Tampere University

MILA BUJIĆ

Immersive Persuasiveness

Investigating media effects of 360-degree immersive journalism

Tampere University Dissertations 526

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ACADEMIC DISSERTATION
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In memory of Vesna Bujić-Pavićević

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Mila Bujić

ABSTRACT

Immersive technologies such as virtual reality (VR) have prompted a new wave of persuasive media content, aimed at augmenting the effects of traditional media using the new, more engrossing dimension of experiences mediated through the technological modality. The touted potentials of such media formats have caused a polarization in public opinion, with proponents often exaggerating the possible benefits and global prosocial implications, and critics diminishing its effects describing the added immersiveness of media as a fluke with very little real-world implications or emphasizing its dangers as a propaganda weapon.

This dissertation therefore revolves around the question of what kinds of affective, cognitive, attitudinal, and behavioural media effects does persuasive media have, depending on the modality through which the content is presented? To that purpose, it examines some of the most relevant effects, or lack thereof, of immersive journalism as an emerging field of immersive persuasive media. It is positioned within the multidisciplinary research and theory of persuasive and immersive media, psychology, and media effects. The contributions and findings are drawn from an early literature review of immersive journalism and a set of empirical studies. The empirical work relies on experimental research (N = 89) comparing media effects across three modalities of low (Article), medium (2D-360), and high immersiveness (VR-360).

The chosen research methods support contrasting and comparing the more traditional format of a written article to a 360-degree video presented either on a 2D screen or in mobile VR. The focus on 360-degree videos has been chosen as that format is the most accessible and widespread in the public commercial sphere, unlike fully immersive virtual reality.

The findings and implications of the research primarily contribute to understanding immersive journalism media effects categories of affect, cognition, attitude, and behavior. Publication I presents an overview of previous studies and maps the trends and interests mainly seen in the empirical research of immersive journalism. Arguably, the most touted promise of immersive technologies is their ability to elicit prosocial attitudes, and this is examined in Publication II which focuses on their effects on human rights attitudes. The primary expected effect of

immersive journalism and immersion in general is seen on a subjective, affective level, which is further criticized for appealing to the non-rational selves. Accordingly, Publication III employs measures of emotional states before and after the experiment, as well as a memory test of content and investigates their relationship. Lastly, media effects are of little consequence if the media is not popularized and consumed. Publication IV, therefore, aims at exploring users' intentions to continue consuming the media through different modalities. Finally, as an original contribution of this summary, modality effects are considered in the wider context of media effects. As a whole, this dissertation presents one of the first extensive studies investigating the effects of modalities and technological immersion on the media effects of immersive journalism as a domain of persuasive media.

TIIVISTELMÄ

Immersiiviset teknologiat, kuten virtuaalitodellisuus (engl. virtual reality - VR), ovat saaneet aikaan uuden aallon suostuttelevan median sisältöä, jonka tarkoituksena on lisätä perinteisen median vaikutuksia käyttämällä uutta, kiehtovampaa kokemusten ulottuvuutta teknologisen modaliteetin välityksellä. Tällaisten mediamuotojen ylistetyt mahdollisuudet ovat johtaneet yleisen mielipiteen polarisaatioon. Mediamuotojen kannattajat usein liioittelevat mahdollisia hyötyjä ja maailmanlaajuisia prososiaalisia vaikutuksia, kun taas kriitikot väheksyvät vaikutuksia luonnehtien lisätyn immersiivisyyden olevan sattumaa, jolla on hyvin vähän todellisia vaikutuksia tai korostavat sen vaaroja propaganda-aseena.

Tämä väitöskirja pyrkii vastaamaan kysymykseen, millaisia affektiivisia, kognitiivisia, asenteellisia, ja käytöksellisiä mediavaikutuksia on suostuttelevalla medialla, sisällön esitystavasta riippuen? Väitöskirja tutkii immersiivisen journalismin vaikutuksia, immersiivisen suostuttelevan median orastavassa kentässä ja hyödyntää suostuttelevan ja immersiisivisen median, psykologian ja mediavaikutusten monitieteistä tutkimusta ja teoriaa. . Väitöskirjan löydökset ja havainnot perustuvat immersiivisen journalismin kirjallisuuskatsaukseen ja joukkoon empiirisiä tutkimuksia. Empiirinen työ koostuu kokeellisesta tutkimuksesta (N = 89) jossa verrattiin mediavaikutuksia kolmella eri modaliteetilla: matala (artikkeli), keskitaso (2D-360) ja korkea immersiivisyys (VR-360).

Käytetyt tutkimusmenetelmät tmahdollistavat perinteisemmän kirjoitetun artikkelin vastakohtaistamista ja vertailua 360 asteen videoon, joka esitetään joko 2D-näytöllä tai mobiilvirtuaalitodellisuudessa. 360 asteen video valikoitui vertailukohteeksi tähän työhön, sillä kyseinen muoto on vielä toistaiseksi julkisesti kaikkein saavutettavin, toisin kuin täysin immersiivinen virtuaalitodellisuus.

Tutkimuksen tulokset ja implikaatiot auttavat ensisijaisesti ymmärtämään immersiivisen journalismin mediavaikutuksen affektin, kognition, asenteen ja käyttäytymisen kategorioita. Julkaisu I esittelee yleiskatsauksen aiemmista tutkimuksista ja kartoittaa pääasiassa immersiivisen journalismin empiirisessä tutkimuksessa havaitut suuntaukset ja kiinnostuksen kohteet. Immersiivisten teknologioiden mahdollisesti ylistetyin lupaus on kyky herättää prososiaalisia asenteita, ja tätä tarkastellaan julkaisussa II, joka tarkastelee immersiivisten

teknologioiden vaikutuksia ihmisoikeusasenteisiin. Immersiivisen journalismin, ja immersion ylipäätään, ensisijainen odotettu vaikutus nähdään subjektiivisella, affektiivisella tasolla, jota edelleen kritisoidaan ei-rationaaliseen itseen vetoamisesta. Näin ollen julkaisu III käyttää emotionaalisten tilojen mittareita ennen ja jälkeen koetta, sekä sisällön muistitestiä, ja tutkii näiden kahden suhdetta. Lopulta mediavaikutuksilla ei ole juurikaan merkitystä, jos mediaa ei tehdä tunnetuksi ja kuluteta. Julkaisu IV pyrkiikin tutkimaan käyttäjien aikomuksia jatkaa median kulutusta eri modaliteettien välityksellä. Lopuksi tämän tiivistelmän alkuperäisenä kontribuutiona modaalisuusvaikutuksia käsitellään laajemmassa mediavaikutusten yhteydessä. Kaiken kaikkiaan tämä väitöskirja esittää yhden ensimmäisistä laajamittaisista tutkimuksista, jotka tutkivat modaliteettien ja teknologisen immersion vaikutuksia immersiivisen journalismin mediavaikutuksiin osana suostuttelevan median kenttää.

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ORIGINAL PUBLICATIONS

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Publication II Bujić, M., Salminen, M., Macey, J., & Hamari, J. (2020). "Empathy machine": how virtual reality affects human rights attitudes. Internet Research 30(5), pp. 1407-1425.

Publication III Bujić, M., Salminen, M., & Hamari, J. (*under-review*). Effects of immersive media on emotions and memory: An experiment comparing article, 360-video, and virtual reality.

Publication IV Bujić, M., & Hamari, J. (2020). Satisfaction and willingness to consume immersive journalism: experiment of differences between VR, 360 video, and article. Proceedings of the 23rd International Conference on Academic Mindtrek. ACM.

RESEARCH CONTRIBUTIONS

The research contributions of all four authors from the included publications are presented below, using the Contributor Roles Taxonomy (CRediT). The boldface publication mentions represent leading role(s). In cases where multiple authors' role are boldface for a single publication, the contribution is shared equally between the authors.

	Mila Bujić	Mikko Salminen	Joseph Macey	Juho Hamari
Conceptualization	**I, II, III, IV**			I, II, III, IV
Methodology	**I, II, III, IV**	II, III, IV		I, II, III, IV
Formal Analysis	**I, II, III, IV**	**II**		
Investigation	**I, II, III, IV**			
Original Draft	**I, II, III, IV**	**II**, III	II	II, III
Review & Editing	**I, II, III, IV**	II, III	**II**	I, II, III, IV
Visualization	**II, III, IV**	**II**		
Supervision		**II, III**		**I, II, III, IV**
Funding Acquisition				**I, II, III, IV**

1 INTRODUCTION

Virtual reality is a technology that could actually allow you to connect on a real human level, soul-to-soul, regardless of where you are in the world.

- Chris Milk (2015)

In an age of unprecedented technologically-enabled hyper-connectedness, but also polarization (Boxell, Gentzkow, & Shapiro, 2020), immersive technologies and virtual reality (VR) in particular have been changing the media landscape with a promise of solving a myriad of humanity's problems such as accessible and effective education, prosocial attitudes, and sustainable behavior (Bailenson, 2018). Today, there seems to be virtually no domain of human operation that is left untouched by one type of such technologies – namely, virtual reality (VR) that uses a head mounted display. VR technology has been tested or even widely employed in, for example, education (Radianti, Majchrzak, Fromm, & Wohlgenannt, 2020), medicine (Campo-Prieto, Cancela, & Rodríguez-Fuentes, 2021), psychotherapy (Asiain, Braun, & Roussos, 2021), and immersive journalism (de la Peña et al., 2010). Of these, immersive journalism as an application domain stands out as an imagination of mass media, that instead of delivering information to a consumer as an observer, is touted to enable individuals to become engrossed in an experience as if it was their own lived experience (de la Peña et al., 2010; Shin & Biocca, 2018; Sundar, Kang, & Oprean, 2017). Although this extreme proposition is not devoid of criticism (e.g. Hassan, 2020), the core idea of putting oneself in another's shoes, so to speak, in order to see a new perspective, and to affect attitudes, emotions and behavior related to the topic in question is not new and constrained to virtual reality. Rather, virtual reality and immersive journalism may only be seen as a novel, more sensory-salient or immersive way of delivering those experiences, and touted to elicit prosocial attitudes and behaviors with a global impact (Milk, 2015).

The VR technology is not in itself new either, despite its slow public adoption. It has in fact been in development for about half a century, albeit the term itself was widely adopted only from 1987 onwards (see Steuer, 1992)). Even though there were early attempts to develop VR as a consumer technology especially during the 1990's

(e.g. with Nintendo's *Virtual Boy* device released in 1995), these efforts quickly subsided as, despite its novelty, wide adoption was not achieved due to its relatively low quality and high prices (Bailenson, 2018). Large, complex VR systems have been used in the meantime, especially for army simulation training purposes and scientific research (Bailenson, 2018). However, it was not until 2010 that the first prototype of the Oculus Rift headset was designed, followed by several other breakthroughs in developing affordable technology. VR adoption has still been slow even after 2016 and the introduction of the first fully commercial headsets (Harris, 2020). Instead, a more approachable for new users and an affordable version of VR is so-called mobile VR. Instead of tracking the full range of motion (6 degrees-of-freedom) in the same way as immersive VR headsets and controllers, and having high resolution displays with a relatively wide field-of-view, it utilizes the gyroscope from a mobile phone for limited tracking (3 degrees-of-freedom) and a headset for displaying a low-resolution stereoscopic view with a modest field-of-view.

In the same year that the first Oculus Rift headset was developed, de la Peña and colleagues coined the term *immersive journalism* (de la Peña et al., 2010), whose main supposition is to experience others' perspectives, by being technologically "transported" to another place and becoming personally engrossed in experiences that are otherwise inaccessible. However, there is no shared understanding of what immersive journalism really entails, either in terms of technology or content (Hardee & McMahan, 2017; Sánchez Laws, 2020). Applications range from scenarios implemented through an on-screen video game (e.g. Guantanamo Bay in Second Life), to first-person embodied immersive VR scenarios specifically developed for this purpose (de la Peña et al., 2010; Slater et al., 2018). However, what they all have in common is the touted capability to affect the viewer in a deeper and more meaningful way than other formats such as text. Moreover, aside from any effects brought on by the content itself, these capabilities are often thought to be particularly augmented by the aspect of *technological immersiveness*. In immersive journalism, this is reflected in commonly employing mobile VR for delivering 360-degree videos, instead of simply a 2D computer screen.

Engagement with the news, global events, and others' experiences have been tried and tested through a variety of persuasive media formats. In the past two decades, these efforts in engaging audiences and users have rightfully been predominantly connected to the rise of video games and gamification (Bogost, 2007; Hamari, Koivisto, & Pakkanen, 2014; Koivisto & Hamari, 2019), where a prominent example are newsgames (Bogost, Ferrari, & Schweizer, 2010) along with various commercial and serious video games and gamified applications (Bogost, 2007; Hamari et al.,

2014; Isbister, 2016) which attempt to infuse important topics with interactivity and playfulness to both draw attention to them and make a bigger prosocial impact. As of late, artistic efforts in this sphere have been particularly noted. In 2017, a special Oscar was awarded to *Carne y Arena*, an interactive exhibition installation which puts the visitor in the shoes of a refugee on the Mexican-USA border, creating a sense of immediacy through the use of VR (Raessens, 2019).

Despite the success of such rich experiences including narrative and interactive dimensions, the high-level design and technological complexity are not always present with similar applications in VR. In fact, they are usually omitted in favor of affordability and approachability both for producers and consumers, so bringing the content to a much wider population with a significantly higher potential for real-world impact. Therefore, immersive journalism often appears in the format of a 360-degree video delivered via 2D screens or mobile VR, rather than in immersive virtual reality. Their more notable production started in 2016 as large news houses such as The *New York Times* started their own 360-degree sections and distributed mobile VR headsets among the general population (Robertson, 2015). These videos are usually available for viewing on both flat 2D screens and in mobile VR. The assumed benefit of adapting the content to be viewable in mobile VR is that the higher technological immersiveness and the viewer's consequent engrossment in themselves mediate a higher impact of the content on its consumers (Hardee & McMahan, 2017; Shin & Biocca, 2018; Soler-Adillon & Sora, 2018).

Research on this topic has not been as prominent as the production of content and its consumption, leaving a dearth in our understanding of the relationship between the modality, or the way the content is delivered, and its media effects. Therefore, the overarching research interest of this dissertation is to investigate w*hat affective, cognitive, attitudinal, and behavioral media effects do persuasive media have depending on the modality via which the content is presented?* To this aim, a literature review along with a set of primary studies is presented and discussed in the context of immersive technologies and immersive media. The dissertation particularly focuses on scrutinizing immersive journalism as an emerging media experience domain and a prominent example of the potential of immersive media for prosocial change.

1.1 Research questions and model

Taken together, the four research questions presented below build a research and narrative whole around immersive journalism, and the affective, cognitive,

attitudinal, and behavioral micro-level or individual media effects (Valkenburg, Peter, & Walther, 2016) of persuasive media and the employed modalities. Additionally, the moderating effects of demographic individual differences, specifically age and gender, are considered in relation to QR3 and QR4. The dissertation's conceptual research model and research question are elaborated in the four RQs and summarized in Figure 1.

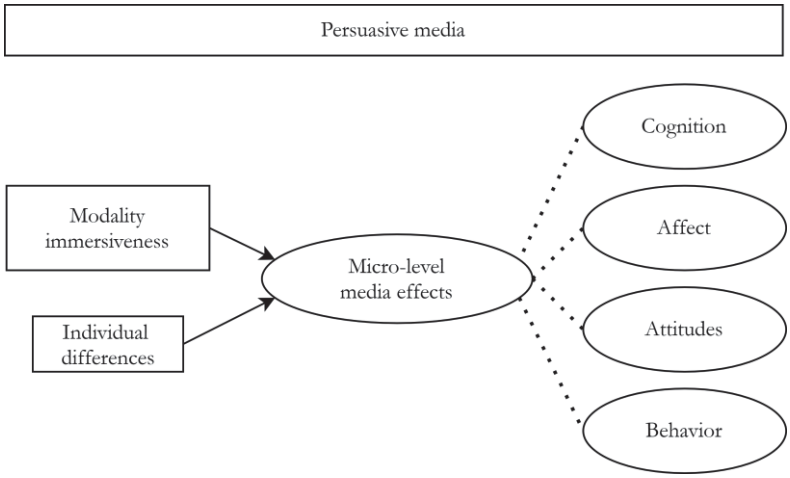

Figure 1. Overview of the research model

As the field of immersive journalism is still in its infancy, both in terms of practices but particularly research, it is important to follow its development and understand how it is being approached and what findings already exist. This importance is even greater when considering the vast multidisciplinary interest in the field which is causing a fragmentation in discussions around communication, with the most prominent areas perhaps being journalism, psychology, media studies, and communication studies. A summary of approaches and outcomes helps to inform future research (Webster & Watson, 2002), and for example, prompts a possible meta-review for attitudinal change effects or gaps in modality comparisons. Moreover, uncovering and discussing the terminology that is used further helps to connect the field towards unified conceptualizations. Consequently, the need for scoping the field, establishing current findings, and most importantly, to identify gaps for future research and development in the field is represented in the first research question which is investigated in Publication I:

RQ1: What are the current existing research avenues, approaches, outcomes, and gaps in the immersive journalism research literature?

One of the prominent hopes and even promises of immersive media and technology is its power for social change (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; Milk, 2015; Sánchez Laws, 2020; van Loon, Bailenson, Zaki, Bostick, & Willer, 2018). It is often represented through their supposed ability to elicit empathy through technology-mediated "stepping in another's shoes" (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; van Loon et al., 2018). However, this issue encompasses a multitude of possible veins for investigation, such as empathizing with the homeless (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018) or with disabled sportsmen (Delmazo, 2019). With the refugee crisis and the related polarization of the public seen during 2017 and 2018 (Ibrahim, 2018), when the empirical study in this dissertation was planned and conducted, it appeared timely and highly relevant to test the hypothesis of immersive media and specifically virtual reality as being "empathy machines" (Bollmer, 2017; Hassan, 2020; Milk, 2015) that could influence attitudes towards others. Beyond the specific circumstances of the time that are indeed still actual in the public discourse, the issues of immigration and human rights attitudes are perpetually important and require action. However, controlled investigations of the media effects relating to attitudes and technological immersiveness are still scarce. Publication II is therefore dedicated to answering the following research question:

RQ2: Can immersive media such as immersive journalism affect individuals' human rights attitudes, and if so, do the effects differ from those of a written Internet news article?

However, if the potential of VR for prosocial change holds true, it is likely that the effects will be existent in relation to affective and cognitive media effects as well. Moreover, the so-called *emotional turn* has now commonly been used to describe the recognition of the emotional component in the production and consumption of journalism (Wahl-Jorgensen, 2020). The emotional component has been further recognized as being exacerbated by technological developments, whereas immersive journalism is sometimes even said to be *emotion-driven* (Lecheler, 2020). This emphasis on the affective aspect of immersive media reveals a dearth in the understanding of how the technological immersiveness of an experience affects the emotional response of users. A more nuanced investigation into the modalities' shaping of emotional experiences thus contributes to discussions about the ethics of immersive journalism (Kool, 2016; Laws & Utne, 2019). As an extension, cognitive media effects, and especially memory of the presented information, have been another concern of immersive journalism with the supposition that journalism's primary aim is to inform (Sánchez Laws, 2019; Wahl-Jorgensen, 2020). Therefore, affective and

cognitive media effects are considered in Publication III and are included in the dissertation under the third research question:

RQ3: How does immersive journalism content influence individuals' emotions, memory, and their relation, compared to a written Internet news article?

Finally, there is the question of whether users prefer consuming more immersive content over more simply presented content. In the context of immersive journalism in particular, producing virtual reality content in general is significantly more resource-costly than other traditional media forms such as 2D videos or written articles, emphasizing the need for the immersive options to be made preferable among the public. Additionally, the potential of virtual reality for social change and other individual benefits (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; Slater & Sanchez-Vives, 2016) is not clear without repeated exposure, as most persuasive media relies on reinforcing attitudes or behavior through repeated exposure (Potter, 2012). For these two reasons, it is important not only to investigate the potential distinct effects of technological immersiveness, but also whether users intend to use mobile VR over 2D screens outside of the study context. Thus, the final research question, investigated in Publication IV of this dissertation is as follows:

RQ4: Are individuals satisfied with the experience of immersive journalism media, and do they intend to continue consuming similar content?

As a summary, Table 1 presents the relationship of the concepts, empirical research questions, and publications, and whether the main media effects are investigated directly or indirectly. Due to research design constraints at the time, attitudes, cognition, and affect were measured directly and immediately during the experiment, whereas behavior stands out as only implicitly considered effect. These indirect findings on behavioral media effects are derived from the interpretation of primary results in connection to existing theoretical and empirical literature. Therefore, the directly measured outcomes of attitudinal change and the intention to continue use of media serve as mediators of behavioral media effects.

Table 1. An overview of research questions and publications in relation to investigated media effects groups.

RQ	*Publication*	*Media effect*	*Results*
RQ2	Publication II: *"Empathy machine": how virtual reality affects human rights attitudes*	Attitudes	Explicit
		Behavior	Implicit

RQ3	Publication III: *Effects of immersive media on emotions and memory: An experiment comparing article, 360-video, and virtual reality*	Cognition	Explicit
		Affect	
RQ4	Publication IV: *Satisfaction and willingness to consume immersive journalism: experiment of differences between VR, 360 video, and article*	Behavior	Implicit

1.2 Dissertation contents and structure

The research work used to form a basis for this dissertation is compiled in three accepted publications and a manuscript currently undergoing peer-review. A total of one literature review of immersive journalism and three empirical studies are included. These four publications broadly correspond to the four presented research questions but are further built upon through a wider positioning within persuasive media and immersive technologies. Contextualization, therefore, contributes to the understanding and interpretation of the research results within a wider media ecosystem, as well as to summarizing theoretical and practical implications, limitations, and further research avenues in the domain of media effects of persuasive media, immersive journalism, and virtual reality.

The structure of the dissertation broadly consists of the background, methodology, results, and conclusions. *Section 2* is dedicated to the positioning of the included publications by presenting a discussion on theories and existing empirical research on persuasive media, immersive journalism, and relevant affective, cognitive, attitudinal, and behavioral media effects. This is followed in *Section 3* by an overview of the methodology of the primary research work. It includes information and justification regarding the research approach choice and design, participants, materials, and data collection and analysis. The obtained results are summarized in *Section 4*, divided by the original publications in which they are presented. Here, they are only briefly discussed, primarily focusing on the correct interpretation of the statistical analyses and their relation to other empirical research. A general discussion on the contributions of the dissertation as a whole, together with its implications, limitations and future research considerations are outlined in the final *Section 5*.

2 BACKGROUND & THEORY

2.1 Persuasive media and immersive technologies

This dissertation is situated in the wider context of persuasive immersive media and technologies, whereas immersive journalism is only one of the representative emerging fields. Persuasion itself can be defined as "an attempt to shape, reinforce, or change behaviors, feelings, or thoughts about an issue, object, or action." (Fogg, 2002). However, in many application domains, including immersive journalism, and especially for individual examples of content, it would be difficult if not impossible to claim whether such intentionality exists. On the other hand, whether the elicited media effects are "persuaded" on purpose or not is inconsequential when considering the effects themselves. Therefore, I will adopt a wider definition and consider persuasiveness as the *capability* of media and technologies, as opposed to intentionality, to have the above-named effects. Moreover, *immersiveness* is considered in this work as technological, as opposed to subjective immersion. This view is perhaps best described as considering that a technology with higher immersiveness can emulate that of lower immersiveness (Slater, 2003). Indeed, immersive technologies and their persuasive effects have proved a fruitful vein of research in the last several years (for reviews, see Hamari et al., 2014; Koivisto & Hamari, 2019; Suh & Prophet, 2018).

Media and technological transformations encompass advances in interactive media such as video games and countless mobile applications. As one small but notable part of these developments, 360-degree videos became a normal part of one's media consumption, accessible using only a personal computer with a 2D screen and controlled with a computer mouse. However, when discussing immersive technologies, virtual reality commonly stands out as a form of persuasive technology (Breves, 2021). Although VR has not permeated the public sphere as fast or as widely as was expected by some, in a diachronic view of the development of media technologies it has indeed exploded along with a number of other technological advancements. Virtual reality has recently been used for persuasive purposes in the domains of, for example, environment and sustainability (Chionidis & Powell, 2020; Markowitz, Laha, Perone, Pea, & Bailenson, 2018), business and marketing (Alcañiz,

Bigné, & Guixeres, 2019), preventive healthcare (Choi & Noh, 2020), tourism (Tussyadiah, Wang, Jung, & tom Dieck, 2018), and prosocial change (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; Ma, 2020).

In the domain of journalism, some of the most prominent paradigm shifts as of late, relating to persuasion, are *the emotional turn* and the use of immersive technologies (Sánchez Laws, 2019; Wahl-Jorgensen, 2020). The emotional turn depicts the recognition of an inevitable permeation of emotions in journalism as opposed to it being solely objective, as well as the intentional engagement with producing emotion-driven content (de la Peña et al., 2010; Wahl-Jorgensen, 2020). Moreover, the use of new technologies and the narrative techniques within them have been an emerging production and research interest over the past years (Hardee & McMahan, 2017; Kool, 2016). These developments are congruent with the above described and increasingly pervasive use of gamification and immersive technologies in virtually all domains of the human condition.

2.2 Immersive journalism

The trend of employing immersive technologies in journalism is perhaps best described through the concept of *immersive journalism*. Although the idea of immersive journalism itself is not as new as the majority of production and research and originates from 2010 (de la Peña et al., 2010), we are only recently seeing an expansion in its production and consumption (Aitamurto, 2019; Vázquez-Herrero & López-García, 2017). Although the use of immersive journalism is not limited to any one topic, it is often considered in the context of bridging distances between individuals and experiences through technology-mediated engrossment (Aitamurto, 2019; Friedman & Kotzen, 2018; Pérez Seijo, 2017). Furthermore, a notable domain is its touted effects in building empathy through first person experiences (Hassan, 2020; Sundar et al., 2017), ultimately fostering prosocial *attitudes* and *behaviors* (Bertrand, Guegan, Robieux, McCall, & Zenasni, 2018; Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; van Loon et al., 2018). It stands on the assumption that if one could experience an event or its simulation, then both geographical and individual barriers of distance would be diminished. On one hand, faraway places could be seen, or even to an extent lived, in one's own living room; and on the other hand, personal identities, biases and prejudices could be blurred with the technologically mediated obscuring of the lines between *me* and *them*.

This idea only gained traction in 2015 and 2016 when *The New York Times*, a prominent news house, initiated its production of 360-degree videos and delivered hundreds of thousands of cardboard mobile VR headsets to their audience (Robertson, 2015). With this initiative, they turned the world of immersive journalism upside down. Additionally, a number of large news houses such as *The Guardian* and the *British Broadcasting Corporation* (*BBC*) have attempted to further advance the field, albeit with arguably limited success compared to expectations at the time. Today, immersive journalism is still predominantly based on 360-degree panoramic videos viewable either on 2D screens or in mobile VR, with mostly experimental experiences in immersive VR (Sirkkunen, Vázquez-Herrero, Uskali, & Väätäja, 2020).

Despite the vaunted global benefits of immersive technologies, it is necessary to consider a wider array of related media effects. For example, the public opinion of such a "close and personal" approach in journalism is not always positive, and further emphasizes the ethical considerations that need to be involved. As a local example in Finland, the national broadcasting agency produced a short 360-degree video depicting a well-known landmark in Helsinki and how it would look if it was bombed, with the description:

> "What would it feel like if Helsinki was the city of Aleppo and you were there? What kind of possibilities does virtual reality offer to journalism? Aleppo-Helsinki is an immersive journalism pilot project developed together with Yle (Finnish Broadcasting Company)."

The initiative, closely in line with the aims and prepositions of immersive journalism, purposefully presents distant events and suffering, from which it is easy to disconnect and to be critical towards, as a local, close, and personal engagement-worthy simulation of "what if". It is available on the *Steam* platform which is namely a platform for commercial games and where this experience is categorized as a VR simulation. The review of the content marked as being the most helpful by the community, as of this date, is the following:

> "It's propaganda made by the Finnish state media to make Finns accept more refugees. You can even see some of the most prolific left wing refugee supporters in the trailer. No idea how they managed to get funding for this."

Even this single but explicit example demonstrates a dire need for a cautious approach to such provocative topics, and a careful consideration of the media's effects and their ethical implication. The added dimension of immersion mediated by new virtual reality technologies additionally poses a danger of unintended

consequences on both the public image, and the actual use and effects of immersive journalism as agenda-driven propaganda playing on one's emotions and abusing psychological mechanisms that lead to effects in attitudes and behavior (Kool, 2016; Lecheler, 2020). Although the emotional turn in journalism does recognize that journalism as made by humans has never been devoid of emotions (Wahl-Jorgensen, 2020), immersive technologies in themselves have had their own share of related criticism (e.g. Hill, 2019). Similarly, then, an important consideration for immersive journalism are the *emotional* and *cognitive* effects, and particularly so in the context of ethical issues (Aitamurto, 2019; Clore & Schnall, 2005; Döveling, von Scheve, & Konijin, 2010). It has further been suggested, for example, that immersiveness heightens the perceived news credibility, and in particular when comparing reading an article or viewing 2D videos to viewing 360-degree videos (Hendriks Vettehen, Wiltink, Huiskamp, Schaap, & Ketelaar, 2019; Sundar et al., 2017), suggesting caution in considering how correctly users remember the contents of 360-degree videos.

Therefore, to understand the distinct effects, potential, and ramifications of immersive journalism and immersive technologies, we need to consider its effects on consumers through the lens of comprehensive media effects. In particular, 360-degree videos are currently one of the most accessible forms of immersive journalism and are widely produced and consumed by a range of news media houses. Hence, they have been in the focus of research efforts, despite not being as technologically advanced as immersive virtual reality.

2.3 Media effects

Throughout this dissertation, the dependency of persuasive media outcomes on the immersiveness of the content delivery modality is investigated through the lens of media effects, and features of media effect theories. Media effects are defined as "deliberate and nondeliberate short- and long-term within-person changes in cognitions (including beliefs), emotions, attitudes, and behaviour" (Valkenburg et al., 2016), here with the focus being on micro media effects or those that users experience on an individual level immediately after the experience. The included publications, therefore, present results relating to the four categories of media effects (see Table 1) – attitudes, affect, cognition, and behavior (Valkenburg et al., 2016) –

whereas this summary expands the discussion into the wider context of media effects features.

In their review of media theories, Valkenburg and colleagues (2016) recognize common features of media effects theories, including: selectivity of media use, media properties (including modality), and that media effects are indirect, conditional, and transactional. All of these features are, directly or indirectly, considered in this dissertation.

The second named feature, *media properties*, is the starting point when investigating immersive journalism, as it moves away from more traditional formats such as written news articles, towards at the very least 360-degree videos and mobile VR. As an extreme, it has even been considered that modality as a media property has a stronger effect than the content itself (McLuhan, 1964; Valkenburg et al., 2016). Studies focusing on this feature of media effects are quite common in immersive journalism and often include articles, 2D, 360-degree video, and virtual reality (Shin & Biocca, 2018; Sundar et al., 2017; Van Damme, All, De Marez, & Van Leuven, 2019), albeit showing mixed effects when considering whether higher technological immersiveness elicits stronger effects. However, these effects are often *indirect*, mediated by another effect brought on by media consumption. For example, different dimensions of affect such as valence and arousal have been shown to affect cognition and behavior (Potter, 2012). *Selectivity of media use* suggests a cycle of media effects and repeated media use, resulting in heightened effects but limited scope due to the limited variance in exposure. This phenomenon has two implications on immersive journalism use and effects. Firstly, if not used repeatedly, any immediate effects might be short-lived; and secondly, that it might be difficult to attract new audiences. These three features, along with the *conditionality* of the effects bound by individual differences and preconceptions existing prior to media exposure, come together and interplay as the *transactional* feature of media effect.

In this vein of transactional effects, this dissertation presents and discusses the differential effects of the modality as a media property on reported intentional selectivity, (partially-) indirect effects on cognition mediated via affect, and the limited conditionality of age and gender.

2.3.1 Empathy and attitudes

One of the prominent touted capabilities of immersive media and technologies is that of their power for social change (Bertrand et al., 2018; Herrera, Bailenson,

Weisz, Ogle, & Zaki, 2018). It is often represented through their supposed ability to elicit empathy through technology-mediated "stepping in another's shoes" through virtual embodiment (Bertrand et al., 2018; Peck, Seinfeld, Aglioti, & Slater, 2013). Therefore, one of the prominent issues in this dissertation is that of technology-mediated empathy and the effects on prosocial attitudes.

Empathy as a concept has been a notably prominent term in the field of virtual reality and its research (Fisher, 2017; Pérez Seijo, 2017; Shin, 2018; Shin & Biocca, 2018), whereas virtual reality has been called an *empathy machine* due to its affordances for providing first-person experiences (Milk, 2015). However, it might be more suitable to investigate relevant attitudes and attitudinal media effects rather than empathy. Indeed, although empathy has been measured and investigated in several works in immersive journalism alone (Sánchez Laws, 2020; Schutte & Stilinović, 2017), its conceptualization and operationalization for research are highly problematic and scrutinized (Bollmer, 2017; Cuff, Brown, Taylor, & Howat, 2016; Fisher, 2017; Hassan, 2020).

Therefore, due to the problems stated above and this dissertation's interest primarily being on effects that might influence society towards prosocial thinking and action, the focus turned towards attitudinal change as an effect considered to be possibly mediated by empathy (Batson et al., 1997; McFarland & Mathews, 2005). Empathizing, on the other hand, does not represent attitudinal change in itself, and could be considered only as a mechanism for eliciting the change (Batson et al., 1997). Therefore, given the refugee crisis and the often-seen public right-wing pushback against immigrants, attitudinal change was deemed as a more relevant and valuable aspect to investigate, and particularly in regard to human rights attitudes.

As also discussed in connection to persuasive media in general, attitudinal changes attributed to media effects have been seen across media and media technologies, from text to VR (Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018; Trommsdorff & Kornadt, 1995). Additionally, immersive transportation and its effects on emotions have been shown to enhance the effects on attitudes (Clore & Schnall, 2005; Green, 2021; Nabi & Green, 2015), implying a positive relationship between technological immersiveness and consequent attitudinal change.

2.3.2 Emotional experiences and memory

Media effects on one's emotions has been a prominent line of research in media psychology, involving predominantly the valence and arousal dimensions of

emotions (Döveling et al., 2010). This encompasses both stimuli leading to affective changes, including immersive technologies (Diemer, Alpers, Peperkorn, Shiban, & Mühlberger, 2015), and the consequent outcomes mediated by emotions, such as memory (Bailey, Bailenson, Won, Flora, & Armel, 2011). Furthermore, research on emotional experiences resulting from media exposure is particularly accentuated in persuasive media studies due to their repeated targeting of users' emotions (Mullins & Sabherwal, 2020; Nabi & Green, 2015). Consequently, the modality's effect on affect and cognition, namely emotional valence states and memory, as well as their relationship, are among the core issues in this dissertation.

Due to previous experiences, conceptions, mental images and associations, stimuli as simple as a word (Kensinger & Corkin, 2003) can influence the targeted dimension of emotions and a specific emotion alike. Furthermore, as with many other psychological phenomena (Pan & Hamilton, 2018), these effects have been shown to be transferable to virtual environments (e.g. Chirico & Gaggioli, 2019; Felnhofer et al., 2015). More complex media such as combinations of words and images, movies, interactive media, and 360-degree videos often intensify and augment the stimulus by engaging more senses and engrossing users, therefore likely heightening the emotional response (Potter, 2012). When considering the first-person perspective in media, emotional contagion causes the emotional valence in particular to likely be strengthened congruent with the actor in the media whose position the user is taking (Elfenbein, 2014).

The relationship between emotional responses and the memory of the stimulus eliciting that response is immensely complex and involves a variety of aspects. It is usually considered how higher negative affect predicts enhanced memory of the experiences, based on the emotional enhancement of memory theory (Hamann, 2001). However, this might hold true only for the broader context of the experiences and the gist memory of its contents, but not verbatim information (Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008; Lang, Dhillon, & Dong, 1995; Van Damme & Smets, 2014), which are differentiated in the fuzzy-trace theory of memory (Brainerd & Reyna, 2004). This is best depicted with the issue of eyewitness testimony credibility linked to a highly emotional experience (Houston, Clifford, Phillips, Memon, & Holloway, 2012). In particular, heightened negative emotional valence could affect memory (Brainerd et al., 2008; Lang et al., 1995; Van Damme & Smets, 2014). This tendency has also been suggested in immersive virtual reality, with those experiencing negative stimuli having impeded memory, as opposed to when the stimulus is positive (Cadet & Chainay, 2020). Together, these indications suggest that a negative stimulus conveyed through immersive media and modality through a first-

person perspective such as immersive journalism, would enhance the emotional reaction but diminish the memory of the content.

2.3.3 Continued use of media

Despite any findings on the immediate media effects on individuals, a single exposure is unlikely to elicit wider attitudinal and behavioral changes without reinforcement achieved through repeated exposure to similar content. However, further exposure is dependent on the users' willingness and intentions to choose one modality over another. As described in the selective use of media feature of media theory (Valkenburg et al., 2016), the user's selection of what to be exposed to determines the possible effects, and thus creates a self-perpetuating effect. In order for immersive journalism to generate a change in society or elicit macro-level effects, the public must be willing and even eager to participate in the endeavor.

The expectation-confirmation theory (Bhattacherjee, 2001) has been widely used, predominantly in marketing and information systems research, to explain and predict users' intentions to continue to use a system. Particularly relevant is the relationship between satisfaction with an experience and the consequent intention to continue to expose oneself to similar experiences (e.g. Joo, Park, & Shin, 2017; Zhou, 2013a). Applying this model to immersive media and technologies is, however, somewhat more novel and unexplored in the domain of immersive journalism. Several factors of media stimuli have been shown to affect satisfaction and intention to continue use, such as engagement and cognitive absorption, making the experience both more enjoyable and more satisfactory (Jumaan, Hashim, & Al-Ghazali, 2020; Mütterlein & Hess, 2017; Shin & Biocca, 2018). Therefore, users are in fact expected to be more satisfied with the richer content delivered through immersive journalism than with written articles, and more likely to continue consuming it if possible.

3 METHODOLOGY

From the four publications included in this dissertation, Publication I is based on a literature review and Publications II, III, and IV on a laboratory experiment. The literature review follows a systematic literature retrieval and coding process (Webster & Watson, 2002) and aims at providing an early overview of the first studies of immersive journalism with an emphasis on possible future research directions (RQ1).

The experiment-based studies rely on quantitative methods and were meant to provide primary insights regarding the media effects laid out in the research questions RQ2, RQ3, and RQ4 of this dissertation. Therefore, the majority of this dissertation is based on an experiment designed to investigate some of the media effects of 360-degree immersive journalism on a 2D screen (*2D-360*) and in mobile VR (*VR-360*), and how they differ when compared to those of a written article (*Article*). Three of the publications included - II, III, and IV - are based on data collected during this experiment. Broadly, they investigate and discuss possible effects on attitudes (RQ2), emotional responses and memory (RQ3) of the presented information, and the satisfaction with the experience and the intention to consume similar media in the future (RQ4). The results are based on self-reports analyzed using a variety of statistical inference tests, as well as with exploratory data analysis (EDA) for a broader understanding of the data.

The choice of approach was based on its suitability for investigating the micro-level media effects of different modalities. Although there are several empirically supported theories related to the research aim, scarce empirical research existed in the domain of 360-degree immersive journalism. Furthermore, the use of experimental research supports a controlled comparison of modalities' effects, as well as detecting changes between attitudes and states before and after introducing the stimulus through a repeated measures design. Finally, as opposed to conducting an experiment at distance, a laboratory experiment enables better control of any external factors that might add noise to data or confound the results, ultimately requiring a relatively low number of participants.

Overall, the research philosophy adopted throughout this dissertation can be described as post-positivistic (Robson, 2002). Although the predominantly

quantitative nature of the research would traditionally point to positivism as the stance that a researcher can be fully objective and remain so while examining a phenomenon and drawing conclusions about what is "real" (Robson, 2002), here, a more subjective stance is taken by acknowledging the shortcomings of positivism. As I have experience with both post-modern constructivism through qualitative studies in anthropology and with positivistic approaches in experimental research, the post-positivist paradigm in a way reconciles these two opposing sides. In this way, post-positivism acknowledges the role of the researcher in producing the findings, and that measures such as psychometric instruments and their interpretation are imperfect due to the researcher's involvement in the process. Namely, this paradigm is reflected in the interpretation of the results contained in this dissertation. Being aware of my positive outlook on immersive technologies and their potential, possible outcomes that would be valorized as positive were considered with a deliberately emphasized critical view, and even borderline effects of possible negative outcomes were examined in more detail, so recognizing and mitigating the presence of subjectivity in the interpretation process. The shift toward post-positivism in social sciences was further supported by the replication crisis seen in psychology (Shrout & Rodgers, 2018) and emphasized the need for meticulous and transparent detailing of the employed methods, as well as a context-aware interpretation of the results. In that vein, the research design and results, as well as the thought process behind them, have always been given special attention in the included publications and this dissertation alike.

Good research practices and research ethics were primarily based on the guidelines of the Finnish National Board on Research Integrity (TENK). As per the guidelines, no ethical permission was required for the empirical portion of this dissertation as the participants' bodily integrity and autonomy were considered not to be endangered. Furthermore, they provided informed consent with the highlighted right to withdraw with no repercussions at any stage of the research. After the research was conducted and during community discussions on research ethics with virtual reality headsets, it has since been considered whether in fact the headsets themselves represent an intrusion for bodily integrity and autonomy. However, as headsets are wearables that can, at any moment, be quickly removed by participants themselves without causing harm, they were ultimately not considered to be threatening to participants. On the other hand, the experiment design and its hypotheses were not preregistered at the time, namely due to my own lack of experience and unawareness of the increasing importance of some of the open science principles. Instead, the employed practice followed the previously

established procedure. Nonetheless, questionable research practices that might endanger the validity of the results such as an omission of non-significant statistical tests, post-hoc hypothesis formation, and any "cherry-picking" of variables were deliberately avoided throughout the research process. This is also evident in the summary of the results (Section 4.5) as only eight out of the total of eighteen hypotheses were fully supported by the data.

3.1 Literature review

A literature review of peer-reviewed research publications on immersive journalism was conducted between April and October 2019, with the aim of mapping the existing research landscape and establishing future research avenues (RQ1). The reviewed body of literature was searched for and collected through *Scopus* during the first month of the review. The process of searching and selecting the literature followed the guidelines for systematic literature reviews offered by Webster & Watson (2002) to ensure an exhaustive a search as possible was conducted.

The Scopus database was deemed relevant and sufficient as one of the largest multidisciplinary databases of peer-reviewed academic publications. The low number of additional records identified using backward and forward reference searching within the retrieved literature further confirmed the sufficiency of the search scope.

The search string consisted of two sections, each encompassing either the *journalism* or *immersive* aspects. For the first, *journalis* OR news* was used, whereas the latter was described by more diverse terms in order to ensure a broad search that would return relevant studies not necessarily using the exact terms "immersive journalism" or "immersive news". Therefore, it consisted of *VR OR "virtual reality" OR HMD OR immers* OR embod* OR 360*. The broader variety of terms was used also to allow results to contain different media and technologies that might be of relevance for immersive journalism. Hence, the full search string was:

> (journalis* OR news) AND (VR OR "virtual reality" OR HMD OR immers* OR embod* OR 360)

Search results were limited to title, abstract, and keywords, as well as to publications classifying as either conference proceedings, journal articles, or book chapters. Furthermore, due to the language constraints of the researchers, the results were further limited to those only in English. Under these constraints, a total of 796 publication records were retrieved, and their titles, abstracts, and keywords were

screened for eligibility. At the same time, 8 duplicate records were identified and removed. After the first round of screening, a total of 41 full-text articles were selected. Four of these were inaccessible as full texts but three more were found through backward and forward reference searches, leaving a total of 40 full texts for eligibility assessment. Finally, 27 full publications were accepted for inclusion in the review. Figure 2 presents the search and screening process.

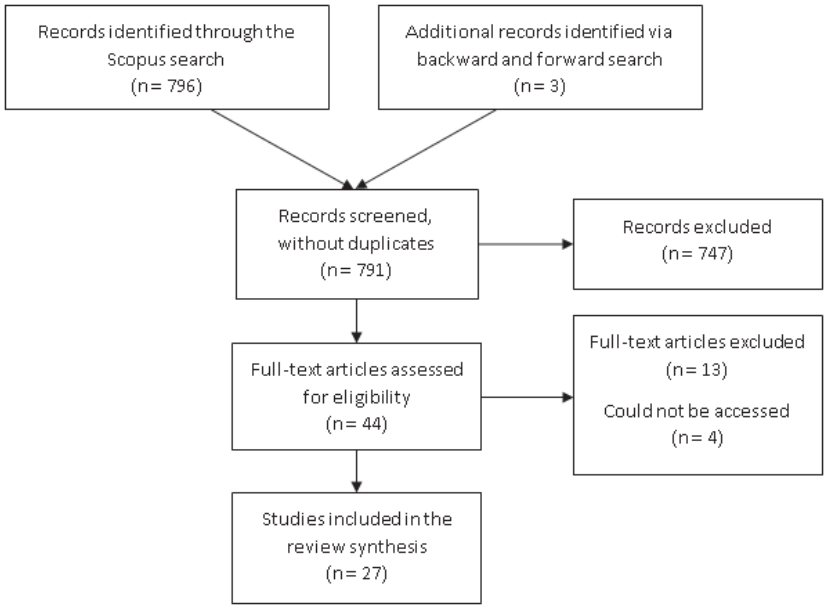

Figure 2. Adapted PRISMA (Liberati et al., 2009) flowchart of the literature review search and selection process

The most commonly applied exclusion criterion was that publications did not refer to any novel immersive technology but rather pertained to other virtual environments such as computer or mobile Internet browsers or applications. The applied inclusion criteria were: 1) focusing on journalism or news domains; 2) considering at least one type of immersive media or technology; 3) published as complete studies; and 4) published in English.

3.1.1 Coding the literature

The selected body of literature was coded using an adapted concept matrix (Webster & Watson, 2002). A total of five matrices were defined as the basis for the analysis.

These were: publication type and year, terminology, type of study and applied methods, presented comparisons of technologies or content, and studied outcomes. Apart from the first category, due to the limited variance in findings, subcategories were devised iteratively during the coding process. For example, a study employing a thematic analysis method would be noted under *type of study – qualitative – thematic analysis*.

Publication type and year were meant to demonstrate the field's development to date, as the number of published studies per year is a good indicator of the publication trend, and a lower number of conference papers compared to journal articles can indicate a young, predominantly exploratory field. *Terminology* is of particular importance as it can be one pitfall of a field, and especially so when it is as multidisciplinary as immersive journalism, resulting in a highly fragmented literature spread across disciplines. *Type of study and applied methods* mapped the approaches to answering the research problems of the emerging field. *Comparisons of technologies and content* explored what different conditions have been contrasted and compared for their effects. *Study outcomes* documented the assortment of outcomes investigated in the reviewed studies, clustering them in thematic wholes.

3.2 Experiment

3.2.1 Experiment design

The experiment was planned as a between-subjects design with the within-subjects factor consisting of repeated measures. Due to the overarching research aim of this dissertation being to investigate media effects of different modalities, it was required that the participants were exposed to only one condition and only one time. Despite participants being randomly assigned to conditions, repeated measures were further employed when needed to ensure that measured effects are not false findings driven by a baseline difference between groups, as well as to determine whether indeed there was a change before and after exposure.

The sample size was determined primarily based on the rule of thumb of 30 participants per condition, the practical constraints of the research project under which the experiment was conducted, and the exploratory nature of research in a young field (Lakens, 2021). Additionally, the work of this dissertation has a particular focus on possible real-world effects, with any statistically significant effects being a

secondary consideration. With that in mind, although an *a priori* analysis of the statistical power for the planned tests was unfortunately not conducted, the design appropriately supported the aims of the study. For example, it had an 80% power of detecting an effect of Cohen's d_z of 0.3 in a paired t-test, and effect sizes of that order of magnitude are still commonly considered as "small" (Cohen, 1977) with questionable effects on daily life. The planned sample size was therefore deemed sufficiently reliable to detect effect sizes estimated to be of relevance for the research aim of the dissertation, if such an effect indeed exists in the population.

3.2.2 Participants

The experiment was conducted using a convenience, non-probability sample. Information on the experiment and an invitation to participate was shared across two campuses of Tampere University and through various student emailing lists. Participants were not required to be students, but due to the recruitment process there is a high likelihood that at least the majority were indeed students.

Although the goal sample size was a total of 90 participants, or 30 per condition, this was not attained because some of the respondents did not complete the experiment. In all cases, this meant that they did not show up at the experiment location at the agreed time. Therefore, there were 27 participants in the *Article*, 29 in *2D-360*, and 31 in *VR* condition. The final sample consisted of 87 individuals, 55 of which identified as *male*, 30 as *female*, and 2 as *other*. Their age ranged from 20 to 39 years (M = 26.38, SD = 4.52). With regard to their nationalities (n = 28), the five most represented were Finnish (28.7%), Chinese (11.5%), Spanish (9.2%), Indian (8%), and Russian (5.7%). Over half of the participants' education level was a Bachelor's degree (52.9%), with similar distributions among those holding a Master's degree (21.8%) and lower than Bachelor's level (25.3%).

To avoid systematic bias, participants were randomly assigned to an experiment condition before arriving at the experiment, while minding the gender distribution. The final assignment consisted of 27 participants in the Article condition (63% male), 29 in the 2D-350 (62.1% male), and 31 in the VR-360 (64.5% male).

3.2.3 Stimuli

The choice of stimuli depended on several requirements:

1) For the study to reflect possible real-world outcomes and effects, the immersive journalism content needed to be available for the public as opposed to that created specifically for the purpose of the study;

2) The content needed to be usable on different technologies in order to determine the effects of the technological aspect;

3) The content needed to reflect an issue of global importance;

4) For the purpose of a controlled experimental setup and due to time constraints, the content should not be longer than approximately 10 minutes in duration.

At the time, the widest repositories of suitable content were the *Daily 360* section of *The New York Times* and *The Guardian VR*. They both presented a variety of 360-degree videos that were viewable on a computer screen as well as in mobile VR.

The final choice of stimuli was *The Sea Prayer*, published by *The Guardian VR*. It is based on the writings by the novelist Khaled Hosseini which was inspired by the story of Alan Kurdi. During the peak of the refugee crisis in 2015, one of the prominent news stories was that of Alan Kurdi, a 3-year-old Syrian who drowned in the Mediterranean Sea. Although reports of refugees' unfortunate destinies and photographs of lifeless bodies on the sea's shores were not unusual, Kurdi's story was prominently used as an iconic representation of the sufferings and losses experienced by refugees (Ibrahim, 2018).

The Guardian video, however, represents an artistic vision of the story from Kurdi's father's perspective. It is compiled from three virtually illustrated scenes that finally constituted a 360-degree panoramic scene. The first scene mostly consists of bright green and yellow tones, the second of dark greys and black, and the third of shades of purple with moonlight illuminating different sections. These visual cues are presented as the narration unfolds and the scenes are drawn at the same time. Congruent with the visuals, the narrator presents different stages in their life – from a calm, family life, through turmoil and civil war, to a time of hope and looking to the future. In the final scene, the narrator is holding their infant on a beach, waiting for ships to emigrate over the sea.

For the 2D-360 and VR-360 conditions, the materials were used unchanged. They were played from their original sources – *The Guardian VR* mobile application for the VR, and *The Guardian* YouTube channel for the 2D-360 condition. For the Article condition, a transcript of the narration was compiled with screenshots of the three scenes, as described above, so as to resemble an Internet news article as commonly found in online news outlets. All of the information that was either visible or audible in the original video was presented verbatim in the article.

3.2.4 Measurements

All data collected during the experiment was done using self-reports (Table 2). Most of them, including attitude and affect related instruments, were in the form of 5- or 7-point Likert ordinal scales. Memory was the exception, being recorded using multiple choice questions. Finally, participants' ages were recorded on an interval scale, and gender on a nominal scale. As a common issue with psychometric self-reports is the possibility of substantial effects of the item order on the response patterns (e.g. Bradburn & Sudman, 2011), the order of the items in each scale was automatically randomized for each participant.

The adopted psychometric instruments' reliability and validity have been ascertained in previous studies. Although their score reliability was confirmed using Cronbach's Alpha (an index commonly used with experiment studies in particular: Cronbach, 1951), no other indices were used. Due to the chosen approach and the relatively small sample size employed, it was necessary to rely on the instruments' history in this regard.

3.2.4.1 Publication II

The second publication included in this dissertation primarily examined the effects of the three conditions on human rights attitudes, with an attempt to explain the effects using users' involvement in the content as a positive influence (RQ2). Therefore, two scales were used: Human Rights Attitudes (HRA) and Involvement (INV).

The *Human Rights Attitudes* scale was an abridged and adapted version of the questionnaire developed by Diaz-Veizades and colleagues (1995), and measured on a 7-point Likert scale with point anchors ranging from "Strongly Disagree" to "Strongly Agree". The selected items were those with higher item loading scores as reported in the original study, considering that the construct validity is largely dependent on this metric. The items' wording was slightly adapted in several cases to lower the possibility of participants misunderstanding the statement.

The HRA scale consists of four constructs: Social security (SOC) ("Everyone has the right to an adequate standard of living."), Civilian constraint (CIV) ("There are times when people shouldn't be allowed to express their opinions freely because they may endanger established ways of thought."), Equality (EQT) ("Everyone has the right to freedom of opinion."), and Privacy (PRI) ("A person's home is his or her "castle" and should not be interfered with by others."). Only the last construct of

Privacy showed a poor internal consistency reliability (Table 2) and for this reason was excluded from the analyses. There was no definitive explanation for the low reliability of the PRI construct, but possible reasons include abridging and slightly revising the original instrument, and poor construct validity in this particular sample.

Involvement was measured using a 7-point Likert scale which is a part of a Presence scale presented by Witmer and Singer (1998). Its end-point anchors were "Not at All" and "Very much" ("Were you involved in the experience to the extent that you lost track of time?"). This construct is closely related to that of immersion and flow, where all signify engrossment with the experience, albeit with somewhat different foci.

3.2.4.2 Publication III

Affective response and memory (MEM) as outcomes from the three experiment conditions were examined in Publication III (RQ3). Emotional valence as the emotion dimension of the experience was measured using existing negative affect (NA) and positive affect (PA) scales, whereas a multiple-choice test as the means for investigating and quantifying memory of the media content was constructed by the manuscript's authors based on the experiment stimulus.

The positive and negative affect schedule (PANAS) affect was developed by Watson, Clark and Tellegen (1988) and has been extensively used and validated across different populations (Crawford & Henry, 2004). The instrument consists of two sets of 10 single-word items representing individual emotions of *positive* (e.g. "proud") and *negative valence* (e.g. "ashamed"). Participants rated how strongly they felt the named emotions from "Very slightly or not at all" to "Extremely". Mean scores for each scale were calculated for both the pre-test and post-test administration. Additionally, these were transformed into variables representing the difference between the two tests for each individual (i.e., how much their negative and positive valence changed after consuming the media, and the direction of change).

For measuring participants' recollection of the content, a 10-question *memory test* with multiple choice answers was devised specifically relating to the stimulus. Each question was presented alongside three answers, where only one was correct. Questions pertained to information presented in various ways, so that they encompassed both visual and narrative elements. Furthermore, both explicit (e.g. "What was the name of the boy the narrator was talking to?") and implicit (e.g. "How many generations in the narrator's family were mentioned?") information was

included. The answers were coded as correct (1) or incorrect (0) so that the score sum which was used as the outcome variable would represent the number of correct answers.

Multiple-choice questions are a convenient way to test the memory of participants, and they do not require researchers to code specific answers as in the case of free recall tests that might lead to bias. However, they are prone to being answered correctly by chance as an answer is required to be selected, and the absolute free recall might therefore be lower. However, as the purpose was to compare scores between different conditions and not to formulate claims whether individuals' memory is acceptable or not, these possible pitfalls of the questionnaire do not pose an obstacle for the study aim.

3.2.4.3 Publication IV

The final study included in this dissertation, Publication IV, included variables relating to the respondents' satisfaction with the media experience and whether participants intended consuming similar media in the future (RQ4). Both scales are adapted from those originating from the expectation-confirmation model (Bhattacherjee, 2001). According to the model, the pre-existing expectations of a system or experience and the consequential (dis)confirmation of those expectations and (dis)satisfaction with the experience significantly influence one's intention to return to it or similar systems. Although the participants were informed about the procedure and study's high-level aim, it was not possible to provide sufficient information about the conditions so as to meaningfully document whether their expectations of the experience were confirmed or not. Furthermore, expectation confirmation is also the main predictor of satisfaction (Joo et al., 2017; Zhou, 2013), meaning that in the scenario of the experiment, it would not create additional value in itself. Therefore, the expectations confirmation variable was omitted and only variables of satisfaction and intention to continue use were employed and analyzed.

Satisfaction (SAT) was measured by asking the participants to rate the experience they just had. All items were anchored uniquely, with sentiment binaries being dissatisfied/satisfied, displeased/pleased, frustrated/content, and terrible/delighted. *Intention to continue use* (CON) was a simpler, more common scale, including different statements that were to be rated on a 7-point Likert scale from "Strongly agree" to "Strongly disagree" (e.g. "I would like to try similar media experiences like the one I just had").

3.2.4.4 Overview of instruments and variables

Table 2. An overview of the instruments, their sources, number of items, Cronbach's Alpha, and Likert scale type.

Variable	*Source*	*Items (n)*	*Cronbach's Alpha*	*5-point Likert*	*7-point Likert*
HRA	(Diaz-Veizades et al. 1995)	*28*			
SOC		6	.76		x
CIV		9	.78		x
EQT		9	.74		x
PRI		4	.22		x
INV	(Witmer & Singer 1998)	5	.83		x
PANAS	(Watson, Clark, & Tellegen 1988)	*20*			
PA		10	.89	x	
NA		10	.88	x	
MEM	Author	10	NA	3 answer choices	
SAT	(Bhattacherjee, 2001)	4	.83		x
CON		3	.86		x

3.2.5 Procedure

Four distinct phases of the experiment study procedure can be identified: two pre-test stages, treatment, and post-test (Table 3). The complexity of the procedure was determined based on the requirements for investigating the research questions previously described, whilst minding the load placed on the participants as it has been show that extensively long questionnaires elicit respondent fatigue (Lavrakas, 2012). The within-subject measurements, for example, were necessary for the human in order to establish a baseline that would be comparable to the post-treatment scores and allow any differences to be identified. Furthermore, the emotional states required a more acute measurement immediately before being exposed to the stimuli, along with the post-test immediately following the exposure. As multiple variables were measured in both the overall pre- and post-test, administering them all on-site would have been unsustainable and likely heightened the measurement error (Lavrakas, 2012). The experiment itself was conducted at Tampere University during April and May 2018, and the instruments were administered using the online survey platform SurveyGizmo.

The experiment was conducted at two locations at Tampere University. Both were plain office spaces, with a desk, monitor, and a rotating office chair. A research assistant and I were synchronously conducting the experiments at both locations, guided by a predetermined and rehearsed script.

Participants were first directed to the first pre-test where they were presented with a consent form including information about the contact person, procedure, confidentiality, compensation, and their right to withdraw from the study with no ramifications. After completing the questionnaire, they were redirected to an online booking application. Upon arrival at the experiment location, they would respond to the second pre-test and be familiarized with the technology. After being exposed to the stimulus, they completed the post-test.

Finally, after administering the post-test, participants were informed in more detail about the purpose of the study, its expected outcomes, and were given an opportunity to ask questions, as well being provided with a contact email.

Table 3. Phases of the experiment research and their contents.

Phase	*Test*	*Variables*
Phase I	First pre-test	- Demographics: Age, gender, nationality - HRA
Phase II	Second pre-test	- PANAS
Phase III	Treatment	Article / 2D-360 / VR-360
Phase IV	Post-test	- PANAS - ECT - HRA - MEM

3.2.6 Data analyses

The data collected during the experiment varies greatly in several aspects, and the appropriate analysis was determined separately for each variable and hypothesis depending on the descriptive statistics of the data itself, as well as the complexity of the intended inference. Overall, the results for this dissertation were obtained using a number of statistical inference tests, including both parametric and non-parametric

tests, and exploratory data analysis (EDA). Data was fully handled and tested using IBM SPSS v24 and v25.

3.2.6.1 Parametric Tests

The most commonly found tests in social science literature tend to be parametric. However, they require a number of assumptions to be met in order for the alpha level of the test to remain as predicted, often posing a threat of false positives and often requiring a larger sample size to reduce the probability of Type II error (Dennis, Emmanuel, & O.A. Paul, 2019). However, they were found to be suitable for the majority of the variables used in the dissertation.

The primary and most common assumptions were the normal distribution of the data, or an approximate so-called Bell curve, and the homogeneity of variances. Normality was mainly tested visually using a histogram (Das, Sheikh, Rahman, Das, & Rahmatullah Imon, 2016), whereas the homogeneity of variances between the three conditions or groups was tested using Levene's test before conducting F and t-tests (Levene, 1960).

3.2.6.2 Non-parametric Tests

Unlike parametric tests, non-parametric tests are far more robust in terms of their sensitivity to data normality and controlling for Type I error and relations of sample size and power (Corder & Foreman, 2014). The predominant reason for turning to non-parametric tests in the included publications was the assumption of normality being violated, and the affect measures were particularly affected by this issue. For a robust comparison of outcomes and devising a meaningful interpretation of the results, if one variable required a non-parametric test, all those related to it were tested using non-parametric tests as well. Publication III, which examines affect and memory, primarily used these types of statistical tests. For example, a Wilcoxon Signed-Rank test was used for repeated measures such as pre- and post-test affect scores instead of its parametric counterpart which is a paired t-test.

3.2.6.3 Exploratory Data Analysis

Using exploratory data analysis techniques can help in cases when there is not enough background theoretical literature and previous empirical findings to fully support forming a hypothesis. However, formulating well-based hypotheses before running a test is still an important practice for controlling for Type I error or false positives due to random chance or systemic bias (Banerjee, Chitnis, Jadhav, Bhawalkar, & Chaudhury, 2009). In this research, when the obtained results from inference tests were unclear or borderline, EDA was used as an additional dimension for correctly interpreting the results. All three publications based on the experiment data employ at least some EDA techniques, such as scatterplots, boxplots, and descriptive statistics.

4 RESULTS

4.1 Publication I: Literature review

As a central theme of this dissertation, a literature review of immersive journalism research was conducted with the aim of setting the grounds for primary findings and depicting the immediate research ecology. Considering the pace at which the field is developing, at the moment of writing this summary, the review it is not meant to be read as a comprehensive overview. However, it does demonstrate the trends and breadth of research interests within them. The review answers the first research question of this dissertation:

> **RQ1**: What are the current existing research avenues, approaches, outcomes, and gaps in the immersive journalism research literature?

The review identified the first mention of *immersive journalism* in 2010 (de la Peña et al., 2010). That publication laid out the main ideas behind using immersive modalities for representing important global topics with the aim of engrossing the user by setting them as an actor in the scene. However, the idea in academic circles only started to be picked up from 2016, followed by a steep rise in related studies. As an indication of the increased interest, the number of analyzed studies from 2018 was identical to that seen in the first quarter of 2019 (n = 13).

The field's infancy is further visible in its fragmented and diverse terminology. Although "immersive journalism" was the one predominantly found terms in the reviewed studies, others like "VR journalism" and "360-degree journalism" were also frequently appearing in the literature. The inconsistency further points to a high probability of publications being omitted due to using terminology that was unrecognized in the review design. However, due to the inevitable bias towards one type of content over others when a reviewer labels studies themself, only those directly indicating immersive news/journalism were included.

Out of the total of 27 publications, 17 were empirical. Methodological approaches were quite varied as well, encompassing different qualitative, quantitative, and mixed-method analyses. Furthermore, all comparisons of modalities were mapped, with no pair standing out as being more represented than others. However, 360-

degree video on mobile VR was the most frequently employed treatment with a total of six studies.

The majority of studied outcomes was found in only one study each, rendering it impossible to draw broader conclusions from this body of literature alone. For easier comprehensions of the scope of the recorded outcomes, however, they were approximately divided into categories. *Affect*, for example, was studied in terms of empathy (Shin & Biocca, 2018; Sundar et al., 2017), personal involvement and distant suffering (Van Damme et al., 2019), and enjoyment (Vettehen et al., 2019; Van Damme et al., 2019); *cognition and attitudes* through, of interest for this dissertation, attitudes on the content topic (Delmazo, 2019), memory (Vettehen et al., 2019; Li, Yang, Ji, & Liu, 2019; Sundar et al., 2017), perceived credibility (Vettehen et al., 2019; Kang, O'Brien, Villarreal, Lee, & Mahood, 2019; Sundar et al., 2017), expectations and experience (Shin & Biocca, 2018); and *behavior* encompassing viewing behavior (Li et al., 2019), following-up on the content topic (Slater et al., 2018; Steed, Pan, Watson, & Slater, 2018), and online reviewing and commenting (Wang, Gu, & Suh, 2018). The findings from these studies are relevant for interpreting those presented in this dissertation and are further discussed in Section 4.

Another contribution of the review is its identification of several gaps and problems in the field. As mentioned, the scattered terminology of such a highly multidisciplinary field makes it difficult for researchers to track relevant studies, and even to define the concept of immersive journalism. Methodologically, the studies are rarely transparent and meticulous in describing their study designs and results, which combined with rarely comparable study conditions is highly problematic for drawing higher-level conclusions. Modalities, stimuli, and participant samples all might differently influence the media effects, and without acknowledging these differences there is a high likelihood of erroneously summarized and generalized findings. Finally, studies relatively rarely focused on investigating the main assumptions about the effects of immersive journalism explicitly, such as empathy (n = 1) and possible ramifications related to users' media literacy (or lack thereof), which might be further emphasized with highly immersive media technologies.

Although this review is now lagging behind the current situation (especially in relation to the fast-developing research on immersive journalism and immersive media in general), it does demonstrate a primarily strong and rising interest in the field. Particularly, the pronounced multidisciplinarity and fragmented research interests in terms of relevant topics, approaches, and outcomes suggest primarily explorative investigations of a field which is in its infancy.

4.2 Publication II: Human rights attitudes

The results of Publication II primarily pertain to the media effects on attitudes. Specifically, whether and to what extent does sorrowful content on hardships faced during a civil war and a consequent decision to emigrate with an infant affect the human rights attitudes of the participants, and whether there is a difference in the effects depending on the modality via which the content is delivered. The results from this publication are related to the second question of the dissertation:

> **RQ2**: Can immersive media such as immersive journalism affect individuals' human rights attitudes, and if so, do the effects differ from those of a written Internet news article?

When looking into the effects on the human rights attitudes scale as a whole, positive changes between before and after consuming the content, as tested using a paired t-test, were found in 2D-360 ($t(86) = 2.42$, $p = .022$, $d = .45$) and VR-360 ($t(86) = 3.22$, $p = .003$, $d = .58$). However, those participants who read the Article containing comparable content exhibited no changes in their attitudes ($t(86) = -0.49$, $p = .627$), suggesting that the commonly seen Internet news articles might not even influence attitudes, unlike a 360-degree video delivered either on a screen or in mobile VR.

A further, more granular analysis of the conditions' effects on different aspects or dimensions of human rights attitudes was conducted using a repeated-measures analysis of variance (ANOVA), which suggested that the differences lied in the social security ($p < .001$) and equality ($p = .046$) factors, but not in civilian constraint ($p = .300$). These findings further warranted paired t-tests which would locate the conditions where these attitudinal changes were occurring. The results indicated that the Article had not elicited changes either in social security ($p = .263$) or equality ($p = .611$). On the other hand, both social security ($p = .013$) and equality ($p = .024$) were affected in those who were in the VR-360 group, whereas the changes for 2D-360 were visible for SOC ($p = .006$), but only approaching significance for equality ($p = .068$).

This overview of the self-reports on human rights attitudes before and after introducing the stimulus overall indicate that HRA is not affected by Article, but that it is by 2D-360 and VR-360. These findings supported the need to test whether there was a difference in the effects between the two latter conditions, or medium- and high-immersion modalities, as well as between the two 360-degree video conditions on one side (immersive journalism) and the Article on the other.

However, an ANOVA suggested that there is a borderline difference only when comparing the changes between 2D-360 and the Article (p = .056), and only approaching significance for VR-360 when compared to the Article (p = .076). The high p-value contrasted against the results presented above might also be explained by the wide 95% confidence intervals of the change due to the small scale of the experiment, but also bring nuance to the understanding of the data by demonstrating that there is a significant overlap between groups.

Here, the examined relationship between technological immersiveness and attitudinal change was hypothesized to be explained by users' involvement in the content of the story. As a starting point, an ANOVA suggested that there was a difference between the participants' reported levels of involvement depending on the condition ($F(2.84) = 6.56$, p = .002, η_p^2 = .135). Moreover, post-hoc Tukey HSD analysis identified that the differences lied between the Article and 2D-360 (p = .023) and the Article and VR-360 (p = .002), but 2D-360 and VR-360 seemed to elicit similar levels of involvement. Interestingly, interaction tests of HRA and involvement across the three conditions suggested non-significance (Article: p = .965; 2D-360: p = .608; and VR-360: p = .361). Finally, a general linear model with an interaction contrast test compared 360-degree conditions on one side and the Article on the other, with high and low involvement scores. With the data simplified in this manner, it was suggested that higher involvement in the immersive conditions showed a higher positive effect on the attitudinal change, albeit showing a low effect size ($F(1.81) = 5.10$, p = .027, η_p^2 = .059).

To conclude, although the main assumptions of the publications appear to hold true, the effect sizes seem to be predominantly lower than expected or assumed to be for real-world significance. This has resulted in somewhat ambiguous findings of the statistical inference tests as the sample size does not support finding such small effects if existing in the population. Nevertheless, the detailed account of the data provides indications about the relationship between the experiment conditions and attitudes. These effects are predominantly in line with other findings on immersiveness and attitudes and empathy, suggesting a positive effect of immersiveness (e.g. Barreda-Ángeles, Aleix-Guillaume, & Pereda-Banõs, 2020; Herrera et al., 2018). However, these effects are likely to be quite small, if even existent, when comparing viewing a 360-degree video on a 2D screen or in mobile VR. This could also be due to the small difference in the immersiveness between the two conditions as it is limited to the field of view and mode of surveying the virtual environment.

4.3 Publication III: Emotions and memory

Affective and cognitive effects of immersive journalism have been further examined in Publication III. Specifically, participants' emotional valence changes and memory of the media content have been compared across the three conditions - Article, 2D-360, and VR-360. Therefore, Publication III answers the following research question:

> **RQ3**: How does immersive journalism content influence emotions, memory, and their relation, compared to a written Internet news article?

First, emotional responses to the media content and possible differences in conditions' effects in this regard were considered. Due to non-normal distribution of variables, a non-parametric paired samples test, Wilcoxon Signed-Rank, was used to test whether positive and negative valence emotion states differed before and after being exposed to the media. The results suggested that all three conditions lowered positive and heightened negative affect in participants, indicating that the media content itself, regardless of the modality, influences users' emotions.

However, although there were no differences detected in the modalities' effects on the overall positive affect state (p = .907), the Kruskal-Wallis test did detect differences for overall negative affect state (p = .030). A following post-hoc examination using Dunn's test specifically located the differences when comparing Article and VR-360 with a Bonferroni adjusted p = .040, indicating that mobile VR modality elicited a higher level of negative affect, as reported by the participants. The Bonferroni correction was used as a robust method for multiple comparisons so as to control for Type I error due to multiple testing (Bland & Altman, 1995).

Pre-test, post-test, and change (pre-test minus post-test) variables were also examined using descriptive statistics and boxplots. Overall, the variance of the change variables when compared across the three conditions showed a significantly wider range of scores, and hence an unpredictability of the effects in the 2D-360 and VR-360 when compared to the Article condition. Approximately a quarter of participants in both medium and high immersion manipulations reported a higher change in the negative affect than those in the Article. Similar observations were not found for the positive affect.

All of the results pertaining to affect point to modality playing a role, with higher immersion eliciting a higher negative affect, and the inequality particularly found between Article and VR-360. It would appear that higher immersion is accompanied with a higher emotional response to the stimulus, regardless of whether the

experience is interactive (Pallavicini, Pepe, & Minissi, 2019) or passive. The same effects were not detected for positive affect, albeit all three modalities did indeed affect it.

Additionally, females (Mdn = .722) were found to have a higher negative affect change than men (Mdn = .333) with a Mann Whitney U test (p = .014). A simple cross-correlation matrix, however, showed no relationship between the participants' age and memory (r = .080).

Regarding the second aspect of memory, memory scores compared across the conditions using Kruskal-Wallis suggested to retain the null hypothesis, or that participants' memory of the content did not differ depending on the delivery modality (p = .309). However, a graphic representation of the data and descriptive statistics again, to some extent, contradicted the findings of statistical inference testing. Memory test suggested that those who read the Article again exhibited a notably more controlled and predictable range of scores, whereas those in 2D-360 and VR-360 exhibited a higher variance in scores. Similarly, as found regarding the negative affect change, visual inspections suggested that immersive conditions showed slightly lower memory of the content.

Third, the relationship between the negative affect state after being exposed to the content and participants' memory of it was found to be significant using a linear regression (F(1.85) = 4.28, p = .042, R^2 = .048), which is consistent with some previous related findings (e.g. Van Damme & Smets, 2014; Cadet & Chainay, 2020). A scatterplot, however, appeared borderline and suggested that those findings might not be definitive. The data represented such an effect size that each point of negative affect, on a scale of 1-5, decreases memory by half a point out of a maximum of 10. Consequently, although there does seem to be an effect, it is questionable as to what implications it might have for real-world situations.

4.4 Publication IV: Continued consumption of media

The final publication in this dissertation examined the relation of the three conditions and participants' satisfaction with the media experience, and their intentions for continuing consuming similar media content. These final outcomes and their relation were further scrutinized by involving an exploratory approach to the influence of individual differences – specifically age and gender. Publication IV thus examines the final research question of the dissertation:

RQ4: Are individuals satisfied with the experience of immersive journalism media and do they intend to continue consuming similar content?

Firstly, the conditions' effects on satisfaction and continued use were tested using a multivariate analysis of variance, or MANOVA, which suggested that the outcome variables indeed differed depending on the modality, albeit only slightly ($F(4.168) = 2.58$, $p = .039$, $\eta p^2 = .058$). However, further investigation of the tests of between-subjects effects clarified that the effects were detectable only for CON ($F(2.84) = 5.47$, $p = .006$, $\eta p^2 = .115$) and not for SAT ($F(2.84) = .276$, $p = .759$, $\eta p^2 = .007$). Finally, a follow-up Tukey HSD post-hoc test, which is widely considered robust at avoiding Type I error or a false positive (Salkind, 2012), suggested that this difference in levels of the reported intention to continue use was statistically significant only between the Article and 360-VR conditions. The mean score for participants in the 360-VR condition was higher than for those in the Article by .998 points on a 7-point scale (95% CI [1.729, .268], $SE = .306$, $p = .005$). The difference in means between Article and 2D-360 similarly was .677, albeit it was not found to be statistically significant (95%CI [1.419, .065], $SE = .311$, $p = .081$).

When it comes to whether satisfaction predicted intended continued use, a borderline significance with a very weak relationship was found with a linear regression ($F(1.85) = 3.84$, $p = .053$, $R^2 = .043$). Although detectable, the difference is only at the level of .247 points of continued use for each full point of satisfaction.

Finally, the individual differences of participants do not seem to make a difference in their intention to continue consuming similar media. A linear regression was found to be non-significant for age ($F(1.85) = 1.237$, $p = .269$, $R^2 = .014$), and similarly, an independent t-test showed no relation between males' ($M = 5.16$, $SD = 1.31$) and females' ($M = 5.39$, $SD = 1.07$) outcome mean scores ($t(83) = -.806$, $p = .423$).

Taken as a whole, these results suggest that higher immersiveness indeed predicts participants reporting a higher intention to continue use of the media and this is not affected by gender or age. However, participants seem to had been equally satisfied with the media experience, regardless of the modality. Nevertheless, in line with the expectation-confirmation theory and previous findings (Joo et al., 2017; Zhou, 2013), satisfaction does, to an extent, predict how willing users are to continue consuming the media.

4.5 Summary of the results (II-IV)

Considering the complexity of the experiment design and taking into account all of the presented research questions, simplified hypotheses, and outcomes, a summary of results is presented in Table 4 below.

Table 4. Summary of the results (Publications II-IV) with emphasis on their relation to research questions, original hypotheses from the included publications, and results.

RQ	*Hypotheses*	*Results*
Research **Question** 2 (Publication II)	All three conditions lead to a positive shift in human rights attitudes.	-
	Immersive conditions, 2D-360 and VR-360, will have a stronger effect on human rights attitudes than the Article.	+
	The gradation of the effects on human rights attitudes positively corresponds to low, medium, and high immersiveness.	-/+
	Level of involvement in a media experience mediates the relationship between the immersiveness of the technology and the change in human rights attitudes.	-
	Involvement has a stronger positive effect on human rights attitudes in 2D-360 and VR-360 than in the Article condition.	+
Research **Question** 3 (Publication III)	All three conditions elicit a lowered positive affect.	+
	All three conditions elicit a heightened negative affect.	+
	Higher immersiveness predicts a higher decrease in the positive affect.	-
	Higher immersiveness predicts a higher increase in the negative affect.	+

	Females experience a more prominent negative affect change compared to males.	+
	Higher age predicts a lower negative affect change.	-
	Higher negative affect predicts lower memory.	+
	Higher media immersiveness predicts lower memory.	-/+
Research **Question** 4 (Publication IV)	Immersive conditions, 2D-360 and VR-360, elicit a higher satisfaction with the experience than reading the Article.	-
	VR-360 condition predicts higher satisfaction than 2D-360.	-
	Immersive conditions, 2D-360 and VR-360 elicit a higher intention to continue use than reading the Article.	+/-
	VR-360 condition predicts higher intention to continue use than 2D-360.	-
	Satisfaction with the experience positively predicts the intention to continue use.	+
	(Exploratory) How do gender and age influence satisfaction and continued use of immersive journalism content?	

5 DISCUSSION

This dissertation aimed to examine the overarching research question:

> *What affective, cognitive, attitudinal, and behavioral media effects does persuasive media have, depending on the modality via which the content is presented?*

For this purpose, it used immersive journalism as an example of the possible use of immersive media and technologies to enhance engagement and persuasion. A literature review (Publication I) and a set of three empirical studies (Publications II, III, and IV) were included, with the findings summarized and shortly discussed in relation to the research questions laid out in Section 1.1:

RQ1: What are the current existing research avenues, approaches, outcomes, and gaps in the immersive journalism research literature?

RQ2: Can immersive media such as immersive journalism affect individuals' human rights attitudes, and if so, do the effects differ from those of a written Internet news article?

RQ3: How does immersive journalism content influence emotions, memory, and their relation, compared to a written Internet news article?

RQ4: Are individuals satisfied with the experience of immersive journalism media, and do they intend to continue consuming similar content?

These four questions are directly derived from and refer to the four publications included in this dissertation. The research design was mainly confirmatory, with clearly grounded and explicated hypotheses. Some of the primary motivations for confirmatory research, as extensively discussed in the Background & Theory section, were the touted relevant implications of technological immersiveness on persuasion, the emotional turn in media and journalism in particular, couples with the public's acceptance of these technologies. On the other hand, the exploratory nature of this dissertation is evident in the broad coverage of various aspects of media effects with some, such as human rights attitudes, not seen in prior literature in this context. Therefore, as a distinct contribution of this summary, implications on media effect categories and media effect features are considered with the aim of gaining a broader

understanding of their implications and the contexts in which the findings are situated. Overall, the studies presented here indicate that media effects in general are likely to be relatively more prominent with higher technological immersiveness than lower technological immersiveness, albeit with some caveats.

Media effects, as presented in Table 1, were divided according to the type of effect – attitudinal, affective, cognitive, and behavioral. However, it is important to highlight that not all of them were directly measured, and sometimes the implications are derived from the related literature. Effects on users' **attitudes** were investigated in Publication II with a focus on human rights attitudes. Unexpectedly, reading an article with content comparable to that of the original 360-degree video used on a 2D screen and in mobile VR did not elicit a change in attitudes. Technological immersiveness by itself did predict a higher persuasiveness as observed through an attitudinal change, but only when considering the magnitude of the effect sizes. However, statistical tests did not confirm that difference. Overall, when it comes to attitudinal media effects, immersive journalism seems to be significantly more effective than traditional, written journalism. Similar results were obtained for **affective** or emotional media effects. In this case, the article also had an effect, albeit notably smaller. Virtual reality again showed more impactful effects, with users reporting higher negative emotions elicited by the content. Results indicating positive relationship between immersiveness and negative affect is consistent with previous literature that even suggests possible mental health ramifications of the exacerbated effects on emotions (e.g. Lavoie, Main, King, & King, 2020). In Publication III, effects on emotions are found to be related to media effects on **cognition**. The results from this study suggest that higher negative valence emotions predict impaired memory of the content. Moreover, the results were ambiguous as to whether higher immersiveness predicts impaired memory in itself. Finally, **behavioral** media effects were investigated only implicitly and speculatively in Publications II and IV. Firstly, as prosocial attitudes elicited through immersive technologies have been suggested to predict prosocial behavior (e.g. Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018), immersive journalism is more likely to affect behavior than an article. Furthermore, the reported intention to continue use of media was higher in more immersive conditions. Although the intention does not necessarily directly and fully translate to sustained media consumption, together with user satisfaction it is an early exploration of the topic in immersive journalism. As such, it represents an implicitly or indirectly studied behavioral media effect.

Overall, the results collected through the literature review and experimental research presented in this dissertation imply that immersive journalism in the form

of a 360-degree video on a 2D screen or in mobile VR might be more effective than written articles, primarily in achieving attitudinal change. The unique affordance of immersive technologies of "placing someone in another's shoes" by presenting a first-person perspective unparalleled in its sensory engagement has further implications for building a more empathetic and inclusive society. However, the potential and the magnitude of immersive technologies' media effects and their influence on individuals often seems to be over-exaggerated and enthusiastic, whereas any detrimental effects, such as those on memory, are rarely considered.

This dissertation also demonstrates a dire need for us to investigate the relationship between content and modality in more detail and scrutinize the concept of immersive journalism. The starting assumption for the empirical research questions was that all three modalities would elicit the examined media effects, albeit of different levels of influence on the participants. It relied on the premise that the content itself is the primary trigger for the effects. However, the controlled experimental investigation demonstrated that this is not always true, but that the modality sometimes plays the deciding role. For example, we have seen an unexpected outcome in Publication II where reading an article did not elicit a change in human rights attitudes. This pointed to the conclusion that immersive journalism as such is far more efficient in persuasion and that it even could elicit effects that are undetectable with written articles. However, as seen, not all effects are so clearly exacerbated by the modalities' immersiveness, even when comparing the article on one side and the two immersive journalism conditions on the other. Moreover, even this dissertation provides opposing evidence on whether viewing a 360-degree video on a 2D screen or in VR are distinctly different experiences. It would appear that both content and modalities play their own roles in eliciting various effects and that there are a number of relevant paths for future research.

It is thus unclear on what *immersive* journalism should represent. On the one hand, we could consider it solely from a technological perspective in the same manner as immersiveness has been conceptualized in this work. Nonetheless, this approach brings its own pitfalls as we can describe various levels of immersiveness, ultimately leaving us with the same issues we face today. On the other hand, this dissetation contributes to our incremental understanding of media effects and it is my hope that it will help in (re)conceptualizing immersive journalism relative to the content and modalities that elicit certain desired effects.

5.1 Theoretical implications

Implications for scientific theories regarding the media effects of immersive persuasive media are primarily examined through the lens of the features of media effects theories, as identified by Valkenburg and colleagues (2016). The results and implications are here discussed with an attempt to elucidate the **transactional** aspects of media effects in immersive journalism and immersive technologies in general.

The first feature is that of **media properties**, which also encompasses one of the central issues in this dissertation – the modality through which content is consumed. Due to its technologically immersive properties with primary being salience for the sense of vision, virtual reality has often been touted as a "game changer" in persuasive media technologies (Milk, 2015; Raessens, 2019). This positive outlook does not often fall short from the extreme notion that the "medium is the message" (McLuhan, 1964). However, the results presented in this summary suggest that at least mobile VR does not always elicit greater effects than its 2D screen counterpart. When it comes to all of the media effect types (attitudinal, affective, cognitive, and behavioral), VR appears to have only marginally stronger effects, and those small differences often could not even be definitively confirmed in the small sample used in the studies. However, the differences found between the 2D and VR which utilized a 360-degree video on one side and a written article with still images on the other side were significantly more prominent. It is unclear, however, whether the lack of sound narration or the dynamic visual representation would be the single aspect responsible for much of the difference in the effects. Attitudinal changes, for example, were not detectable at all for those in the Article condition, which might be explained by the reported personal involvement in the contents. Moreover, this notion of a possible mediation of outcomes points to the effects as **indirect**, similarly as investigated in relation to the affective and cognitive effects. Indeed, the negative valenced emotions seem to predict slightly impaired memory of the contents. Furthermore, the intention to continue use was found to be considerably stronger for 2D and VR compared to the Article, but also predicted by the users' satisfaction with the media experience. This relationship further contributes to the validation of the **expectation-confirmation theory** (Bhattacherjee, 2001) in the context of immersive media and technologies. Moreover, the intention to continue use is of particular importance when considering the **selectivity of media use** and whether the immersive content reaches an audience. However, it is unlikely that a significant portion of the public would, at this moment, choose to take up a mobile VR, set up

the system, and watch a video instead of simply reading an Internet article that was easily available on any screen such as a mobile phone or laptop. The satisfaction with the experience and the desire to expose themselves to the experience again might in fact originate from the novelty effect (Wells, Campbell, Valacich, & Featherman, 2010) and subside when the users become accustomed to 360-degree video experiences. Furthermore, in relation to the novelty and previous notions of emotional and memory-related effects, it is possible that these effects would subside as the immersive experiences become more akin to everyday ones (Poppenk, Köhler, & Moscovitch, 2010). Finally, the **conditionality** of media effects has been probed from the perspective of demographic individual differences – namely age and gender – for affective and behavioral effects. However, in these studies there seems to be little conditioning from these factors, and indeed, only gender predicted a differing change in participants' negative emotional states. This is congruent with a review suggesting that emotional virtual content affects women more strongly than men, possibly due to a higher prominence of neuroticism as a personality trait (Grassini & Laumann, 2020).

5.2 Future research avenues

The number of combinations of content types, modalities, users, and effects is virtually incomprehensible. However, each of these factors presents its own opportunity as a unique future research vein. They are not entirely unheard of, but they are, at very least, under-researched and worth emphasizing. Furthermore, each of these veins branches out into a number of more focused topics, each with its own value and potential contribution in the ecosystem of immersive technologies and persuasive media. The following gives an outline of some of the major considerations for future research.

The primary empirical studies described in this dissertation, as well as a significant number of those seen in the related literature, used arguably a simplistic base stimulus in the form of a non-interactive panoramic 360-degree video. This domain is indeed particularly relevant as both a prelude to more immersive forms, and as the currently prevalent form in the wider public consumption of persuasive media. However, as shown through the literature review, scant research exists on, for example, 360-videos that also feature interactional affordances. Here, the added layer of engagement with the content could positively relate to involvement and emotional

responses, further affecting end-media effects such as diminishing the ramifications on true memory of the content. A similar situation is seen with immersive VR in comparison to mobile VR, which adds the dimension of movement through the environment and possibly embodied agency in the space, which quite literally puts the user in another's, virtual, shoes (e.g. Slater et al., 2018b). Even though these kinds of experiences are being studied, they are still in their early stages and are predominantly examined in stripped-down controlled virtual environments.

Moreover, as an extension of the discussion of the distinct effects of content and modality, a number of studies are needed to examine the nuances of these differences. For example, videos with the same message could be augmented with slight disparities eliciting different levels of emotional change. This manipulation would then further be enriched by a factorial design including several modalities. In such a way, it would be possible to pinpoint what elicits the effects and how the content and modalities interplay in mediating those effects.

A usually unfeasible but important aspect for research is longitudinal and behavioral design. The immediate media effects that are usually examined only present the implications of the effects for the future, and assumptions on how long the effects persist. When considering real-world macro-level media effects and the potential for social change on a global level, a longitudinal approach and particularly in combination with behavior tracking, is the only way to obtain primary results (for an example, see Herrera, Bailenson, Weisz, Ogle, & Zaki, 2018).

Finally, even if they do not seem particularly fresh, novel, and exciting, both failed and successful replications of existing studies such as those presented in this dissertation are sorely needed as future studies as well. The current global research climate is overly supportive of moving forward and beyond on quite feeble grounds. Unfortunately, however much effort is put into one's methods, the likelihood is such that not all findings are going to be true or are constrained by the sample. Statistical inference requires a repetition of the old at the expense of novelty. This is similarly true with qualitative research, even though not as often explicitly stated. The particular issue with multidisciplinary and even interdisciplinary fields such as immersive media is the resulting lack of coherence and solid grounds upon which the field is built. Therefore, a replication and strengthening of the conceptualizations, instruments and related findings is perhaps the most urgent and valuable future research avenue.

5.3 Limitations

Although this dissertation is successful at providing some insights regarding the broad research question around which it is built, its context and findings are not without limitations. They mainly concern the internal validity and the external generalizability of the results from the empirical experimental studies and the discussion that followed.

When it comes to internal validity, the limitations are primarily bound to the constraints imposed by the experiment conditions, sample size, and psychometric measurement instruments.

The empirical portion of this dissertation is based on a laboratory experiment and primarily the comparison between the effects of three levels of modality immersiveness. Due to the context of immersive journalism, the low-immersion modality was a written article with still images depicting the graphics from the 360-degree video used in the other two conditions. The form of the content, therefore, was not identical across the three conditions, with the article most notably missing the audio narrative component, which was instead presented as text. This discrepancy could elicit specific effects that were not considered. However, the design supported the intended comparison between more traditional and immersive ways of delivering content, with the experimental manipulation representing the modality aspect.

The sample size contributed to producing a number of borderline or inconclusive results, with relatively broad 95% confidence intervals of the mean scores that were used in the analyses. Therefore, some of the results should be interpreted with caution and in relation to other literature and research.

All measures were collected using self-reports, which are susceptible to potential internal validity issues. An attempt was made to control, for example, for order-effect, where participants' subsequent answers are influenced by a previous question, by randomizing the order in which the items appeared. The sample size further limited the validity tests that could be performed on the instruments, even though all of the psychometric tests used were previously validated on large samples. The memory test employed can be perceived as somewhat arbitrary as there does not exist a clear rule on what would more or less relevant to remember. Furthermore, with the multiple-choice question type the chance of randomly choosing a correct answer cannot be excluded, albeit there is no reason to assume that the likelihood is not distributed equally across the experiment conditions.

Lastly, behavioral effects were not measured directly nor longitudinally. Although the intention to continue use is a valuable indicator, it is still reliant solely on participants' reports immediately after the exposure to the stimulus. Moreover, it might be a weak signal due to the inevitable lessening of the novelty effect of new media technologies after continuous multiple exposures.

The external validity of the research could be limited mainly by a few factors including the research design, sample composition, and stimulus properties. The conducted experiment resulted in three publications that consider different aspects of media effects. Although they could be discussed together to an extent, their inter-relatedness was not analyzed in order to maintain high methodological rigor. Avoiding the fallacies of multiple testing, as well as testing outside of the published results, so led to the inability to provide a conclusive in-depth discussion of, for example, the relationship of affective and attitudinal changes.

Sample composition concerns various dimensions such as age, gender composition, cultural, and other differences relating to individuals' own lived experiences. The latter aspect is particularly important with socially and culturally sensitive topics such as civil wars and becoming a refugee, as presented in the stimuli used for Publications II-IV. Personal and close experiences, as well as previous knowledge and media exposure on a topic in question, could significantly alter the effects of a subsequent stimulus during an experiment. Therefore, the theme of the stimulus itself could be reacted to differently than to say something of a less globally charged nature. Additionally, the stimulus was not photorealistic nor as if recorded with a 360-degree camera, but represented panoramic virtually drawn visual content.

The sample was recruited through University internal outlets which renders it likely that it was composed primarily of University students, even if it was not a prerequisite for participation. As a common ailment of experimental research, this is not unusual, but it is also not representative of the general population. This non-representation is reflected namely in the basic demographic data, such as age, gender, and level of education. Furthermore, even though the sample consisted of over a dozen nationalities, Finnish participants accounted for over a quarter of the sample. As a final observation, participant-reported gender counted only two not identifying as male or female. This is particularly important to note for the examined moderation effects of gender, as those identifying as non-binary had to be excluded from the analyses involving gender as a variable due to the unacceptably few data points.

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PUBLICATION I

Immersive journalism: Extant corpus and future agenda

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Immersive journalism: Extant corpus and future agenda

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Abstract. The goal of journalism is to disseminate information to people as accurately and holistically as possible. Therefore, unsurprisingly, the recent advances in multisensory and multimodal technologies have spawned a new research area of immersive journalism (IJ). It is believed that the more holistic and engrossing media experiences afforded by virtual, augmented, and mixed reality technologies can lead to more comprehensive information internalization, both cognitively and emotionally. The literature has increasingly started to propagate since approximately 2016 onward. Therefore, while the domain is still only in its inception phase, and while the related technologies continue to develop, it is already mature enough to both look backwards to what has already been done and forwards to delineate future research agenda. In this review, we investigate what has been investigated in the extant corpus, including: methods and data, technologies and types of content in experiment settings, and dimensions related to the resulting experiences.

Keywords: virtual reality, mixed reality, 360 video, journalism, perspective taking, literature review

1 Introduction

Immersive journalism (IJ) is becoming increasingly available and popular, primarily due to The Guardian and the New York Times (NYT) and their 360-degree video sections. Additionally, NYT had sent out over a million of Google's Cardboard VR goggles in 2016, introducing their readers to the medium. However, the idea of merging new technologies and journalism was introduced already in 2010 [A5] with the aim of creating engaging experiences through placing the user in another's shoes and bridging the gap between *you* and *them* or *there*. Originally, it was envisioned as an immersive virtual reality experience, including embodiment, interactivity, and freedom of movement, which would help represent others' experience and emphasize promoting empathy and affective understanding [A5, A21]. This trend can also be seen simply as an extension of previous use of new technologies, with the same purpose of enhancing user engagements through the development of newsgames [1, 2], and the overall drive of gamification [5].

Closely connected to this idea of engagement is the notion of collapse of compassion [8] which describes the global phenomenon where the distant suffering of many is not experienced deeply, nor even objectively understood, in terms of its collective individual effects. Instead, news pieces dealing with these topics are often taken as merely information, with possibly some experienced uneasiness. Although there is a psychological defensive reason for this as no one can carry all the burden of the world, it also hinders compassion and action for the betterment of humanity. Immersive journalism emerged as an attempt to use new technologies such as virtual reality to bridge this gap. Virtual reality (VR) is sometimes referred to as an "empathy machine", particularly in popular discourse [9], presenting a technology that might be able to enhance human connection by allowing an individual to cross space or even time and walk in another's shoes [6, A8, A17]. Similarly, *Carne y Arena* by Alejandro Iñárritu is a unique dramatic experience of which a large portion is in VR and has won a special Oscar in 2017, indicating that there is both recognition and faith in the development of similar projects. It places the user as an immigrant at the U.S.-Mexico border with all the hardships that surround similar feats, diminishing the distance between the user and the immigrant through intuition [7]. However, as producing fully immersive pieces is still resource-heavy, the majority of IJ available to the general public is in the form of 360-degree videos that are viewable on-screen (2D surface) or in mobile VR which provides further technological immersiveness [A7].

Despite interest and eagerness in the potential of VR, IJ became visible as an interest of academics only from the year 2016 onward, after both an increase in the production of 360-videos and NYT's initiative which helped popularize VR and the content. Further development and better affordability and accessibility of both the technology and content is heightening interest in related themes, both in public and academia. The domain seems to still be only in its inception considering its breadth and the different possible types of content (360-video, interactive, digital reproduction, filmed, etc.) and technologies (screen size, mobile VR, immersive (embodied) VR with all its variations).

Thus, this review aims at providing an overview of the field, to identify pitfalls and gaps, as well as delineate possible future research avenues. It presents several key points in the literature: methods and data, technologies and types of content in experiment settings, and studied outcomes.

2 Method

This study relies on Webster and Watson's [10] process for systematic literature reviews. It supposes a reproducible research consisting of a rigorously defined search, transparent inclusion criteria of the retrieved papers, and a pre-defined concept matrix for analyzing the selected body of literature.

The search for literature was conducted during April 2019 in *Scopus*, one of the largest databases of peer-reviewed publications. Exploratory searches by the authors had been conducted two years prior with the aim of getting acquainted with the field and terminology. This prior knowledge was used in constructing the search string,

which was composed out of two sections: one describing *journalism*, and the other describing *immersive*. Both sections were built using multiple related terms and employing wild cards for a comprehensive search where appropriate. Thus, the following search string was construed:

(journalis OR news) AND (VR OR "virtual reality" OR HMD OR immers* OR embod* OR 360)*

A total of 796 results were retrieved, including conference papers, journal articles, and book chapters. The first round of reviews included scanning the retrieved abstracts of the final results, leaving 41 results. Publications were discarded due to referring to virtual reality in the wider sense as digital environments, not being related to news or journalism, or for only mentioning the field in passing. Although immersive news could, additionally, entail augmented reality (AR) applications, and the search string supported that premise, no such applications were found during the search.

Four full papers out of the 41 that were chosen for full analysis could not be accessed, leaving 37 full manuscripts. During this stage, 13 additional publications were discarded for the same exclusion criteria listed above, leaving 24 publications deemed suitable for inclusion in this review. Finally, backward and forward reference searches were conducted revealing 3 new manuscripts. The analysis of the final 27 results was performed using a concept matrix pre-determined by the authors.

3 Results

The analysis was conducted using an adapted concept matrix [10] and all the results are presented by these investigated aspects of the literature. All of the papers that were analyzed in their entirety (N = 27) were individually coded according to the following pre-defined bases for the matrix:

1. Publication type and year
2. Terminology used
3. Type of study and methods
4. Presented comparisons between media technologies or types of content, and
5. Studied outcomes

Whilst the categories of some of these points for investigation (1 and 3) were predictable (e.g. whether a study is empirical or non-empirical), others (2, 4, and 5) were further defined during the analysis itself. For example, all of the outcome variables that were found in the reviewed body of literature were recorded under *Studied outcomes* as they appeared in the papers. Using this method, not solely particular pre-defined outcomes were reviewed, but rather all that were studied in this domain and were documented in the retrieved literature.

3.1 Emergence of a field

Before year 2017 the only published articles are from De la Peña and colleagues [A5] which introduced immersive journalism in 2010 and a lone conference paper from 2016 (A20) which drafted the future possibilities of journalism in VR. More prolific academic study of the field started only in 2017 (n = 12) and the number of publications is on a significant rise. During the first quarter of year 2019 only (n = 13), the number of peer-reviewed studies had already reached the total number of those from 2018 (n = 13).

3.2 Terminology

Table 1. Terminology found in the literature.

Term	Studies
360-degree (video) journalism	A1, A12, A25
360-video news	A3
360-degree VR	A27
VR news	A3, A11, A13
VR journalism	A8, A13, A25
Immersive news	A23
Immersive journalism	A2, A4, A5, A6, A7, A8, A9, A10, A11, A13, A14, A15, A16, A17, A18, A19, A20, A21, A22, A23, A24, A25, A26

In most cases, the authors used the term *immersive journalism* for 360-degree videos on screen or in mobile VR, and for immersive virtual reality applications. However, there are inconsistencies with the terminology which might stem from and contribute to the high granularity of the field with articles scattered in a variety of venues. Therefore, familiarity with the used terminology should ease the cohesion of the research and with time consolidation of the currently vague terminology. Table 1 documents the terms found in the literature. It is worth noting that, while those containing *360* in their name are limited to the 360-degree videos, it is not always clear what is considered under *immersive journalism*, *immersive news*, and *VR news* and *VR journalism*. These can, but do not necessarily, denote both immersive and mobile VR content. Furthermore, *360-video news* has only been used in conjunction with *immersive news* (A3), and *immersive news* only in conjuction with *immersive journalism* (A23). Several other studies have used different terms together with no particular pattern (A8, A11, A13, and A25).

3.3 Types of studies and methods

All of the manuscripts were classified either as *empirical* (n = 17) or *non-empirical* (n = 10), and according to the methods used. In the further sections of this review, only

the results of the empirical studies are examined and presented. These are further noted as *quantitative* (n = 8), *qualitative* (n = 6), or *mixed methods* (n = 3) studies.

Table 2. Types of studies and methods.

Methods			
Empirical	Quantitative/(mixed)	Inference	A9, A11, A19, A21, A23, (A24), (A25), A27
		Descriptive	A3, (A12), A14, A21
	Qualitative		A1, A4, A6, A10, A22, A26
	Mixed		A12, A24, A25
Non-empirical			A2, A5, A7, A8, A13, A15, A16, A17, A18, A20

The majority of the quantiative studies analyzed the data using statistical inference (i.e. hypothesis testing), and only 3 (A3, A13, and A15) presented it using solely descriptives such as mean values. Almost all of the measurements were collected via psychometric tests. Interestingly, one study analyzed users' behavior using objective, publicly available data from the streaming platform *YouTube* (A27).

Qualitative studies mainly investigated the content (A4, A10, A22, and A26), or conducted interviews or focus groups with users (A6, and A10) or practicioners (A1).

3.4 Comparisons

Table 3. Treatment comparisons

Treatments	VR, no body	360, mobile VR	360, Card-board VR	360, screen	2D, screen
VR embodied	A21, A23				A19
360, cardboard VR		A25		A25	A11, A25
360, screen		A24, A25			
2D, mobile VR		A9			
2D, screen		A25		A25	
Article		A24		A24	
No treatment			A11		A11

Table 3 presents identified comparisons implemented in study designs. The majority of the labels consists of two parts, one denoting the type of content and the other referring to the type of technology or other affordance of the application. When it comes to the content, there are: *VR* – digital 3D virtual environments for immersive VR; *360* –360-degree videos; *2D* – 2D video or fixed perspective 360-degree video; and *article* – written news article. The second half of the labels is as follows: *embodied* – user is presented as inhabiting a body in the content; *no body* – user is not presented in the content; *mobile VR* – different VR head-mounted displays that provide stereoscopic view using a mobile phone; *cardboard VR* – the simplest VR device similar to the mobile VR but

in lower quality and needs to be held to the head; *screen* – a common label for 2D screens, regardless of the size and technological specifications.

Empirical studies often employed comparison of the effects of different media and/or media technologies. The most represented comparisons employ 360-degree videos in mobile VR on one side, and a variety of treatments on the other. The least studied in comparable settings are immersive VR (A19, A21, and A23), as imagined immersive journalism, and written articles (A24), as a more traditional form of journalism.

3.5 Studied outcomes

Table 4. Studied outcomes.

Category	Measure(s)	Studies
Affect	Empathy	A19, A24
	Personal involvement	A25
	Distant suffering	A25
	Enjoyment	A9, A25
Cognition and attitudes	Attitudes on the topic	A6
	Memory	A9, A12, A24
	Attention-allocation	A24
	Narrative understanding	A9
	Perceived credibility	A9, A11, A24
	Expectations and experience	A19
	Intention to share	A24
Engrossment	Flow	A3
	Cognitive absorption	A3
	(Tele)Presence	A3, A9, A11, A19, A21, A23, A24, A25
	Immersion	A19
	Body ownership	A21, A23
	Agency	A21, A23
	Engagement	A21
Behavior	Viewing behavior	A12
	Follow-up	A21, A23
	Online reviewing and commenting	A27
Production and journalistic norms		A1, A4, A10, A12, A14, A26

For better readability of the output, the studied outcomes are loosely divided into five categories – *affect*, *cognition and attitudes*, *engrossment*, *behavior*, and *production and journalistic norms*. There were coined by the authors and do not represent concrete analytical value. On the other hand, categories in the Measure(s) column were taken directly from the investigated literature and represent their measured outcomes.

Unsurprisingly, users' engrossment is studied the most, with (tele)presence as the most studied outcome, However, it is highly granulated across different media and media

technologies, as can be seen from Section 3.4. Only one study employed a measure of attitudes towards the topic of the content (A6), and two tracked whether users showed interest beyond the experiment and have followed up to learn more (A21 and A23). Finally, the category of production and journalistic norms entails studies on, for example, use of annotations (A14) or subtitles (A12).

4 Discussion

This review is the first attempt to summarize empirical research on the topic of immersive journalism, which is gaining increasing interest in academia. The field is multidisciplinary and highly topical, and studies are greatly dispersed and disconnected, as can be seen throughout this study, starting with the inconsistent terminology. it is hoped that this review will serve as a step toward consolidating the field by representing the state of the art and identifying gaps and points for further research.

However, it should only be taken as a stepping stone toward a more nuanced one. Considering the speed at which the field is expanding, it is necessary that it is updated and expanded when possible so as to provide more solid grounds for examining the effects of immersive journalism.

4.1 Identified gaps and future directions

Already from this short review there are several issues and gaps identified in the literature. Some are minor but expected as they mostly stem from the field being novel and multidisciplinary; others pertain to methodological drawbacks and overlooked central concerns in immersive journalism.

1. Authors rarely define the variety of terms used, making it difficult to denote what immersive journalism is and what it is not. Some more clearly denote it as embodied immersive VR experiences (A5, A21, A23), but it would seem that the majority refers to 360-videos commonly available to the general public. A more transparent approach while at the same time contextualizing the research in the wider field could aid in structuring it at this crucial time of growth.
2. Even though not limited to this field [4], quantitative data and results are not always well and clearly presented, succumbing to various misconceptions when drawing conclusions. It is of particular relevance here, because of the breadth of the technologies as well as content, to diligently lay out both descriptive and inferred results. This practice would allow for meta-analyses that would additionally enable reviewers to gather higher level implications from the studies.
3. Similarly, as seen from Table 3, there are rarely multiple studies employing same pairs of treatments, as out of sixteen comparisons only three pairs are to an extent comparable. Instead, it would be beneficial if treatments are replicated, while for example using different type or topic of the stimuli. Such a practice is incremental, but necessary for strengthening the findings.
4. Furthermore, as the VR technology is becoming more available and fully immersive experiences gaining more popularity, it is imperative that these are investigated in a

timely manner beside the 360-videos. On the other hand, a comparison of immersive and traditional, written news pieces has only been found in one example (A24), revealing a dearth of knowledge in how they compare to each other.

5. Only a handful of the reviewed studies investigated palpable outcomes of these immersive experiences. This is particularly unexpected in the light of immersive journalism's aspirations to engage and induce empathy, as well as the popularization and recognition of similar content in the artistic domain through *Carne y Arena* [7]. The attitudinal and behavioural effects are vastly hypothesized but rarely investigated. Considering that empathy is a highly problematic concept [3], it might be more beneficial to examine measurable outcomes such as attitudinal changes (A6) and following-up (see A21 and A23). Notable by their absence are longitudinal and behavioral studies showing whether these possible preliminary outcomes can truly affect an individual and the society [9].
6. Finally, the most crucial and largest gap in the reviewed empirical literature on immersive journalism is the lack of scrutiny of users' media literacy - in particular when it comes to critical evaluations of the consumed content. Although it can be argued that there are benefits to the emphasized individuality and the subjective experience of immersive journalism [7, 8, 9], there should also be a counterbalance ensuring that the public is at the same time informed and vigilant. Future empirical studies should weigh these two aspects – subjectivity and objectivity – in order to obtain a more comprehensive account of the effects and ethics of immersive journalism.

4.2 Limitations of the review

As with any review, there are certain drawbacks to this one that ought to be noted. With a wide field such as immersive journalism there is no way of making certain that all published studies are taken into account despite the best efforts in constructing the search string. However, it is meant as a broad overview of the state of the field and its findings rather than aiming at one particular aspect in detail. Moreover, due to the length constraints, it was mainly focused on empirical research while leaving conceptual and theoretical discussions in the background. Finally, even though the number of publications included in this review is not negligible, there are not enough comparable studies that would enable a deeper discussion of the results and whether or not immersive journalism truly is more effective in engaging users and bringing about positive change.

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PUBLICATION II

"Empathy machine": how virtual reality affects human rights attitudes

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"Empathy machine": how virtual reality affects human rights attitudes

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Abstract

Purpose – This study aims to investigate how media content consumed through immersive technology may evoke changes in human rights attitudes. It has been proposed that our inability to empathize with others could be overcome by stepping into another's shoes. "Immersive journalism" has been postulated as being able to place us into the shoes of those whose feelings and experiences are distant to us. While virtual reality (VR) and 360-degree news videos have become widely available, it remains unclear how the consumption of content through immersive journalism affects users' attitudes.

Design/methodology/approach – Utilizing a between-subject laboratory-controlled experiment ($N = 87$) this study examined participant scores on the Human Rights Questionnaire before and after consuming 360-degree video immersive journalism content via VR ($n = 31$), 2D ($n = 29$), and Article ($n = 27$) formats. Collected data were analysed using statistical inference.

Findings – Results indicate that immersive journalism can elicit a positive attitudinal change in users, unlike an Article, with mobile VR having a more prominent effect than a 2D screen. Furthermore, this change is more strongly affected by users' higher Involvement in the content.

Originality/value – These findings are relevant for grasping the distinct effects novel and recently popularized technologies and media have on attitudinal change, as well as inform the current debate on the value of VR as "empathy machines".

Keywords Virtual reality, 360-degree video, Immersive journalism, Human rights, Attitude change, Being-there

Paper type Research paper

Introduction

It has been proposed that inducing empathy towards those who are temporally or geographically distant is best achieved by stepping into their shoes (Coke *et al.*, 1978; Harris and Foreman-Peck, 2004; Tosh, 2015). In particular, it is difficult to empathize with people whose actions and experiences have little relation to our own (Gutsell and Inzlicht, 2012; Kunstman and Plant, 2008). Therefore, we may be less likely to care about the human rights of people whose hurdles are culturally, temporally and/or geospatially distant, despite the fact that equal human rights for all would be one of the building blocks for a stable and functioning society.

Immersive computer technologies are increasingly being explored as a potential means to increase the empathy of humankind (Kors *et al.*, 2016). Virtual reality (VR) technologies in particular have been popularly proposed as the "ultimate empathy machines" (Constine,

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2015; Milk, 2015) – primarily because of the technological characteristics that strengthen the users' feeling of "being there" (Cummings and Bailenson, 2016). At the same time, the availability and low cost of mobile VR headsets have popularized consuming 360-degree videos in VR sourced from the internet, such as immersive journalism (Jones, 2017).

Similarly, in the VR documentary *Clouds Over Sidra* viewers are immersed into the Za'atari refugee camp in Jordan, containing tens of thousands of Syrians displaced by civil war. The experience builds upon the concept of perspective-taking – the ability to adopt another person's point of view (Coke *et al.*, 1978), which has been suggested as encouraging prosocial behaviour when used in VR (e.g. van Loon *et al.*, 2018). In 2017, a special Oscar was awarded for *Carne y Arena*, an immersive VR experience that engages users in a dramatic illegal border crossing between Mexico and the United States. Although the work is currently only available at specific exhibition sites, and therefore, inaccessible to a wider audience, the award suggests that we should expect more similar experiences in the future.

The relevance of stepping into another's shoes is not restricted to artistic audiences or public education, it is particularly important for politicians responsible for ratifying foreign policies. Undoubtedly, the human rights attitudes of both the politicians and citizens will have an effect on globalization and policies regarding foreign outreach. Moreover, the relevance of human rights is not limited to foreign policy but is, instead, a prominent part of any human interaction.

However, computer sciences research has focused predominantly on the relationship of information technology use and rights of an individual, such as information access (e.g. Lazar and Stein, 2017), rights to privacy and other similar ethical issues (Lazar *et al.*, 2017; Tavani, 2003), rather than on how attitudes to human rights could be influenced by new technologies. Indeed, immersive experiences, akin to those outlined above, could help reframe this issue from the more abstract level of institutions to the personal one in order to make it more accessible and tangible. It is yet unclear how different immersive media technologies can affect a population's attitudes and behaviour using the same source content. Considering the rising popularity and relevance of these technologies in the public discourse, as well as the recent refugee crisis and ambiguous reactions to it (Hangartner *et al.*, 2019), this study investigates *how immersive technologies, utilised via immersive journalism, can affect consumers' human rights attitudes, and whether the effects differ when compared to written articles.*

Theoretical background and hypotheses development

Human rights attitudes

The concept of human rights has been endorsed by legislative bodies and institutions across the world. The most widely known and, arguably, influential is the United Nations' Universal Declaration of Human Rights (UDHR). According to the UN, human rights can be broadly divided into civil-political rights and social, economic, and cultural rights. While the UDHR has become the cornerstone of contemporary human rights, both in respect to legislation and a general conceptual framework, the 20th Century also saw rights extended in the areas of universal suffrage, civil rights and workers' rights.

In terms of psychological measurement and the conceptualization of human rights, literature is commonly focused on the attitudes or beliefs that people hold towards others, and to what rights people are entitled. Understanding the conceptualization of human rights attitudes in particular has tended to fall into one of two camps: the first states that there is a single underlying attitudinal approach, with the second proposing that attitudes are clustered into distinct constructs or dimensions. Proponents of the first approach state that any disparity in attitudes to different "sets" of human rights, for example in supporting civil rights but denying cultural rights, is due to a lack of understanding or political "know-how". On the other hand, research has demonstrated links between distinct dimensions and

psychological or ideological characteristics (Crowson, 2004). This debate, specific to the concept of human rights, can be seen to reflect that of the more general processes underlying moral reasoning outlined above.

Whether attitudes to human rights can be attributed to a single unidimensional perspective, or whether they can be conceived of as distinct dimensions, the psychological operationalisation of human rights could broadly be divided into the following areas: (a) social security; (b) equality; (c) civilian constraint (or the lack thereof); and (d) privacy (Crowson, 2004; Diaz-Veizades *et al.*, 1995). The first two can be seen to address the social, economic and cultural aspects of human rights, while the latter two can be seen to address the civil-political dimension of human rights (Diaz-Veizades *et al.*, 1995). Consequently, the measurement of human rights has largely focused on similar distinctions. The way in which these attitudes are formed and maintained has been studied in respect to political ideology (Cohrs *et al.*, 2007), peer-influence (Dunbar *et al.*, 2007) and personality (Swami *et al.*, 2012). However, personality traits and beliefs have themselves been shown to be malleable (Cohen, 2003; Mischel and Shoda, 1995), whether in regard to natural experience (Roberts *et al.*, 2006) or designed interventions (Dweck, 2008; Gerber *et al.*, 2010).

Empathy has been shown to be a predictor for endorsing the ideals of both human rights (McFarland and Mathews, 2005) and social equality (Pratto *et al.*, 1994). With this in mind, we can assume that utilizing new media to create "the ultimate empathy machine" (Constine, 2015; Milk, 2015) would be an effective means for promoting human rights and contributing to social equality and overall human well-being.

Immersive journalism

The field of immersive journalism relies specifically on the advantage of allowing users to immerse themselves within a virtual scene. It is a medium which relies on immersive media and technologies such 360-degree video and virtual reality (Jones, 2017) in order for users become involved in the content and, consequently, empathize with a specific group as a direct result of "being there" (Heeter, 1992; Slater and Wilbur, 1997), of being directly involved in the depicted events (Aitamurto, 2019; De la Peña *et al.*, 2010; Sánchez Laws, 2017). Nonetheless, an analysis of different representative cases from immersive journalism indicated that some examples are more successful than others in inducing empathy in users (Sánchez Laws, 2017). However, the analysis did not investigate the effects of different platforms, but rather the design of the experience itself.

There is some preliminary evidence suggesting that a VR-mediated, first-person view of tragic situations promotes empathy and compassion. For instance, Schutte and Stilinović (2017) showed that experiencing Clouds Over Sidra via a head-mounted display (HMD) increased perspective-taking and empathic concern in comparison to watching it in a 2D format. This branch of VR-content production and research is, however, in its early stages; it is mostly exploratory and experimental, while possible attitudinal changes in users are largely hypothetical and evidence of prosocial behaviour is anecdotal.

Media and attitudes

Different types of media have been widely used to elicit emotional responses and to induce changes to individuals' attitudes and biases throughout the history of media. From the 20th century, notable examples include wartime propaganda materials (Trommsdorff and Kornadt, 1995) and, more recently, video games (Gabriel, 2017; Gentile *et al.*, 2009; Isbister, 2016). Although war propaganda was primarily intended to evoke negative images of the enemy, it was also partially aimed at promoting prosocial behaviour on the home front (Trommsdorff and Kornadt, 1995). Several decades later it has been suggested that video games have the capability to encourage both prosocial thought and behaviour (Gentile *et al.*,

2009; Greitemeyer and Osswald, 2010), as well as empathy whilst also decreasing antisocial affect (Granic *et al.*, 2014; Greitemeyer *et al.*, 2010; Koivisto and Hamari, 2019). Based on these established findings that different media in general have been shown to alter attitudes, the first hypothesis is as follows:

H1.1. Viewing journalistic media content leads to a positive shift in human rights attitudes.

Compared to other media, such as films and books, video games provide a step forward for eliciting empathic responses in users by affording interactivity and user agency. This is achieved via avatars, which act as inhabitable protagonists (Isbister, 2016), thereby allowing users to identify and empathize with characters (Li *et al.*, 2013). Notably, a body of video games exist which are seen to teach human rights; narration and player agency have been understood as the elements that drive and define experiences in such games (Gabriel, 2017). A notable example is *This War of Mine* (11 bit studios), a survival game set in a besieged city, where players must make choices which have both strategic and moral consequences which, in turn, influence both the potential survival and mental state of their characters (De Smale *et al.*, 2017). Furthermore, news-games draw from the history of persuasive games and stand at the intersection of journalism and videogames (Bogost, 2007; Bogost *et al.*, 2010). Newsgames, such as *Cutthroat Capitalism* by Wired, therefore, represent one of the earlier attempts to utilize new media with the aim of involving or engaging the audience with news content (Bogost *et al.*, 2010). These examples depict how more intricate, immersive, and complex (multi)media forms and technologies could have a higher influence on users' attitudes than simpler media, such as written text. Therefore:

H1.2. Immersive journalism has a stronger effect on human rights attitudes compared to written journalism.

Additionally, technological immersiveness is often seen as the main predictor of presence and the subsequent involvement in the virtual environment (Slater, 2003). A meta-review confirmed the position of the relatedness of technological immersion and presence but also emphasized the effects of some technological properties over others (Cummings and Bailenson, 2016). For example, the field of view and stereoscopy have a medium effect, whereas image quality has a small effect on presence. However, some studies show there might be either a ceiling effect or individual user differences that as an effect evoke the same levels of presence mostly regardless of the technology (e.g. Shin, 2018; Shin, 2019a). In the context of immersive journalism, considering the findings of the meta-review (Cummings and Bailenson, 2016) and building upon H1.2, the third hypothesis is as follows:

H1.3. Technological immersiveness of immersive journalism is positively associated with a shift in human rights attitudes.

The immersive direction in media production is of particular importance when considering mass social issues connected to the "collapse of compassion" (Slovic, 2010); a term used to denote the psychological perspective in which an individual's suffering is more impactful and actionable than that of many. This principle is evident in the emergence of "empathy machines", a commonly used term that describes the attempt to humanize the objects of news stories, for example, by relaying experiences to users via immersive technologies. This specific term, and the aim of inducing empathy via VR, has often been criticized in regard to the inability of humans to truly know and feel others' experiences. According to this critique, subjects are absorbed, through consumption, and transformed into an object in an attempt to consolidate oneself and the other, ultimately understanding the other through this process (Bollmer, 2017; Fisher, 2017; Hassan, 2019). However, this seems to be a misconception, which may stem from a literal interpretation of popular discourse, as the absolute understanding of

another's experiences is not the goal. "Empathy machines" are utilized in an attempt to bring the user closer to others via immersion and perspective-taking, to transform them into a subject with whom they can relate. Consequently, users' attitudes towards both the presented individual and the respective group are affected (e.g. Herrera *et al.*, 2018). Considering the posited heightened personal engagement in immersive media and its suggested relevance to attitudinal changes, two additional hypotheses emerged:

H2.1. Level of involvement in a media experience mediates the relationship between the immersiveness of the technology and the shift in human rights attitudes.

H2.2. Involvement in the experience has a stronger positive effect on human rights attitudes in immersive journalism than in written journalism.

Despite these growing trends in popular discourse, digital humanities and immersive journalism, there is still relatively little scientific research examining the theorized ability of VR to positively affect human rights attitudes in particular. The majority of existing research into the positive social influences of VR concentrates on therapeutic use, face-to-face interactions, and attitudinal change (Bailenson, 2018). Concerning empathy and prosocial behaviour, the evidence is promising but not conclusive; current findings suggest virtual embodiment increases some aspects of empathy (Oh *et al.*, 2016; Shin, 2018) and that affective VR-documentaries are able to evoke empathy more effectively than text or 2D video format (Sundar *et al.*, 2017; Shin and Biocca, 2017; Schutte and Stilinović, 2017). We can observe, therefore, that despite the theorized potential for immersive technologies to affect human rights attitudes there is a dearth of empirical studies that quantitatively test these assumptions in controlled settings.

The empirical study

A between-subjects pretest-posttest laboratory experimental study was designed and conducted in order to test the hypotheses. A between-subjects design was applied to participants' assignment to conditions to avoid multiple exposures to the stimuli, which are the hypothesized sources of the measured outcome. The pretest-posttest factor refers to administering the measurement instrument on attitudes before and after the exposure to the stimulus in order to obtain a baseline and be able to track changes in scores.

The sample size of approximately 30 per experimental group was pre-planned in accordance with a controlled laboratory environment, planned analyses, and the context and aim of the study. A higher number of participants would provide for higher granularity in the collected data sample and reduce the possibility of not finding existing small effects (i.e. false negative, Type II error). However, due to the context of this study being immersive journalism and its possible influence on the attitudes of the public, the objective was not to look for any minimal effects that might be detectable through statistical inference tests. Instead, the aim was to test for effects that potentially might have practical implications. For detecting even small effects as Cohen's d of 0.4 (Cohen, 2013) using a one-tailed paired t-test with the statistical power of 80% and alpha set to 0.05, the recommended minimum total sample size in the compared groups is 41 participants, as calculated in G*Power v. 2.1.9.4. As such, the total number of participants comfortably exceeds the minimum threshold.

Participants

A total of 87 individuals participated in a laboratory-controlled experiment; 31 (VR), 29 (2D), and 27 (Article). The ratio of female to male participants was approximately 2:1. Participant distribution in experimental conditions is described in Table 1. The mean age was 26.38 years (SD = 4.52 years; 20–39 years). The participants consisted of a diverse international sample

and were contacted through universities' bulletin boards and email lists. The experiment was planned and conducted following the guidelines of the National Board on Research Integrity.

The sample is specific to the university context and the country in which participants were recruited, although it was not necessary for them to be students in order to take part in the study. The majority of participants were accounted for by the following nationalities: Finnish (26.4%), Chinese (10.3%), Spanish (9.2%), Russian (9.2%) and Vietnamese (5.7%). Approximately three-quarters of participants had university-level education (Bachelor, 52.9%; Master, 21.8%), while 25.3% had some lower-level education.

Furthermore, participants' political orientation was predominantly liberal or neutral ("In politics people sometimes talk of liberal and conservative. Where would you place yourself on a scale from Liberal to Conservative?", anchors 1 and 7 signified liberal and conservative respectively). Only 10.3% of participants indicated a more conservative orientation.

Procedure

Those interested in participating in the study were first directed to SurveyGizmo, an online survey service, where they completed the pre-questionnaire. Participants were presented with all relevant information about the study, i.e. its aim, procedure and compensation, and were required to consent to participation. In all instances involving psychometric questionnaires, all items on a single page in the survey service were presented in a randomized order. The human rights attitudes were measured across two pages. At the end of the questionnaire, they were asked to leave their email address so that they would be contacted in order to book the time for the experiment. This email address was later used to provide the post-treatment reports on the background data. Participants were offered two movie tickets as compensation. The study was conducted in April and May 2018.

The study was conducted at the premises of two universities in the same city and participants were free to choose at which location they wished to participate. Both spaces were similarly-sized empty office rooms. A between-subjects design was utilized with participants being assigned to groups using simple randomization, i.e. one of the three conditions for each experiment time slot was randomly chosen before the arrival of the participant and without any precognition about them. Table 2 describes the conditions in detail.

Table 1. Participant distribution to experimental conditions

Gender	HMD-360 *N* (%)	Monitor-360 *N* (%)	Monitor-article *N* (%)	Total
Male	20 (64.5)	18 (62.1)	17 (63.0)	55
Female	10 (32.3)	11 (37.9)	9 (33.3)	30
Other	1 (3.2)	/	1 (3.7)	2
Total	31 (100)	29 (100)	27 (100)	87

Table 2. Properties of the three experimental conditions

Condition	Technological immersiveness	In-text abbreviation	Output device	Mode of control	Content type
HMD-360	High	VR	Google Daydream VR with Samsung S8 phone	Head movement	360-degree video
Monitor-360	Medium	2D	Computer monitor (24")	Click and drag with a computer mouse	360-degree video
Monitor-article	Low	Article	Computer monitor (24")	Scrolling with a computer mouse	Internet article

The entire experiment lasted between 20 and 30 min, depending on the treatment, as the text article did not necessarily require the allocated 7 min to read. During that time, the invigilator stayed in the room but out of sight. In all conditions, participants used noise-cancelling headphones and were seated in a revolving office chair. Participants experienced the media content once. In the VR condition, the head-mounted display was worn for the full duration of the video; for the 360-degree video condition the full video was viewed on a monitor; for the third condition, the article was read once from the beginning to end on a computer monitor. After the treatment, participants were asked to fill out the post-questionnaire in SurveyGizmo using the computer screen.

Material

An existing 360-degree video, *The Sea Prayer* published by Guardian VR, was used as the stimulus. In its original form, it is viewable on both the computer screen and a head-mounted VR display device. The video itself was drawn in 3D in Tilt Brush for VR and the narration was written by Khaled Hosseini. The length of the video is 7 min and 4 s. The material is a mix of journalistic and artistic content portraying the refugee crisis of Syria in the form of a story narrated by the imagined father of a refugee boy. The official description of *The Sea Prayer* is as follows:

> Inspired by the story of Alan Kurdi, the three-year-old Syrian refugee who drowned in the Mediterranean Sea, Khaled Hosseini, the novelist and Goodwill Ambassador for UNHCR, the UN Refugee Agency, has written an exclusive story brought to life in virtual reality. The night before a potentially fatal journey, a father reflects with his son on their life in Syria before the war – and on their unknown future. (*Guardian VR*)

The first scene presents a happy family home and life; the second introduces the transformation of the city into a war zone; finally, the third depicts the father (narrator) and his infant son waiting for boats to emigrate from Syria.

For the Article condition, the authors created a transcript of the narration, accompanied by stills captured from each of the scenes in the video. The content was unaltered for the 2D and VR conditions.

Measurements

Existing questionnaires were used to measure human rights attitudes (HRA) and involvement with media content. All items were measured using seven-point Likert scales, with response options ranging from 1 (strongly disagree) to 7 (strongly agree) for HRA, and 1 (not at all) to 7 (very much) for Involvement. The items in both scales were presented in a random order within the corresponding scale.

First, we employed an abridged version of the Human Rights Questionnaire (Diaz-Veizades*et al.* 1995) which consists of four constructs – social security, civilian constraint, equality and privacy. The participants were instructed to: "Please rate the following statements on a scale from Strongly Disagree to Strongly Agree". The questionnaire was administered both before and after exposure to the stimulus.

Social security (SOC; Cronbach's $\alpha = 0.76$) used 6 items to measure attitude towards the right of access or entitlement to adequate standards of living (e.g. "People are entitled to have the food, housing, and medical care necessary to maintain their health and well-being").

Civilian constraint (CIV; Cronbach's $\alpha = 0.78$) used nine items to measure attitude towards ensuring individual civic and political rights, or the limitation of thereof (e.g. "Arrest for political reasons is always wrong").

Equality (EQT; Cronbach's $\alpha = 0.74$) used nine items to measure attitude towards equal access to basic rights for all individual regardless of race, gender, or beliefs (e.g. "Men and

women of full age have a right to marry and establish a family, without regard to their race, nationality, or religion.").

Privacy (PRI; Cronbach's $\alpha = 0.22$) used four items to measure attitude towards individual privacy rights (e.g. "Everyone should be free to speak his or her opinions."). The PRI dimension was discarded due to the unacceptably low Cronbach's alpha value and PRI data was not used in any part of the subsequent analyses. Discarding of the Privacy construct is in line with a previous study, which validated the scale consisting of the remaining three factors (Crowson, 2004).

Mean scores for SOC, CIV and EQT dimensions were computed for both pre- and post–experiment questionnaires, as was the difference between pre- and post-questionnaires for each dimension. These scores present the change in the attitudes after consuming the media content during the experiment. Additionally, a mean score for the overall human rights attitudes was computed for both pre- and post-experiment questionnaires, as was the difference.

Second, Involvement (INV; Cronbach's $\alpha = 0.83$) as a dimension of presence was measured via 5 items adapted from a widely used Presence questionnaire from Witmer and Singer (1998). The instruction was as follows: "Please answer the following questions on a scale from Not at All to Very Much". The scale aims to reflect the level of involvement with the media content (e.g. "Were you involved in the experience to the extent that you lost track of time?"). For the contrast analysis, one dichotomous mean score was computed for this measure, denoting high and low involvement.

Results

The analyses were conducted in several phases. All results were obtained using IBM SPSS version 25.

First, the mean scores for overall human rights attitudes before and after the treatments were compared using paired *t*-tests for each of the treatments.

Second, changes in individual dimensions were tested to gain further insight into the data. So as not to run unnecessary analyses across three dimensions and three conditions, a repeated-measures ANOVA was used to find in which dimensions there was a detectable change in attitudes. Next, paired *t*-tests were used for those dimensions where significant results in the ANOVA were obtained to identify in which of the conditions the changes occurred.

Third, ANOVA and a contrast test were used to examine if there is a difference in the effects on HRA between conditions.

Finally, the reported involvement in the three conditions and its effects on the attitudinal change was analysed using ANOVA and a generalized linear model (GLM) with an interaction contrast test.

Changes in overall HRA

Paired *t*-tests were conducted in order to test for a change in the overall human rights attitudes in 2D, VR, and Article conditions. Considering that only 2D and VR conditions elicited a statistically significant change in participants' HRA, H1.1 was not supported (Table 3); however, these results support H1.2. These two hypotheses were further found to be supported with tests that examine changes in the individual dimensions of HRA, as described in the following section.

Changes in dimensions of HRA

After examining overall attitudes to human rights, individual dimensions were investigated separately. A statistically significant effect was found when employing the repeated

measures ANOVA for two of the three dimensions: SOC factor: $F(1, 84) = 13.33, p < 0.001$; and EQT factor: $F(1, 84) = 4.09, p = 0.046$. These two dimensions of human rights attitudes were both rated higher overall in the post- than in the pre-questionnaires. No statistically significant difference was observed between pre- and post-scores for the CIV factor: $F(1, 84) = 1.09; p = 0.300$.

Consuming the content in VR elicited a positive attitudinal shift in two out of the three dimensions of HRA (SOC and EQT); consuming the content in the 2D condition led to a statistically significant positive shift in attitudes in one dimension of HRA (SOC) and a statistically borderline change in another (EQT); finally, consuming the content in the Article condition elicited no changes in attitudes in any dimension (Table 4).

Differences between immersive journalism and the article

The results for the overall HRA scale indicate whether there was an attitudinal change in each of the conditions. However, although VR and 2D seem to have an effect on the measured attitudes the results do not indicate whether the changes were significantly different between the conditions. Therefore, a One-Way ANOVA was conducted to compare the changes in participants' human rights attitudes according to the condition in which they consumed the media content. The results show a statistically significant difference in the change in HRA dependent on condition: $F(2, 84) = 3{,}39, p = 0.038$. Effect size index ($\eta_p^2$) suggested that the condition in which the media content was consumed accounted for 7.5% of the variance in HRA.

As Levene's test indicated equal variances ($F(2,84) = 1.01, p = 0.368$) and group sizes are roughly equal, the Tukey HSD post hoc test was used in order to further investigate the effects of viewing conditions on HRA. The post-hoc analysis suggested borderline significant

Condition	Pre Mean (SD)	Post Mean (SD)	Paired *t*-test *t*	*p*	*d*	95% CI
HMD-360	5.78 (0.46)	5.98 (0.52)	−3.22	*0.003*	0.58	−0.327, −0.073
Monitor-360	5.61 (0.62)	5.83 (0.51)	−2.42	*0.022*	0.45	−0.403, −0.034
Monitor-article	5.94 (0.50)	5.92 (0.58)	0.49	0.627		−0.113, 0.184

Note(s): SD = Standard deviation, 95% CI = 95% Confidence interval. Cohen's *d* values should be interpreted as small effect size when *d* value is between 0.2 and 0.5, and medium when *d* value is between 0.5 and 0.8 (Cohen, 2013). Statistically significant results are in italic font ($p < 0.05$)

Table 3. Results of the paired *t*-tests on the change in overall HRA

Condition	Pre Mean (SD)	Post Mean (SD)	Paired *t*-test *t*	*p*	*d*	95% CI
	Social security (SOC)					
HMD-360	6.15 (0.87)	6.35 (0.78)	−2.64	*0.013*	0.47	−0.358, −0.046
Monitor-360	6.16 (0.82)	6.46 (0.60)	−2.98	*0.006*	0.55	−0.495, −0.091
Monitor-article	6.30 (0.66)	6.44 (0.56)	−1.14	0.263		−0.414, 0.118
	Equality (EQT)					
HMD-360	6.66 (0.57)	6.81 (0.38)	−2.39	*0.024*	0.43	−0.275, −0.021
Monitor-360	6.45 (0.66)	6.63 (0.51)	−1.90	0.068	0.35	−0.387, 0.015
Monitor-article	6.80 (0.27)	6.76 (0.46)	0.52	0.611		−0.133, 0.222

Note(s): SD = Standard deviation, 95% CI = 95% Confidence interval. Cohen's *d* values should be interpreted as small effect size when *d* value is between 0.2 and 0.5, and medium when *d* value is between 0.5 and 0.8 (Cohen, 2013). Statistically significant results are in italic font ($p < 0.05$)

Table 4. Results of the paired *t*-tests on the change in dimensions of HRA

differences in mean scores of HRA when comparing the Article condition to 2D as well as to VR. When comparing the positive change in HRA between the Article condition and 2D, the mean difference was 0.25, SE = 0.11, $p = 0.056$. Regarding comparisons between Article and VR, the mean difference was 0.24, SE = 0.11, $p = 0.76$.

A statistically significant contrast test (Contrast 1), indicated a more prominent change for the 2D and VR conditions when compared to the Article condition (Table 5). However, there was no statistically significant difference between 360-degree video and VR (Contrast 2) in human rights attitudes change.

The results suggest that the difference in changes in HRA scores for 2D and VR are non-significant. However, previously obtained results indicate that VR elicited a change in two out of the three dimensions of HRA (see Table 4), while 2D only affected one of the dimensions, and a borderline statistically significant for a second. Hence, H1.3 is partially supported. Immersive journalism (2D and VR conditions) indeed have a stronger effect than the Article, but there seems to be no difference between the medium and high degrees of immersiveness.

Involvement as a mediator of HRA change

First, involvement scores between the three conditions were examined. An ANOVA analysis suggested a difference exists in the reported involvement between conditions: $F(2, 84) = 6.56$, $p = 0.002$, $\eta_p^2 = 0.135$. Tukey HSD further indicated between which pairs of conditions there is a difference in mean Involvement scores. The only statistically significant differences in means were found when comparing the Article condition to 2D (mean difference 0.82, SE = 0.30, $p = 0.023$, 95% CI [0.096, 1.547]) and Article to VR (mean difference 1.04, SE = 0.30, $p = 0.002$, 95% CI [0.326, 1.753]). There was no significant difference in reported involvement by participants in 2D and VR conditions. These results indicate that the participants in 2D and VR rated involvement higher than those in the Article condition, partially supporting H2.2 (Figure 1).

When examining each of the individual conditions, involvement did not have a statistically significant effect on HRA change in the Article ($p = 0.965$), 2D ($p = 0.608$), or in the VR ($p = 0.361$) conditions. A non-significant interaction test across all three conditions implies that involvement does not mediate the effect of the condition on the change in attitudes, therefore, H2.1 was not supported.

In order to further investigate possible effects of involvement on the change of the total HRA score, a GLM with an interaction contrast test was specified. In the contrast test, the 2D and VR conditions were compared to the Article condition (Figure 2). A statistically significant result indicated that high involvement had a more prominent effect on HRA change in the 2D and VR conditions than in the Article condition; $F(1, 81) = 5.10$, $p = 0.027$, $\eta_p^2 = 0.059$. A significant interaction contrast test supports H2.2.

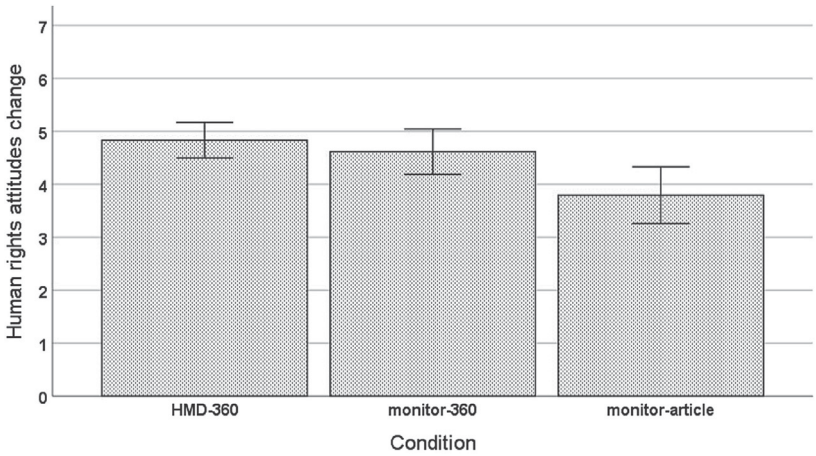
Summary

Finally, Table 6 provides a systematic presentation of hypotheses, pertinent tests, and outcomes in order to improve the clarity and comprehensibility of the results.

Source	SS	SSE	df	MS	MSE	F	p	η_p^2
Contrast 1	1.12	13.87	1, 84	1.12	0.17	6.76	*0.011*	0.074
Contrast 2	0.005	13.87	1, 84	0.005	0.17	0.03	0.863	

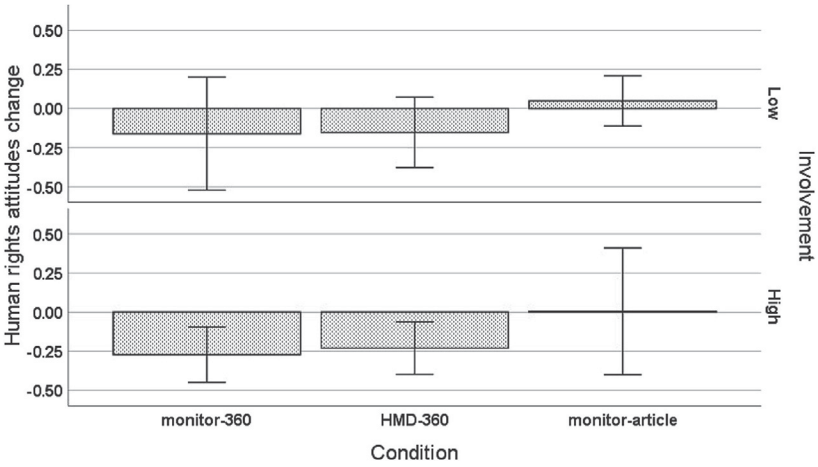
Table 5.
Results of the contrast analyses on the change in overall HRA

Note(s): η_p^2 = partial eta squared, SS = Total sum of squares, SSE = Error sum of squares, df = Degrees of freedom, MS = Mean square, MSE = Mean squared error. Statistically significant results are in italic font ($p < 0.05$)



Note(s): Error bars present 95% CIs

Figure 1.
Mean scores for Involvement in the three conditions



Note(s): Error bars present 95% CIs

Figure 2.
HRA change in the three conditions for high and low Involvement scores

Statistical test		Hypotheses	Outcome
Paired *t*-test	H1.1	Viewing journalistic media content leads to a positive shift in human rights attitudes	Not supported
Repeated measures ANOVA Paired *t*-test	H1.2	Immersive journalism has a stronger effect on human right attitude compared to written journalism	Supported
ANOVA Contrast test	H1.3	Technological immersiveness of immersive journalism is positively associated with a shift in human rights attitudes	Partially supported
ANOVA Interaction test	H2.1	Level of involvement in a media experience mediates the relationship between the immersiveness of the technology and the shift in human rights attitudes	Not supported
GLM with interaction contrast	H2.2	Involvement in the experience has a stronger positive effect on human rights attitudes in immersive journalism than in written journalism	Supported

Table 6.
A summary of results

Discussion

This work investigated if, and to what extent, the platform on which media content is consumed affects attitudes toward human rights. Despite the increasing availability and popularity of mobile VR and 360-degree videos, distributed through *YouTube* and online news media outlets, it remains unclear how it affects users' attitudes pertaining to the content topic. Results of this study suggest that viewing an immersive journalism 360-degree video via mobile VR, or on a computer screen, can have a positive effect on users' human rights attitudes. Immersive conditions (2D and VR) elicited a positive change in users' HRA, although the change is slightly more prominent in the VR condition. On the other hand, the Article condition, which is closer to traditional journalism, had no effect on individuals' HRA. Furthermore, involvement was shown to have no overall mediation effect, although a statistically significant interaction contrast suggested high involvement led to a more prominent positive change in the HRA in the immersive conditions.

Overall, the results from the sample collected in this study indicate that even the most simplistic immersive journalism content, such as an animated 360-degree video, can bring about a positive shift in users' human rights attitudes, and that VR is statistically somewhat more efficient at this than 2D. In contrast, comparable content in the format of an article elicited no attitudinal change in participants.

General discussion

Firstly, we hypothesized that the content itself will positively influence participants' attitudes regardless of the platform (H1.1). The results indicate that there is a media-specific difference in the way the content is experienced and, consequently, how it affects an individual's HRA. Both VR and the 2D conditions evoked a positive change on participants' overall HRA. However, participants that consumed the content in the article format showed no change in their HRA compared to the pre-experiment assessment. Overall, the most significant finding is that the two immersive conditions were more likely to have an effect on one's attitudes compared to the Article condition (H1.2).

The three individual dimensions of HRA were affected differently depending on the treatment. Following the non-significant results of the overall HRA scores, the Article condition showed no effect on the participants' attitudes for any dimension. Although analysis of both immersive conditions showed a significant overall HRA change, further analysis showed that VR elicited a change in two out of the three dimensions: Social security and Equality. At the same time, 2D only affected attitudes regarding Social security issues, and only borderline affected Equality (H1.3). However, the origin of this difference is unclear; whilst VR was expected to have a stronger effect on attitudes compared to 2D, differences in the affected dimensions were not predicted.

The rationale underpinning H1.3 assumed that involvement brought on by the platform would mediate the effects of the content on the HRA (H2.1). However, the results for the collected data show that there is no interaction effect when looking into all three conditions. On the other hand, immersive conditions did elicit a stronger experience of involvement with the content as a dimension of presence. Likewise, a differentiation between the effects of high versus low levels of involvement showed that higher involvement did indeed have a positive effect on the change in overall HRA (H2.3), meaning that partially presence and the feeling of "being-there" (De la Peña *et al.*, 2010; Schutte and Stilinović, 2017) affect the intensity of change in users' human rights attitudes.

Theoretical implications

The primary theoretical implication that can be derived from this study stems from the investigation of the relation between the technological immersiveness and attitudinal change.

The results provide evidence and support for the trend of using richer experiences for a more profound effect on one's cognition and affect (e.g. Bogost *et al.*, 2010; Schutte and Stilinović, 2017). Thus, they support the main premise and aim of immersive journalism of using new media and new media technologies for engaging consumers in otherwise inaccessible events or experiences (Aitamurto, 2019; De la Peña *et al.*, 2010). Therefore, they also indirectly support the notion of "empathy machines" (Constine, 2015; Milk, 2015), and their role in subjectifying distant, or otherwise non-comprehensible human experiences (e.g. Herrera *et al.*, 2018).

However, it is unclear whether the unexpected results regarding the effects on involvement stem from a specific element of the content, or if viewing a 360-degree video in 2D and in mobile VR do not provide for distinct enough experiences. Furthermore, it remains inconclusive whether the difference in the technological immersiveness of mobile VR compared to a 2D screen might affect user's attitudes not only more strongly, but also in a different manner. If distinct dimensions of certain attitudes are affected in distinct ways, this could be due to, for example, the perceived distance from the content and involvement evoked by different interaction mechanics.

Furthermore, there are theoretical implications for our understanding of human rights attitudes and their genesis. If attitudes toward human rights were derived from a single underlying psychological construct (Kohlberg, 1978; McClosky, 1964; McClosky and Zaller, 1984) it would be reasonable to assume that any changes resulting from the experiment are broadly consistent. However, the results clearly demonstrate that this is not the case: the VR condition showed positive changes for Social security and Equality, but not for Civilian constraint; while the 2D condition showed a positive change for SOC, but not conclusively for either CIV or EQT. In fact, the only consistency of results was observed in the Article condition, where there were no changes in either SOC, EQT, CIV, or in the overall HRA. With this in mind, the results support the theoretical position that attitudes toward human rights can be different for distinct clusters, or dimensions (Diaz-Veizades *et al.*, 1995; McFarland and Mathews, 2005). It has been argued that differences are the result of a lack of political "know-how" regarding the implementation or applicability of human rights concepts (McClosky, 1964; McClosky and Zaller, 1984). If this were true, it would be expected that samples consisting of highly-educated participants would support a unidimensional construct, but this is not the case, either in this work or in other studies (Crowson, 2004; Diaz-Veizades *et al.*, 1995).

Practical implications

The notion of the "collapse of compassion" describes the decrease in compassion when the number of people in need of help increases (Cameron and Payne, 2011; Slovic, 2010). This is of particular relevance when considering possible practical implications of our results as a large group of people in need may be perceived as overwhelming by an individual, potentially evoking emotion regulation. This effect is also visible in evidence suggesting that although the number of individuals in need of help increases, the willingness to donate to charity may not increase (Slovic, 2010). Furthermore, studies show that help is more often allocated to identifiable, versus statistical, victims (Kogut and Ritov, 2005; Small and Loewenstein, 2003). Charity organizations recognize this issue and often use visual material of individuals in need in an attempt to humanize mass, or even global, issues. Therefore, various charity and non-government organizations dealing with related global issues might benefit from utilizing VR as a novel way to overcome the collapse of compassion and to present identifiable victims in need.

Similarly, VR could be exploited in various fields of education. There are already numerous academic and industry examples of applications in simulation training and science education (Lamb *et al.*, 2018; Moro *et al.*, 2017; Süncksen *et al.*, 2018). However, it might also

prove useful in respect to social sciences and humanities. For example, it has been suggested that the effectiveness of studying history would be supported by so-called historical empathy (Davis *et al.*, 2001; Endacott and Brooks, 2013; Yilmaz, 2007) which aims to bring temporally or geographically distant societies or individuals closer to the student, enabling a deeper understanding of the depicted context.

Limitations and future studies

The results pertaining to participants' change in HRA was based exclusively on data collected via self-reported measurements immediately after the experiment and, therefore, lacks behavioural and qualitative data that would provide further validity. It has been suggested that measures of implicit attitudes could be more useful in detecting the effects of media than self-report measures (Blanton and Jaccard, 2015; Payne and Dal Cin, 2015). Thus, it is possible that a study utilizing implicit attitudes measures could produce more nuanced insights. Furthermore, this study only considered participants' change in attitudes immediately after consuming the content. A longitudinal study would further develop our understanding on how attitudes change, and how sustainable that change is over time, as some studies have shown that empathy induced change in attitudes was even further strengthened after a period of a couple of weeks (Batson *et al.*, 1997; Herrera *et al.*, 2018). It has been suggested that perspective-taking in VR in particular enhances empathy over a period of several weeks, as well as encouraging prosocial behaviour (Herrera *et al.*, 2018). As such, it would be beneficial to investigate possible behavioural effects of immersive journalism, such as involvement with charities, non-government organizations, or public calls for social awareness and change.

We have used an otherwise blank webpage for the Article condition, which might be problematic when it comes to external validity as web pages usually contain plentiful amounts of other stimuli. Moreover, the Article condition did not contain any audio, but rather only text and images, while the immersive conditions were comprised of both video and audio. Furthermore, it is probable that participants watching the video in immersive conditions were exposed to the stimulus for a longer time period than those reading the article. Although the two types of conditions and media are intrinsically different, which may pose issues regarding internal validity, this design was necessary in order to compare a more traditional means of delivering news-related media with the novel, immersive ones.

The underlying reasons for changes in some, but not other, dimensions of human rights attitudes also require further examination. One possible cause for changes in only two of the three dimensions could be the theme of the content itself or the manner in which it is narrated or visually presented. Likewise, it is plausible that users perceive that aspects of the content are differently emphasized according to the platform on which it is consumed. Investigating these nuances is crucial for effective and targeted representations of a certain issue. Although this study suggests that, overall, VR is more effective in evoking attitudinal change, in some cases 2D might be comparably efficient but more cost-effective and commercially viable.

A promising avenue for future work is an empirical investigation of this theoretical issue via a large-scale study in which different populations would be compared to one another. As the diversity in our sample is limited to the study locality and context, the results cannot be reliably prescribed to different populations that may be utilizing immersive technologies. Replication studies with diverse samples would help ascertain external validity and allow for a more nuanced understanding of how content similar to the one used in this study influences the attitudes of users with different backgrounds. For example, it has been repeatedly suggested that presence, and consequent empathizing, is influenced by users' individual differences rather than only the technological disparities in immersiveness or the content itself (Iachini *et al.*, 2019; Jurnet *et al.*, 2005; Shin, 2018; Shin, 2019b). Additionally, the low

degree of attitudinal change could be partially explained by the predominantly liberal political orientation of the participants. It has been suggested that an existing liberal viewpoint allows for a smaller positive change, whilst conservative views allow for a greater shift in attitudes (Emler *et al.*, 1983; Passini, 2014). Furthermore, those of a politically conservative standpoint have been found to be avoidant of information which conflicts with their worldview, whereas liberals have been found to be more receptive to information which supports their political stance (Garrett and Stroud, 2014). As such, it can be argued that when an individual of conservative opinions is presented with information which they cannot avoid, for example via an immersive experience, they are more likely to be receptive to that information than someone of a more liberal perspective. A more conservative sample in a replicated or similar experiment could provide further insights into the effects of the media.

It has been suggested that embodiment enhances empathy (for a review, see Bertrand *et al.*, 2018), therefore, of particular importance would be to study how the effects of a VR experience differ depending on whether the user is embodied within the experience or not. In this way, differentiation could be made between the effects of particular affordances of the designed experience itself and those of the immersive qualities of the employed hardware.

Finally, it should be taken into consideration that VR is still a young medium to which most users are unaccustomed, it has been suggested that the novelty effect influences the way content is experienced (e.g. Wells *et al.*, 2010). A such, it would be worthwhile to compare the effects immersive journalism content has on users' cognition and behaviours, depending on their familiarity with VR. Well-versed users could be less affected by similar content and, hence, less immersed, which could influence its effects on their cognition. On the other hand, long-term consumption of immersive journalism could eventually lead to burnout and desensitization, due to the potential psychological toll of its effects (Moroz and Krol, 2018; Slovic, 2010).

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PUBLICATION III

Effects of immersive media on emotions and memory: An experiment comparing article, 360-video, and virtual reality

Bujić, M., Salminen, M. & Hamari, J.

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PUBLICATION IV

Satisfaction and willingness to consume immersive journalism: experiment of differences between VR, 360 video, and article

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Satisfaction and Willingness to Consume Immersive Journalism: Experiment of Differences Between VR, 360 Video, and Article

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ABSTRACT

Immersive journalism has been touted to revolutionize journalism due to its ability to afford a multi-modal engrossing experience. However, hardly any experiments have been conducted whether consumers' satisfaction and consequent intentions to use immersive journalistic media may differ from traditional forms of journalistic content. Therefore, in this study, we investigate the differences in satisfaction and continued use intentions between article, 360 video and VR-based interaction with content. The data was collected via a randomized controlled laboratory experiment with between-subjects design (N = 87). Participants were randomly assigned to reading a written article based on the video (article) and watching the video on a computer screen (2D 360) or in mobile VR (VR 360). The collected data consisted of demographics (age and gender) and reported satisfaction and intention to continue use. Results suggest that those who were assigned to VR 360 had higher intentions to continue use, but not greater satisfaction than those in the other two conditions. However, the intention was predicted to an extent by satisfaction as suggested by previous literature. Finally, age and gender did not predict continued use. These findings imply that users prefer the new media technology for consuming journalism content and support previous findings of the relationship between satisfaction and intention to continue use. Finally, avenues for further research are presented.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; • **Social and professional topics** → *Gender*; *Age*.

KEYWORDS

immersive journalism, 360-degree video, intention to continue use, satisfaction, virtual reality, gender, age

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1 INTRODUCTION

Users' continuance intention and satisfaction with a product have usually been investigated in the context of some version of the expectation-confirmation theory and model [2, 7]. Traditionally, this theory was established in marketing and later information systems research concerning user experience and retention research [4, 7].

However, even though users' satisfaction and intention to continue use have both been extensively investigated in different IS contexts, extended reality is a rich and diverse medium and its effects should be explored further [12, 18]. For several years, virtual reality (VR) technologies have been struggling to acquire and retain the expected number of users because of slow advance, variety, and accessibility of both the technology and the available content. The latter in particular possibly diminishes satisfaction with the experience and the related intention to continue use. The literature on the perceived usefulness as an antecedent of continued use of VR systems is conflicting [8, 13]). However, these studies only investigated continued use in the context of VR, with no comparisons in different virtual environments.

This comparison is particularly of relevance for the new but expanding domain of immersive journalism (IJ) whose primary aim is to engage users with the story in an attempt to bring stories closer to the audience and be more impactful (e.g. [5]). If users are not retained and continue consuming similar content in the future, the effect of IJ on individuals would be very limited. As it is an emerging vast field, little is still known about its effects, its users, and in particular whether it encourages continued use compared to more traditional forms of journalism. In this context, there are some studies on how many participants follow-up on the viewed topic [25, 26] and intent to share it with others [27]. These suggest that immersive journalism and the VR version in general is more preferable than other journalistic forms.

However, there is still little evidence whether viewing IJ could become a routine and part of an everyday life, similarly to reading the news. One study in particular investigates multiple predictors of the intention to continue use of virtual reality [8], but its used measurement combines items pertaining to both continued use and follow-up. It suggests that, among others, that the experienced telepresence has an effect on the users' continue to use the system. Telepresence [17], as the subjective experience of being virtually transported to another place, is one of the main features of IJ [5] and VR in general as its effects are emphasized in highly immersive virtual environments [23, 24].

On the other hand, not all journalistic content is best received in the VR form [11, 19], suggesting that simply porting content to environments with higher technological immersion might not always

be useful for users' experiences such as enjoyment and consequent intention to continue use of the media. For example, a qualitative study considered IJ audience in the lens of user gratifications and found that users were not inclined to continue use of IJ content over traditional forms [19].

Overall, there is a severe dearth in our understanding of different journalistic forms and modes of consumption. It is important then to consider that IJ currently represents a wide array of content and more studies are needed to understand their differences when it comes to audience reception and user experience, as well as the effects of different levels of immersion.

Therefore, this study aims at comparing user experiences of an IJ 360 video content in three levels of technical immersion (low, medium, and high) and how their satisfaction and intention to continue use differs depending on the media and mode of consumption. Additionally, it explores whether and how basic demographic factors (age and gender) predict how intent they are to continue use of similar content in the future.

1.1 Hypotheses

Immersive journalism 360-video either viewed on-screen or in mobile VR provides a higher technological immersion [20, 23, 25] than a written article. Richer media elicit higher engagement, presence, as well as cognitive absorption, which in turn affect satisfaction and use continuance [6, 18, 22]. Therefore, satisfaction and continued use are expected to be positively affected by the richness and immersiveness of the media. The hypotheses related to different ways of consuming content and consequent satisfaction and use continuance intention are as follows:

H1.1 Viewing immersive journalism content will elicit a higher satisfaction with the experience than reading an article.

H1.2 Viewing a 360 immersive journalism video in VR will elicit a higher satisfaction with the experience than viewing it on a computer screen.

H2.1 Viewing immersive journalism will elicit a higher intention to continue use of media than reading an article.

H2.2 Viewing a 360 immersive journalism video in VR will elicit a higher intention to continue use than viewing it on a computer screen.

Additionally, previous research (e.g. [9, 29]) suggests a connection between how satisfied users are with the experience and what they think how likely they are to continue using similar products or environments. However, these have mostly been conducted in the information systems, such as computer work packages or Internet services, and not immersive media contexts.

H3 Reported satisfaction with the experience will positively predict reported intention to continue use.

Finally, there is a variety of individual factors that could influence these outcomes. Gender has been suggested to affect use continuance in different contexts (e.g. [16, 28] and a qualitative study has identified user attributes [18] as one of those factors. However, there are conflicting results, suggesting that in some contexts these variables do not affect users' intention to continue use (e.g. [15]). Therefore, there seem to be no solid grounds to hypothesize whether or not gender and age would affect this outcome and instead we set forth the following exploratory research question: **RQ**: How do gender and age influence satisfaction and continued use of immersive journalism content?

2 METHOD

2.1 Participants

A total of 87 participants were recruited for the experiment. Calls were made through University bulletin boards and student email lists. Participants were aged 20-39 (M = 26.4, SD = 4.5), and 33 declared themselves as female, 55 as male, and 2 as other. Demographic data was collected prior to the experiment. Participants were randomly assigned one of the three treatments - Article (n = 27), 2D 360 (n = 29), or VR 360 (n = 31).

2.2 Materials

2.2.1 Stimuli. The content of 360 video The Sea Prayer by the news media house *The Guardian* was used for the stimuli. The video consists of panoramic digitally drawn images. Three of its scenes that make up the 360 scenery are being drawn as the story progresses. The story is inspired by real events related to the refugee crisis from year 2015 and is written by a famous novelist, Khaled Hosseini. In the video, the narration is conveyed via a voice-over. Its length is 7 minutes and 20 seconds.

The video was used in its entirety and from the original source for the 2D (YouTube, *The Guardian*[1]) and mobile VR (Google Play, *The Guardian VR* [2]) conditions. For the Article condition, a transcript with three three image stills was combined and set up as an Internet news article[3]. The transcript contained all of the both audio and written information available in the video; the image stills represented the three scenes the panoramic video is comprised of and were placed where appropriate in the text, corresponding to the development in the video itself.

2.2.2 Measurements. Scales for Satisfaction (SAT) and Intention to continue use (CON) dimensions were adapted from the expectation-confirmation model [2]. Items were adapted to the context of the study and the used stimuli. For example, *OBD* was replaced with the *overall experience*, and *similar media experiences* were used in order for the items to be applicable to all three conditions and ensure internal validity. All items were assessed on a 7-point Likert scale. For both dimensions mean scores were calculated for each participant to be used in statistical analyses.

Satisfaction (SAT, Alpha = .83) consisted of four items that were introduced by *Please rate how you feel about the overall experience that you just had.* The anchors were unique for each item and stated as follows: *very dissatisfied - very satisfied*; *very displeased - very pleased*; *very frustrated - very content*; *absolutely terrible - absolutely delighted.*

Intention to continue use (CON; Alpha = .86) was assessed using three items with strongly disagree and strongly agree anchors. The items were: *If possible, I intend to continue engaging with similar media experiences like the one I just had*; *I would like to try similar media experiences like the one I just had*; and *I intend to rather*

[1] https://youtu.be/LKBNEEY-c3s
[2] https://play.google.com/store/apps/details?id=com.guardian.gvrhl=en
[3] The article was posted on a website for the experiment purposes but is not publicly available due to copyright.

Table 1: Obtained means, standard errors, and 95% confidence intervals for CON and SAT in the three conditions

DV	Condition	Mean	SE	95% CI
CON	Article	4.68	.224	4.23, 5.12
	2D 360	5.36	.216	4.93, 5.79
	VR 360	5.68	.209	5.26, 6.09
SAT	Article	4.56	.199	4.16, 4.95
	2D 360	4.66	.192	4.27, 5.04
	VR360	4.76	.186	4.39, 5.13

continue than discontinue having media experiences like the one I just had.

Age was collected using an integer scale. Gender was reported as one of the three categories: *male*, *female*, and *other*.

2.2.3 Procedure. The data collection consisted of three stages. Participants filled out a pre-survey containing their demographic information when booking a time slot for the experiment. When they came in they were randomly assigned to one of the three treatments (Article, 2D 360, and VR 360). Between-subjects experiment design was employed and each participant was only subjected to one of the treatments. After the experience, they filled out the questionnaires pertaining to SAT and CON. In the end, all participants were informed about the purpose of the experiment and were compensated with movie tickets.

The experiment was held at an University, in an office room space with a desk, PC monitor, and a swirling chair. All participants were equipped with stereo noise-cancelling headphones. A researcher was present for the whole duration but out of sight. In the 2D condition, the participants could survey the panoramic 360-video by the click-and-drag mechanic with a computer mouse. In the VR condition, the chair was moved away from the desk to enable free rotating on the chair and the participants surveyed the video by moving the head position.

3 RESULTS

The results are comprised of all obtained descriptive data and statistical inference tests results. The p significance threshold (α) was set to .05 and effect sizes are presented wherever possible. All results were obtained using IBM SPSS version 25.

3.1 Treatments, satisfaction and continuance

Satisfaction with the experience (SAT) and intention to continue use (CON) were compared between the three conditions in order to investigate what effect does immersive journalism have (2D 360 and VR 360) compared to a written article. Descriptive statistics for these two factors are presented in Table 1 and visually for identifying trends in Figure 1.

A multivariate analysis of variance (MANOVA) test was conducted to test for statistically significant differences in mean scores. Multivariate tests using Pillai's trace suggested that there is a difference in the SAT and CON scores between the conditions ($F(4, 168) = 2.58$, $p = .039$, $\eta p^2 = .058$. However, tests of between-subjects effects suggested that the treatments only affected CON ($F(2,84) = 5.47$, $p = .006$, $\eta p^2 = .115$, but not no SAT ($F(2,84) = .276$, $p = .759$, $\eta p^2 = .007$. These results suggest that H2.1 should be confirmed, but not H2.2.

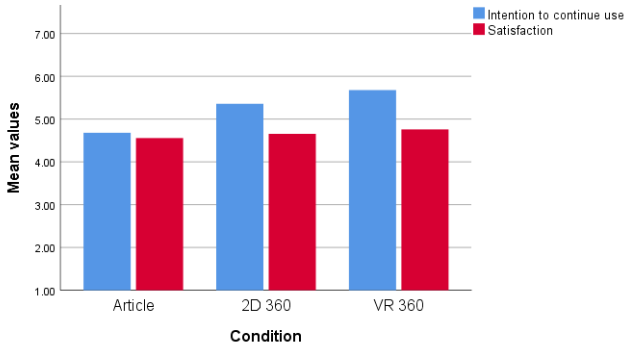

Figure 1: Mean values for CON and SAT across the three conditions

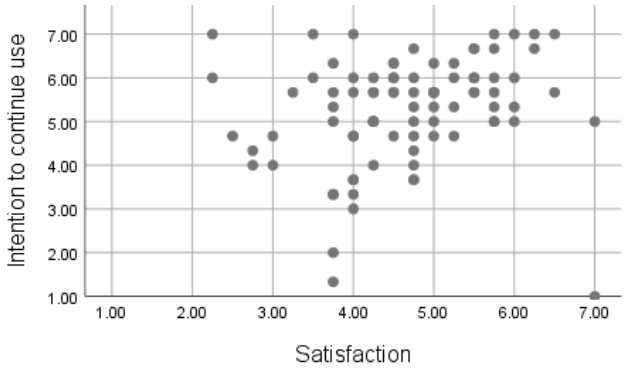

Figure 2: A scatter plot showing the relation of reported satisfaction and intention to continue use

Post-hoc analysis using robust Tukey HSD test (see Table 2) was used to identify pairs of treatments between which there was a difference in the intention to continue us. From Figure 1 it is visible that there is a clear upward trend in the scores starting with the Article, over 2D 360, and to VR 360, but only the difference between Article and VR 360 was statistically significant with the p threshold at .05.

Overall, there is a trend showing that those who read the article reported the lowest intention to continue use, whereas the highest was among those who viewed a 360-degree video in mobile VR. On the other hand, there are no statistically significant differences in the reported satisfaction with the experience.

3.2 Satisfaction and continued use

The first step to probing whether satisfaction positively predicted intention to continue use (H3) was a visual inspection of the scatter plot with the two variables (Figure 2).

As the scatter plot suggested a trend where continued use is higher for higher satisfaction, a linear regression test was conducted

Table 2: Tukey HSD results for CON with mean differences, standard errors, p values, and 95% confidence intervals

DV	I	II	Mean (I-II)	SE	*p*	95% CI
CON	Article	2D 360	-.677	.311	.081	-1.419, .065
	Article	VR 360	-.998	.306	**.005**	-1.729, -.268
	2D 360	VR 360	-.321	.300	.536	-1.038, .396

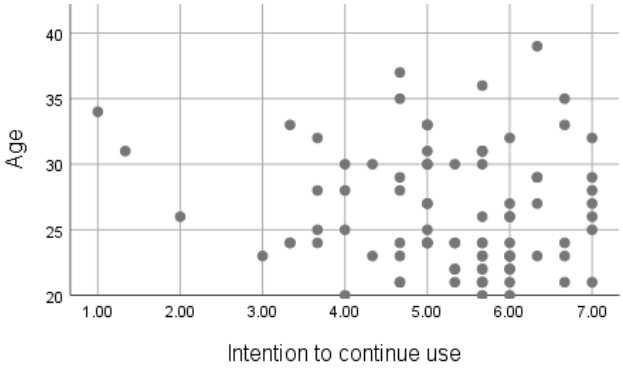

Figure 3: A scatter plot showing the relation of age and CON

to confirm satisfaction as the predictor. A borderline significant regression equation was found (F(1,85) = 3.840, p = .053), R2 = .043. Participants' intention to continue to use increased on average for .247 points for each full point on the satisfaction scale. Therefore, H3 is confirmed as satisfaction seems to predict the intention to continue use.

3.3 Demographics and continued use

Finally, the potential relationship between demographic factors (age and gender) and the intention to continue use were investigated.

A scatter plot representing age and CON was found to be inconclusive (Figure 3). A further linear regression analysis suggested no possibility to predict CON from users' age (F(1,85) = 1.237, p = .269), R^2 = .014.

For tests including gender, only male (M = 5.16, SD = 1.31) and female (M = 5.39, SD = 1.07) categories were taken into account, leaving out other as it held only two cases. An independent samples t-test was non-significant, or showed no difference in how males and females rated their intention to continue use of media after the experience t(83) = - 806, p = .423.

Therefore, no statistically significant relations were found between age or gender on one side and the reported intention of use continuance on the other.

4 DISCUSSION

This study investigated users' satisfaction (SAT) and the intention to continue having similar experiences (CON). Additionally, it explored how users' traits such as age and gender can predict their CON. It utilized an immersive journalism 360-video, The Sea Prayer, viewable on-screen and in mobile VR (immersive journalism: medium and high immersion respectively) and a written article compiled from video stills and a transcript of the 360-video (traditional journalism: low immersion).

Surprisingly, only the intention to continue use was rated better for immersive journalism than the traditional written article. Overall, the trend in the data suggests that users have a higher intention to continue use of similar content the higher the technological immersion. In particular, a statistically significant difference in the mean scores was found between the mobile VR and written article treatments, where users favoured the first. However, no such trend nor any statistically significant difference was found for satisfaction. This outcome was rated approximately evenly regardless of the experimental treatment.

Aligned with previous research [3, 14], results suggest that satisfaction should significantly predict users' intention to continue use. However, at the same time, satisfaction was not rated higher in the conditions with the 360-video than with the article. It would seem that the higher intention to continue use found in the immersive conditions cannot be explained by the related satisfaction, but that rather there are other factors that drive this higher intention. This could possibly be a more pronounced experience of telepresence as previously suggested [7], but warrants further investigation.

Finally, statistical inference tests indicated no way to predict users' intention to continue related to their age and gender. However, when it comes to age, reading Figure 3 suggests a slight trend, with younger participants being more likely to report a higher intention for continued use compared to older ones.

4.1 Implications and further research

The obtained results strengthen theoretical models and previous empirical findings between the relation of users' satisfaction and intention to continue to use [7]. However, they do not explain the differences in users' intentions in the three applied treatments. Therefore, it is possible that with VR there are stronger factors that drive the users' continued use which should be investigated. For example, it was found that telepresence can have a direct effect on the intention to continue use of social digital worlds [10]. Some other potentially fruitful avenues to investigate in the context of VR might be the influence of novelty [21], interactivity, and agency or autonomy, all of which have been shown to enrich the media experience [1, 25].

Furthermore, this study suggests that users might be more interested in consuming immersive journalism than traditional written articles. This should encourage media houses to develop the field further. However, unlike previous research [22], it showed no higher satisfaction when consuming a 360-video in VR. It should be explored whether this discrepancy could be due to different types or styles of the stimuli.

Future research agendas could also consider behavioural and not solely intentional outcomes, and investigate further whether these intentions were followed through. For example, some studies showed that embodiment in VR led to higher rates of follow-up cases on the topic of the content than non-embodied versions [25, 26]. However, it remains uncertain whether this would be the case with less complex settings, such as 360-videos in VR compared to a written article.

4.2 Limitations

There are a few limitations to this research that should be addressed and taken into account when interpreting and comparing its results to other studies.

Firstly, it focused on the effects of the content of solely one 360-degree video consumed in three distinct ways. It is a digitally drawn panoramic 360 video for which the narration was written by a novelist, and it was inspired by actual events but is not depicting them neither photo-realistically nor extensively factually. This implies that there is a limitation to the external validity as the results are only suggestive of the effects of similar videos.

Secondly, the article condition had no sound nor moving pictures, which limits the comparability of the experiences. However, considering that immersive journalism aims to distinguish itself from traditional journalism with its distinct or simply stronger effects on its users, it is necessary to compare the outcomes of consuming these different forms. Otherwise, it would not be possible to test the hypothesized advantages of immersive journalism, but rather only its outcomes in a vacuum. This kind of study design would leave us with no further knowledge on how different forms and different media technology affect the consumers. Therefore, the issue of how to better design these kinds of experimental comparisons and strengthen internal validity remains to be resolved.

Thirdly, no users' expectations are taken into account but rather only the outcomes of the experiences and therefore not any variation of the full expectation-confirmation model was investigated. This might have resulted in omitting some explanations of the results and warrant further research building on this study.

5 CONCLUSIONS

Despite a drawn 360 degree video in VR being rather simplistic, it seems to provide for a more favourable experience in terms of continued use than a non-VR or written version of journalistic content. Considering that fully immersive and embodied virtual reality experiences in this domain are still rare, the findings are encouraging when it comes to this most widely spread type of immersive journalism content. This study provides for a stepping stone for expanding our knowledge on the expectation-confirmation theory in new contexts as well as some of the demographic factors in the context of immersive journalism that could be contribute to both theory and practice.

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