money for environmental protection following this documentary?”). Response was given on a seven-point scale ranging from 1 (*not at all*) to 7 (*very much*). Second, participants indicated the donation amount to Greenpeace they considered justified for the protection of the natural area presented in the documentary (“I think a donation of ___ € to Greenpeace for the protection of the natural area depicted in the documentary would be justified”). We opted for such wording, which is based more on the evaluation of perceived personal norms (instead of personal ability to donate), to attenuate the influence of personal disposable income. Participants provided any amount in Euros. Third, to capture a possible generalizing effect of the Greenpeace campaign on participants' willingness to donate, we assessed the donation amount in general by asking how much money they would donate for environmental protection in general if they decided to do so (one-off payment) (“Assuming you

generally donate money for environmental protection, how much would you donate after seeing the documentation just presented?"). Participants provided any amount in Euros.

2.4. Analyses

We conducted all analyses using SPSS Statistics 29. To ensure the robustness and generalizability of the results, we aggregated the values of the dependent variables across the three documentaries by calculating arithmetic means across them. The corresponding dependent variables showed significant and considerable positive correlations between the three documentaries (according to common guidelines, see Gignac & Szodorai, 2016), ranging from $r = 0.377$ to $r = 0.928$, all $p < 0.001$ (for detailed results, see Supplementary Table 1), supporting their aggregation. We thus obtained single scores (per participant) for each of the dependent variables, which we then included in the subsequent analyses reported in the results section below. Nevertheless, we have also carried out all the main analyses for the three individual documentaries (see Supplementary Tables 2a–c and Supplementary Figs. 1a–c). The results showed that the individual documentaries were comparable in descriptive terms, as the individual effects tended in the same direction, although certain effects differed in their strength or statistical significance. Thus, individual documentaries appear to have effects of different strengths, so averaging over several documentaries provides a clearer and more generalized overall picture.

To examine the effects of presentation mode on presence (H1a), narrative transportation (H1b), positive affect (H2a), and negative affect (H2b), we performed four-levelled one-way Analyses of Variances (ANOVAs). The presentation mode (360° VR video, 2D video, audio track, text) served as the independent variable (between-participants factor). In the case of a significant effect of the presentation mode, we conducted the Tukey-test for pairwise comparisons.

We also conducted randomization checks for the demographic variables gender, age, and occupation. Analyses showed only a contrast in age between the 2D video and the text condition, $M_{diff} = 5.97$, $SE = 1.97$, $p = 0.016$. However, there were no significant differences in the dependent variables between these two groups which this age difference could have caused. Nevertheless, we also calculated the analyses with age as a covariate. The results did not change in principle. There were no other differences in demographics between the groups, all $p \geq 0.157$.

To test the hypotheses of indirect effects (H3a, H3b), we conducted an analysis of indirect effects using the PROCESS macro for SPSS (Hayes, 2022). We did not previously test the potential effect of the presentation mode on the outcome variables, which would have been in line with the traditional approach of Baron and Kenny (1986), but which has since been rejected. In fact, analyses of indirect effects are strongly recommended regardless of the presence or absence of intervention effects on outcome variables, because mediation effect can be present in the absence of a total or overall effect (O'Rourke & MacKinnon, 2015, 2018). Taking into account the current state of research on mediation and indirect effects, Memon et al. (2018, p. V) also concluded that "a mediation analysis does not require an association between X and Y" and "one should not test X and Y when testing for a mediation effect". The immersive potential, especially the vividness (i.e., the sensory richness of the environment produced by the medium, cf. Steuer, 1992), continuously increases from texts to audio tracks to 2D videos to 360° VR videos due to technological features and modalities of the respective presentation mode. We therefore considered presentation mode as an interval scaled variable to enable the correlational analysis of indirect effects. We coded the presentation mode accordingly (coded: 0 = text, 1 = audio, 2 = 2D video, 3 = 360° VR video). To test H3a, we used the model 4 template of the PROCESS macro, with presentation mode as predictor, environmental protection intention as the criterion variable, and spatial presence, narrative transportation, positive affect, and negative affect as parallel mediator variables. We assessed the confidence intervals using bootstrap method with 10.000 iterations. H3b was

tested similarly, and we conducted three analyses of indirect effects, one each for donation intention, donation amount to Greenpeace, and donation amount in general as criterion variables. Beforehand, we identified outliers in the reported donation amounts to Greenpeace and the donation amount to environmental protection in general. Upon analysing the cumulative frequencies of donation contributions, we capped values exceeding €200 at this amount, as less than 5 % of the sample reported donation amounts over €200. The capping minimised possible distortions due to outliers in the data distribution.

3. Results

Table 2 presents the descriptive values for all dependent variables, including arithmetic means and standard deviations for each presentation mode across the three documentaries.

3.1. Effects of presentation mode on presence (H1a) and narrative transportation (H1b)

We hypothesized significant effects of the presentation mode on presence (H1a) and narrative transportation (H1b). To test this, we conducted two one-way ANOVAs with presentation mode as the between-participant factor and presence and narrative transportation, respectively, as the dependent variable. The analyses indicated significant main effects of the presentation mode on both dependent variables, presence with $F(3, 124) = 10.97$, $p < 0.001$, $\eta_p^2 = 0.210$, and narrative transportation with $F(3, 124) = 4.98$, $p = 0.003$, $\eta_p^2 = 0.107$, supporting H1a and H1b. We subsequently conducted Tukey-tests for pairwise comparisons (two-sided testing) between presentation modes for both dependent variables, as summarized in Table 3. Participants in the 360° VR video condition reported feeling more present in the documentaries' scenes than participants in the 2D video, audio, and text conditions, all $M_{diff} \geq 0.61$, all $p \leq 0.011$. Furthermore, participants experienced significantly higher narrative transportation when watching the documentaries as 360° VR videos compared to listening to the audio file or reading about it in text form, both $M_{diff} \geq 0.48$, both $p \leq 0.032$. Also, experienced narrative transportation was, by trend, higher in the case of 360° VR video in comparison to the 2D video condition, $M_{diff} = 0.44$, $p = 0.059$. Outside of the 360° VR video condition, there were no significant differences between the remaining presentation modes.

3.2. Effects of presentation mode on positive affect (H2a) and negative affect (H2b)

We conducted two one-way ANOVAs with presentation mode as the between-participants factor, and positive and negative affect as the dependent variables, respectively. We identified a significant effect of the presentation mode on positive affect, $F(3, 124) = 7.06$, $p < 0.001$, $\eta_p^2 = 0.146$, but not on negative affect, $F(3, 124) = 1.01$, $p = 0.391$, $\eta_p^2 = 0.024$. These results support H2a but contradict H2b. Consequently, we conducted Tukey-tests for pairwise comparisons between presentation modes only for positive affect (for detailed results, see Table 3). Participants who watched the documentaries in 360° VR videos reported stronger positive affect compared to those who watched them in 2D, listened to the audio version, and read about them in text form, all $M_{diff} \geq 0.31$, all $p \leq 0.044$. Again, outside of the 360° VR video condition, there were no significant differences between presentation modes.

3.3. Indirect effects on environmental protection intention (H3a) and donation intentions (H3b)

Finally, and most important, we tested for indirect effects of presentation mode (coded: 0 = text, 1 = audio, 2 = 2D video, 3 = 360° VR video) on environmental protection intention (H3a) and donation intention measures (H3b) via parallel mediation by presence, narrative transportation, positive and negative affect. Supplementary Table 4

Table 2

Descriptive values for each dependent variable, separately for each presentation mode (averaged over the three documentaries).

	VR		2D		Audio		Text	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Presence	3.62	0.57	2.72	0.88	3.01	0.89	2.61	0.70
Narrative transportation	4.98	0.40	4.54	0.86	4.50	0.73	4.35	0.69
Positive affect	1.73	0.47	1.39	0.40	1.43	0.51	1.21	0.46
Negative affect	1.09	0.58	1.38	0.84	1.27	0.72	1.17	0.68
Environmental protection intention	5.22	0.92	4.89	0.94	4.68	1.34	4.82	1.13
Donation intention	5.18	1.18	4.80	1.33	4.86	1.77	4.64	1.72
Donation amount to Greenpeace	50.47	49.31	45.74	45.84	43.92	57.43	50.41	49.57
Donation amount in general	57.22	56.20	59.48	55.82	50.15	60.53	51.88	45.93

Table 3

Results of one-way ANOVAs (*F*, *df*, *p*, η_p^2 , observed power) with presentation mode as independent variable (360° VR video, 2D video, audio, text) and the corresponding dependent variable. If the effect of the presentation mode was significant, results of the Tukey-test are also reported (*M_{diff}*, *SE*, *p*).

Dependent variable	<i>F</i>	<i>df</i>	<i>p</i>	η_p^2	Observed power	Pairwise comparisons via Tukey-test		<i>M_{diff}</i>	<i>SE</i>	<i>p</i>	
Presence	10.97	3, 124	<0.001	0.210	0.999	360° VR video vs.	2D video	0.90	0.19	<0.001	
							Audio	0.61	0.19	0.011	
							Text	1.01	0.19	<0.001	
							2D video vs.	Audio	-0.29	0.19	0.438
								Text	0.11	0.19	0.934
								Audio vs.	Text	0.41	0.19
Narrative transportation	4.98	3, 124	0.003	0.107	0.906	360° VR video vs.	2D	0.44	0.17	0.059	
							Audio	0.48	0.17	0.032	
							Text	0.64	0.17	0.002	
							2D video vs.	Audio	0.04	0.17	0.996
								Text	0.20	0.17	0.664
								Audio vs.	Text	0.16	0.17
Positive affect	7.06	3, 124	<0.001	0.146	0.978	360° VR video vs.	2D video	0.34	0.12	0.018	
							Audio	0.31	0.12	0.044	
							Text	0.52	0.12	<0.001	
							2D video vs.	Audio	-0.04	0.12	0.998
								Text	0.18	0.12	0.415
								Audio vs.	Text	0.22	0.12
Negative affect	1.01	3, 124	0.391	0.024	0.269	n.a.					

presents the inter-correlations between mediator variables and outcome variables. With a few exceptions where statistical significance was not achieved, there were medium to high positive correlations between the variables, indicating a suitable starting point for analysing the indirect effects (cf. O'Rourke & MacKinnon, 2015).

Fig. 1 shows the model proposing an indirect effect of presentation mode on (a) environmental protection intention, (b) donation intention, (c) donation amount to Greenpeace, and (d) donation amount in general (for even more detailed results, see Supplementary Table 3). First, we did not find any significant total effects of the presentation mode on any of the criterion variables, with *c* ranging from 0.16 to 2.54, all *p* ≥ 0.106. Second, there were significant positive effects of the immersion level in terms of presentation mode on presence, *a*₁ = 0.27, *p* < 0.001, narrative transportation, *a*₂ = 0.19, *p* < 0.001, and positive affect, *a*₃ = 0.15, *p* < 0.001, but not on negative affect, *a*₄ = -0.01, *p* = 0.829. The analyses also revealed direct positive effects of the mediator variable narrative transportation on the criterion variables environmental protection intention, donation intention, and donation amount in general, with *b*₂ ranging from 0.52 to 18.85, all *p* ≤ 0.047. Additionally, we found direct positive effects of negative affect on environmental protection intention, donation amount to Greenpeace, and donation amount in general, with *b*₄ ranging from 0.33 to 20.70, all *p* ≤ 0.019.

Importantly, with respect to our hypotheses, the analyses revealed significant (positive) indirect effects of presentation mode via narrative transportation on environmental protection intention (H3a, effect *ab* = 0.10, 95 %-CI: 0.03–0.20), donation intention (H3b, effect *ab* = 0.14, 95 %-CI: 0.04–0.26), and donation amount in general (H3b, effect *ab* = 3.67, 95 %-CI: 0.16–7.89). Consequently, the presentation of the documentaries with more immersive technology evoked a stronger narrative transportation than the presentations with less immersive technical

features, and this narrative transportation was in turn positively related to environmental protection intention and donation intention (two out of three measures). The other mediators (presence and affect) did not contribute to indirect effects as the 95 %-CI for the respective effects always included zero (see Fig. 1). Importantly, in addition to the absence of any total effect, we also found no significant direct effects of presentation mode on any dependent variables with *c'* ranging from -2.94 to -0.00, all *p* ≥ 0.461. Thus, we found clear evidence for pure indirect effects via narrative transportation but not for mediation in the narrower sense, which would require an effect of the predictor variable on the criterion variable that could be mediated (cf. MacKinnon, 2008).

4. Discussion

4.1. Main findings

The present study investigated the effects of different presentation modes (text, audio, 2D video, and 360° VR video) on the recipients' feelings of presence (H1a), narrative transportation (H1b), positive affect (H2a), and negative affect (H2b). In particular, we examined potential indirect effects of presentation mode on environmental protection intention (H3a) as well as donation intention, donation amount to Greenpeace, and donation amount in general (H3b) through presence, narrative transportation, and affect.

First, we found significant main effects of presentation mode on both presence and narrative transportation. Participants' experience of presence was higher when watching the documentaries in 360° VR video condition compared to 2D video, audio, and text formats. There were no differences between text, audio, and 2D video, which emphasizes the special capability of 360° VR videos to evoke feelings of presence,

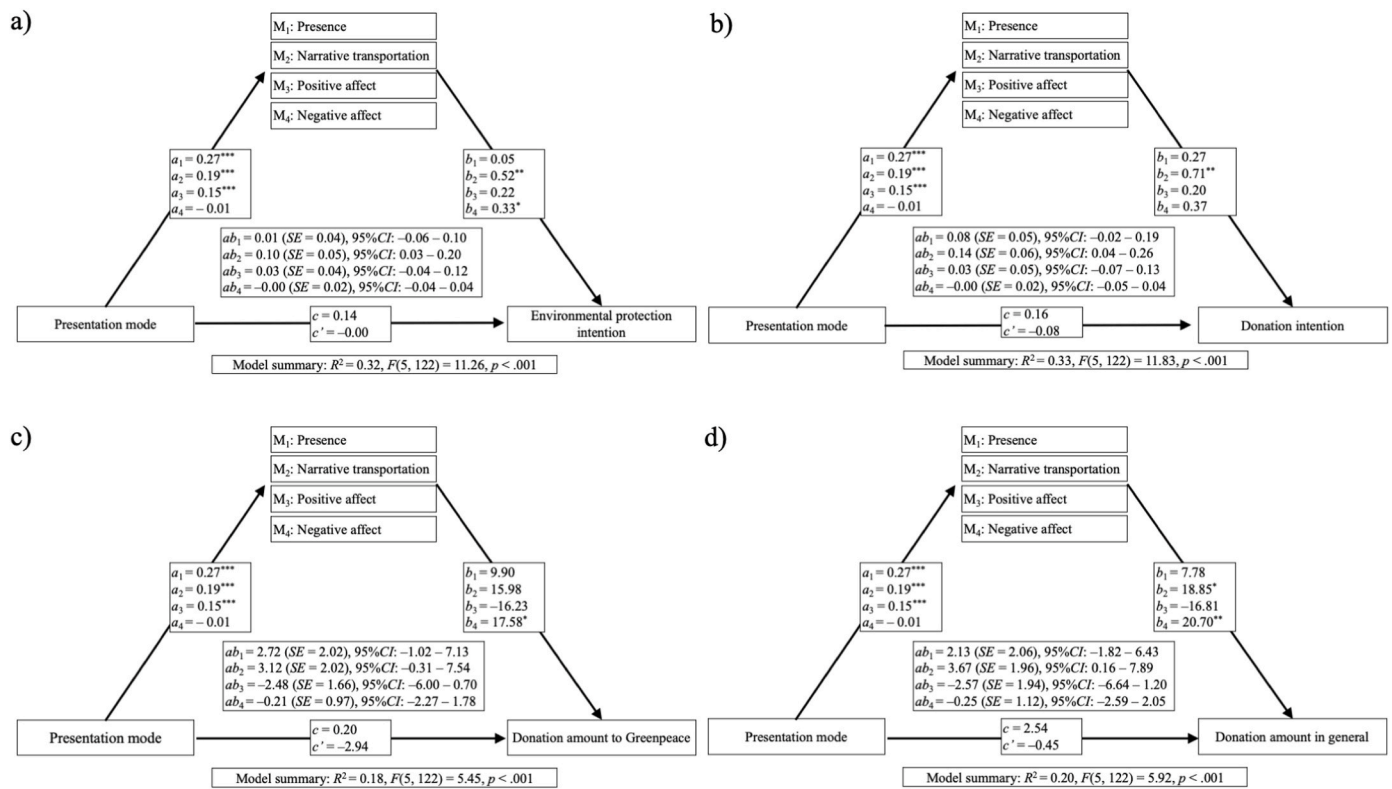


Fig. 1. Results of the analysis for indirect effects of the presentation mode on (a) environmental protection intention, (b) donation intention, (c) donation amount to Greenpeace, and (d) donation amount in general through presence, narrative transportation, positive affect, and negative affect. Presentation mode was coded with 0 = text; 1 = audio; 2 = 2D video; 3 = 360° VR video. * $p < .05$, ** $p < .01$, *** $p < .001$.

supporting and replicating previous findings that highlighted the potential of HMDs and 360° VR videos to evoke stronger feelings of presence compared to other media (e.g. Moriuchi & Murdy, 2022; Walewijns et al., 2023). In addition to feelings of presence, feelings of narrative transportation were also stronger in the 360° VR video condition compared to the other presentation modes, supporting the crucial role of immersive technology and presentation modes for narrative transportation (Ma et al., 2023; Pianzola et al., 2019; Elmezy et al., 2018). These results align with Walter et al. (2017), who demonstrated that audio-visual narratives with a broader sensory spectrum tend to elicit a more intense narrative transportation than printed texts.

Second, analyses also revealed a significant main effect of presentation mode on positive affect, but not on negative affect. Our study did not confirm previous research by Nelson et al. (2020) and Bolouki (2024) who found that both positive and negative affect were significantly increased in VR environments. In the present study, the experience of positive affect was stronger in the 360° VR video condition than in all other conditions. These results are in line with previous studies that have already shown that VR environments can increase positive affect in other contexts (Mostajeran et al., 2023; Chan et al., 2020; Allcoat & von Mühlenen, 2018) and that 360° VR videos can increase users' enjoyment in the context of environmental protection campaigns (Yang & Zhang, 2022).

Third, we found no direct effects of presentation mode on environmental protection intention and donation intentions, but, in accordance with our hypotheses, we found significant indirect effects of presentation mode via narrative transportation on environmental protection intention, donation intention, and donation amount in general. Presentation modes with more immersive potential like 360° VR videos evoked stronger narrative transportation than the presentation modes with less immersive characteristics, and this narrative transportation was in turn positively related to the three dependent variables. In contrast, there were no significant indirect effects of presentation mode

via presence and affect.

4.2. Theoretical and practical implications

Our findings are in line with the concept of telepresence by Steuer (1992) who postulated that the vividness and interactivity of the medium, which is highest in 360° VR videos, generate strong feelings of presence. However, our results also show that a purely auditory presentation of content as well as a transcribed text version can create a comparable sense of presence as audio-visual 2D videos. One explanation for this could lie in the mental imagery of the presented scenes. Though not explicitly tasked, the participants probably created specific mental images of the reported scenes, even if these may have varied individually. Such mental imagery is actually connected to experiencing presence (for a review, see Rodríguez-Ardura & Martínez-López, 2014). For instance, mental imagery capabilities contribute to feelings of presence when reading a text (Weibel et al., 2011). This could also be the case for plain auditory stimuli, too, though this has not been investigated yet to our best knowledge. Nevertheless, the present study underlines and replicates the special ability of 360° VR videos to evoke a strong experience of presence.

The results also align with the assumptions of the (Extended) Transportation-Imagery Model (Green & Brock, 2000, 2002; Van Laer et al., 2014) which posits that narrative transportation is connected to intentions and attitudes. This demonstrates the potential of narrative transportation and narrative persuasion for nature documentaries and environmental protection campaigns in general. Our findings are also consistent with previous studies that have shown the indirect influence of presentation mode through narrative transportation on participants' attitudes and behavioural intention in other thematic contexts (e.g., Chen & Yao, 2022; Ma, 2020). We can now confirm these effects in the context of environmental protection campaign videos. However, the present results also show that, in addition to the role storytellers and

story-receivers play in the experience of narrative transportation according to the Extended Transportation-Imagery Model (van Laer et al., 2014), further attributes such as the presentation mode and the medium affect narrative transportation. Future research could focus on the implementation of these factors into the current model.

Narrative transportation may be even more important than inducing a feeling of presence in the scene as indicated by our results. Thus, we found no indirect effects through presence on the environmental protection intentions and the three donation intention variables. These results are consistent with those of Pressgrove and Bowman (2021) who found that narrative engagement and not presence was connected to behavioural intentions. This suggests that investment in immersive technologies alone is not sufficient, but investment in compelling storytelling and non-fictional narratives is equally relevant. Especially since presence can also be detrimental to persuasion (for a review, see Breves, 2023). Interestingly, Ma (2020) found that presence mediated the influence of an immersive VR environment, compared to more traditional media, on narrative transportation. Therefore, presence may also be a prerequisite for narrative transportation. As a result, presence could impact attitudes and intentions indirectly through narrative transportation.

Though, due to the lack of effects of the presentation mode on the criterion variables, it seems that the effects are purely indirect effects via narrative transportation and not mediation. Thus, in such cases, “Holmbeck (1997) concludes that there is an indirect effect but not a mediated effect. The idea is that if there is not a significant relation between two variables then it does not make sense to talk about mediation, but it does make sense to talk about indirect effects” (MacKinnon, 2008, p. 9). Moreover, the lack of indirect effect through narrative transportation on donation amount to Greenpeace could also be due to the fact that in this case we asked more about personal norms of what they consider to be an appropriate donation. Therefore, our results now indicate that personal intentions may be more likely to be influenced by immersive technologies than perceived norms.

The present results, which reveal the special role of narrative transportation, are also relevant from the perspective of media producers: To effectively change recipients’ environmental behaviour and attitudes, it seems to be crucial to engage them with fitting content and a compelling narrative. Previous research has already shown that characteristics of the narrative influence recipients’ perceptions. For example, Das et al. (2008) demonstrated that the effectiveness of fundraising messages and donation intentions depended on the framing of the message, the type of information provided, and whether information about the charity’s goal attainment was given. Nelson et al. (2020) also found that 360° VR videos increased donations especially when the video was negatively framed. Additionally, the presence or absence of specific characters in a documentary may be important. For example, the presence of a likeable protagonist who is likely to experience negative outcomes in a story can create a feeling of suspense in the recipients, which in turn was found to be positively linked to the enjoyment of and interest in the story (Kaspar et al., 2016). Identification with a main character can also lead to increased credibility and reduce the viewers’ critical perception of the content (Green & Brock, 2000). Furthermore, identifiable characters positively impact narrative transportation, according to the Extended Transportation-Imagery Model (Van Laer et al., 2014). We can therefore assume that the content of the scene can modulate the indirect effect of 360° VR videos via narrative transportation.

The findings offer valuable strategies for the virtual marketing of environmental and charitable organisations to raise awareness of environmental protection and to encourage donations. Creators of nature documentaries and fundraising campaigns may focus on eliciting narrative transportation. While creating these videos in 360° VR may not directly influence environmental protection and donation intentions, they have the potential to facilitate narrative transportation, which in turn may enhance these intentions. This in turn emphasizes the

importance of the narrative and the script. The importance of the narrative is growing, especially regarding artificial intelligence, which is increasingly capable of creating images and even entire videos from simple text (e.g. Sora), thereby increasing the immersive potential and narrative transportation of the own text in an easy way.

Regarding affect, our findings may indicate that 360° VR videos still offer a novel experience for most of its users. The unfamiliarity with the technology can lead to an automatic and immediate positive affective response (Duckworth et al., 2002). Various studies have postulated that the novelty of VR experiences could influence emotions (Amrhein & Balaban, 2024; Bujčić et al., 2020). This may also explain the increase in positive affect for the 360° VR videos in the present study. This novelty effect could also account for the lack of impact on negative affect, as positive affect may have overshadowed the experience, although both dimensions are regarded as independent. Interestingly, negative affect was found to be as crucial for eliciting environmental protection and donation intentions as positive affect in some earlier studies (Baberini et al., 2015; Bennett, 2015; Erlandsson et al., 2018; Liang et al., 2016). Our findings support this again as we found significant positive relations between negative affect and environmental protection and donation intentions. However, the documentaries in the present study have shown only a few shocking images that emphasise the extent of the threat to the natural area. Conversely, Nelson et al. (2020), who found increased negative affect in VR, used a video about coral reef protection, documenting coral death and bleaching, which visualised the negative consequences of an environmental problem. In contrast, the documentaries used in the present study primarily depicted animals and humans in intact habitats. As a result, the higher immersive potential of 360° VR videos could not develop its full affective potential with these stimuli. This shows the importance of triggering negative affects despite the fundamentally positive media experience when using VR for environmental protection campaigns.

4.3. Strengths, limitations, and future research perspective

The present study has several notable strengths. There is only a small amount of research examining the potential of 360° VR videos for environmental protection campaigns and fundraising, an area of increasing importance given the urgent problem of climate change. To our best knowledge, the present study is the first to compare the effects of such documentaries with a range of traditional media while considering indirect effects of the presentation mode through presence, narrative transportation, and affect. Consequently, the results are novel within the context of nature documentaries and environmental protection campaigns, but the findings also contribute to a better understanding of how immersive technologies influence relevant outcomes such as behavioural intentions more generally. Moreover, we included a substantial sample size, providing sufficient test power to detect relevant effects. We also analysed the group of young people and university students, who are particularly important for the topic of environmental protection as they especially perceive climate change and environmental protection as serious threats and are concerned about these issues (cf. D’Uggento et al., 2023; Poortinga et al., 2023). Finally, we analysed the effects of presentation mode across several different documentaries, enabling us to achieve some generalizability and validity of the results regarding the stimuli.

Despite these strengths, the results of the study should be interpreted with consideration of certain limitations. First, we did not control for the extent of participants’ pre-existing pro-environmental attitudes, although these are related to environmental behavioural intentions (Liu et al., 2020). We deliberately refrained from assessing the pro-environmental attitudes to avoid potential sensitizing effects that can obscure persuasive effects (cf. Campbell & Stanley, 1966; Hoeken, 1994). Instead, our participant acquisition strategy focused on the group of young academics who perceive climate change and environmental protection as serious threats and are concerned about these issues.

Second, it should also be noted that we did not assess actual donation behaviour. Instead, we asked participants to indicate their hypothetical willingness to donate. Actual donation behaviour might differ if participants were asked to donate specific amounts of actual money, as some other studies have already done (e.g., Kristofferson et al., 2022; Martingano et al., 2023). However, Benz and Meier (2008) showed that participants' donation intentions in a laboratory setting correlate with their real-life charitable giving decisions, suggesting that the reported hypothetical donation amounts can serve as an indicator of willingness to donate in actual scenarios. Moreover, our proposed model of the effects of presentation mode on behavioural intentions was based on the analyses of indirect effects and did not test causal mediation in the strict sense. Due to the lack of experimental manipulation of the mediators, we tested them only as parallel mediators and not sequentially (cf. Hayes, 2012). Indeed, some authors suggested double randomization for causal mediation analysis (Bullock et al., 2010; Green et al., 2010): "In such an experimental design, participants are not only randomly assigned to the levels of the independent variable to examine its impact on the observed mediator. Rather, participants are also randomly assigned to different levels of the mediator to examine its effect on the observed dependent variable" (Kaspar & Cames, 2016, p. 5). However, this approach also presents a methodological challenge in the present context: while narrative transportation or affect can easily be manipulated by very different approaches, the experience of presence by definition depends on the immersive potential of the presenting medium.

Finally, when thinking of future research, the first steps could be taken towards more complex models with correspondingly adapted analysis strategies. The focus should be on recognizing that the fundamental question of the impact of presentation modes, such as 360° VR videos, is not a question of direct effects. Rather, the analysis of mediation processes should be an inherent part of this research. Basically, media technologies with their varying immersive potential must trigger some kind of perceptual, emotional, or cognitive process, which then affects protection intention or donation intention, for example. The present study analysed three prominent constructs (presence, narrative transportation, affect). However, more complex effect pathways are conceivable, for example, a causal effect chain of mediating variables or inter-correlating versus independent mediators. This places increased demands on both the statistical models and the assumptions that have to be made for their specification. Accordingly, Schuler et al. (2024, p. 8) noted that „a growing literature on multiple mediator analysis has emerged, highlighting the complexities (and required assumptions) of identifying path-specific effects through multiple mediators". Current research in this area has so far relied on rather simpler approaches to analysis (e.g., Breves, 2020; Thoma et al., 2023), including the present study. However, such a straightforward analysis strategy of the data, which is equipped with as few prior assumptions as possible and proven robustness, also appears (still) appropriate against the background of the current state of knowledge. In this context, it seems advisable to consider existing explanatory models to make progress based on theory, such as the Transportation-Imagery Model (Green & Brock, 2000, 2002) or the four-step model of persuasion through spatial presence (Breves, 2023). For future research, it will also be important to consider other potentially significant constructs as mediators and, at the same time, to ensure that the constructs and corresponding operationalizations are sufficiently discriminant. For example, recent studies have suggested a close relationship between the sense of presence and mental imagery processing (Alyahya & McLean, 2022; Wu & Lai, 2023), but the conceptual overlaps and differences between these two constructs have so far received insufficient attention. In addition, quantitative rating scales are mainly used to assess mediator variables that usually describe experiential processes. A stronger focus on the qualitative elaboration of perceptual and emotional experiences during media consumption in VR would help to further sharpen these constructs and their operationalization (cf. Riches et al., 2019).

4.4. Conclusion

Overall, the present study enhances the understanding of the potential of immersive 360° VR videos compared to the more traditional media of 2D videos, audio tracks, and texts in the context of environmental documentaries and campaigns. We observed indirect effects of the presentation mode on environmental protection intention and donation intentions through narrative transportation, emphasizing the importance of the narrative. The results also demonstrated that immersive 360° VR documentaries can evoke stronger feelings of presence, narrative transportation, and positive affect in recipients compared to all other presentation modes. Future research, including theory development, and the practice of media producers can draw conclusions from this.

CRediT authorship contribution statement

Daniel Zimmermann: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Paulina Wolf:** Writing – review & editing, Visualization, Investigation. **Kai Kaspar:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Resources, Project administration, Methodology, Formal analysis, Conceptualization.

Ethics approval

All procedures performed in the study were in accordance with the ethical guidelines of the German Psychological Society (DGPs) and with the 1964 Helsinki declaration. This study was approved by the Ethics Committee of the Faculty of Human Sciences at the University of Cologne (September 27, 2019, registration number: KKHF0036).

Consent to participate/for publication

Written informed consent to participate in this study and for publication of their data was provided by the participants.

Code availability

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chb.2025.108643>.

Data availability statement

The data that support the findings of this study as well as the used materials are available from the corresponding author upon reasonable request.

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