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DOES MEDIUM MATTER?

Exploring the Role of Virtual Reality in Journalism

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EMBLEMATIC.   FRONTLINE   PBS

ABOUT

The Norman Lear Center is a nonpartisan research and public policy center that studies the social, political, economic and cultural impact of entertainment on the world. The Lear Center translates its findings into action through testimony, journalism, strategic research and innovative public outreach campaigns. On campus, from its base in the USC Annenberg School for Communication & Journalism, the Lear Center builds bridges between schools and disciplines whose faculty study aspects of entertainment, media and culture. Beyond campus, it bridges the gap between the entertainment industry and academia, and between them and the public. Through scholarship and research; through its conferences, public events and publications; and in its attempts to illuminate and repair the world, the Lear Center works to be at the forefront of discussion and practice in the field. For more information, please visit: **www.learcenter.org**.

At the Lear Center's **Media Impact Project** (**www.mediaimpactproject.org**), we study the impact of news and entertainment on viewers. Our goal is to prove that media matters, and to improve the quality of media to serve the public good. We partner with media makers and funders to create and conduct program evaluation, develop and test research hypotheses, and publish and promote thought leadership on the role of media in social change.

FRONTLINE, U.S. television's longest running investigative documentary series, explores the issues of our times through powerful storytelling. FRONTLINE has won every major journalism and broadcasting award, including 89 Emmy Awards and 20 Peabody Awards. Visit pbs.org/frontline and follow us on Twitter, Facebook, Instagram, YouTube, Tumblr and Google+ to learn more. FRONTLINE is produced by WGBH Boston and is broadcast nationwide on PBS. Funding for FRONTLINE is provided through the support of PBS viewers and by the Corporation for Public Broadcasting. Major funding for FRONTLINE is provided by the John D. and Catherine T. MacArthur Foundation. Additional funding is provided by the Ford Foundation, the Abrams Foundation, the Park Foundation, The John and Helen Glessner Family Trust, and the FRONTLINE Journalism Fund with major support from Jon and Jo Ann Hagler on behalf of the Jon L. Hagler Foundation.

Emblematic Group creates award-winning immersive content powered by proprietary technology. Founded in 2011 by VR pioneer Nonny de la Peña, Emblematic has been a leader in volumetric storytelling and one of the world's premiere producers of virtual, augmented, and mixed reality. 'Hunger in Los Angeles' was the first ever VR documentary to be shown at the Sundance Film Festival in 2012. Since then, the company has built a critically acclaimed body of work that has included tracking the chaos of the Syrian civil war; capturing the tension of a wheel change during the Singapore Grand Prix; and conveying the scope and scale of climate change. Emblematic partners with organizations including Google, Mozilla, The Wall Street Journal and The New York Times to create both tools and content that enlighten, empower, and educate audiences.

ACKNOWLEDGEMENTS

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For more information about this report, please email media.impact@usc.edu.

EXECUTIVE SUMMMARY

This report presents the results of two studies examining audience impacts of two virtual reality experiences created by FRONTLINE and Emblematic Group. In *After Solitary*, viewers were confronted with one man's memories of his solitary confinement and life after incarceration, while *Greenland Melting* introduces viewers to two scientists measuring glacier melt.

Virtual Reality (VR) provides a potentially exciting new way for audiences to experience journalism, yet questions remain about the role of VR in engaging audiences on important social issues. The USC Media Impact Project (MIP) is working to understand how this new technology can be best employed and how it can engage audiences to learn, understand, and act on the stories presented.

FRONTLINE and Emblematic group collaborated to create two Room-scale VR experiences, using a variety of cutting edge techniques to share journalistic content. We at MIP then presented participants with these experiences and collected data on what they thought, felt, and were likely to do in response to these stories through surveys and interviews. Although both pieces were developed for Room-scale VR, they were adapted for use in other formats (including traditional video, 360 video, and Immersive 360 video).

METHODS

Participants were randomly assigned to experience the story in Room-scale VR or a comparison group. They were given a pre- and post-survey to ask about their participant experience as well as to measure changes in knowledge, attitudes, and behavioral intention based on their experience. *Greenland Melting* participants were shown a second version after the post-survey and asked to compare their experiences in small groups. These studies had relatively small samples that do not fully represent the U.S. population yet, they are a promising step in understanding how VR technology can be leveraged to enhance the impact of journalistic content.

FINDINGS

- Participants in *After Solitary* reported that the experience helped them gain a personal perspective on Kenny's physical state and emotional journey. Participants in *Greenland Melting* reported that virtual space helped demonstrate key concepts, especially by using time lapse and granting access to hard-to-reach locales.

- Both experiences inspired interest in FRONTLINE topics and in VR journalism. This effect was strongest among VR novices and for participants unfamiliar with FRONTLINE. For these individuals, the virtual experiences served as an invitation to explore new topics and sources of content.

- VR provided an outstanding immersive experience, but an imperfect knowledge acquisition environment. Participants were fully engaged in exploring their environment—which came with a tradeoff. Compared to the same experiences on other platforms, participants remembered details less accurately after a Room-scale VR experience and some commented on "missing" details in the content.

- Participants enjoyed taking control and testing the boundaries of each experience, and they wanted fully interactive experiences. Such interactivity designing experiences that heighten agency is challenging because participants became frustrated when they believed they missed what they were "supposed to be" watching.

- The presence of a guide or central character gave participants context for the physical experience and information in *After Solitary* and *Greenland Melting*. Both Kenny and the scientists offered moments of connection that made the virtual experiences' unique features of sensory immersion, embodiment, and agency stand out.

The development process for *After Solitary* and *Greenland Melting* created an opportunity to explore best practices for journalistic content in VR and its impact on audiences. Our findings support the potential for VR journalism to capture an audience's attention, and encourage attitude and behavior change, to a greater extent than content produced for other platforms. However, the platform alone is not a magic bullet— it has unique affordances which, combined with effective storytelling and appropriate choice of subject matter, had an impact on a receptive audience. Additional research into the impacts of medium on viewer experience can serve to enhance our understanding of this new platform and leverage it to engage new audiences on important issues.

INTRODUCTION

Virtual Reality (VR) is one of many interactive technologies increasingly being used by newsrooms as a new opportunity to connect with audiences (Watson, 2017).

VR is not defined by any single piece of technology (such as a head-mounted display), but by a combination of features that together construct a world where users can take action (Dow, 2008). The unique features of VR are often described as a sense of presence, meaning the technology creates the "feeling of being there"; and a sense of agency, meaning users control their experience in a virtual environment, such as navigating the space, interacting with characters, or changing the course of events (Dow, 2008).

Past research has found that virtual experiences can improve a surgeon's skills during real operations, change the outcome of negotiations, and increase pro-environmental and pro-social behavior (Ahn, Bailenson, & Park, 2014; Gehlbach et al., 2015; Rosenberg, Baughman, & Bailenson, 2013; Seymour et al., 2002). Researchers have attributed these effects to VR's ability to evoke presence, encourage perspective-taking, and give participants a sense of being in control of their environment.

While researchers have demonstrated several effects of virtual experiences, we know far less about how users interact with immersive journalism. This ability to give users a chance to experience a new perspective, and the consequences of taking on that perspective, are especially significant for journalistic content. Journalism serves multiple purposes, including accurately informing the public about current issues, and framing public conversations to facilitate active civic participation (Tofel, 2014).

By placing users within specific events and giving them a degree of agency, immersive VR could encourage the creation of new emotional connections between viewers and the events being depicted (Gajsek, 2016). Compared to journalism presented through other media, the unique immersive characteristics of VR is an important step to understanding how this new technology compares to other linear media in achieving the journalistic purpose to inform and engage audiences on important social issues .

In *After Solitary* and *Greenland Melting*, FRONTLINE and Emblematic explored new ways to use VR to draw audiences into journalistic content. Both pieces capitalized on VR's potential to give audiences a chance to visit unfamiliar places and perspectives. By placing users at the center of the story and giving them a degree of agency, virtual experiences upend traditional methods for telling journalistic stories and encourage a closer emotional connection to the events depicted.

FRONTLINE and Emblematic engaged the Media Impact Project (MIP) to conduct an evaluation of *After Solitary* and *Greenland Melting*. The goal of this research was to investigate participants' responses to a journalistic experience in virtual reality. Together, we set out to answer the following questions:

1. What is the general viewer response to a VR journalism experience?

2. What (if any) differences are there between viewing the same content in Room-scale VR and less immersive technologies (e.g., 360 video, 2D video, especially in terms of their experience, knowledge, attitudes, and intended future behaviors?

This report presents the methods and results of both studies, then concludes with implications and recommendations for future research and practice in VR journalism.

STUDY 1: AFTER SOLITARY

> " *"Getting even a little inside his world... gave a great foundation to really connect with the experience and empathize."*

BACKGROUND

After Solitary chronicles Kenny's memories of solitary confinement and his life after incarceration, putting users in his former cell and bedroom as he describes his experiences, while factual information about the U.S. prison system accompanies his story.

To study *After Solitary*, we focused on how virtual reality affects people's ability to see the world through the experiences of others, their feelings about whether they have control (or "agency") in a story, and how this experience might change a user's experience, knowledge, attitudes, and behaviors. Immersing a user in the virtual environment of Kenny's former prison cell offers the opportunity to reduce the distance between the user and the events that transpired at the Maine State Prison. The physical dimensions and story of the events can be told in real time and at a human scale, instead of describing the space with text or depicting it in 2-D video. The user is also free to explore the entire virtual environment and decide where to focus his or her attention, unlike in text or conventional video formats.

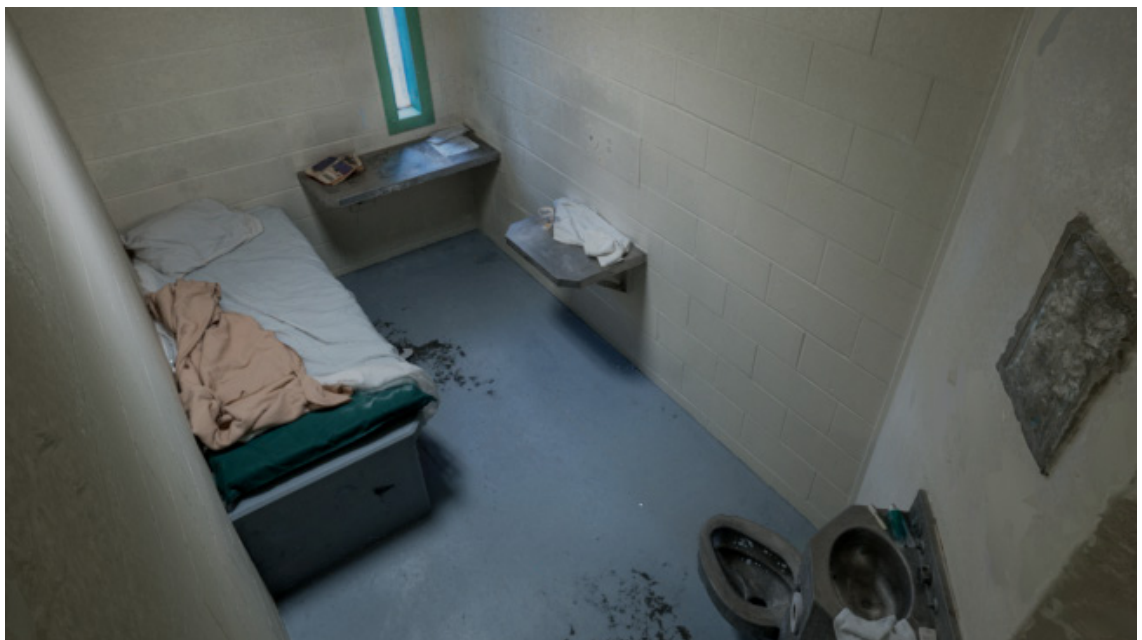We designed our study around two central questions:

1. What is the general viewer response to the *After Solitary* experience?
2. What (if any) differences are there between participants' experience, knowledge, attitudes, and behavioral intentions when viewing *After Solitary* based on the platform used?

We used survey responses to address these questions, and compared outcomes between participants who experienced *After Solitary* as a 360 video, an Immersive 360 video, or in Room-scale VR. Our approach and results, summarized below, found that more immersive platforms created the best user experience overall. Although participants critiqued some aspects of the technology, they responded differently to the story based on the degree to which the platform allowed them to inhabit the virtual world. The participants who used more

A scene from *After Solitary*

immersive platforms were more likely to recommend the experience, look for more information about the topic, and look for more VR journalism on other topics.
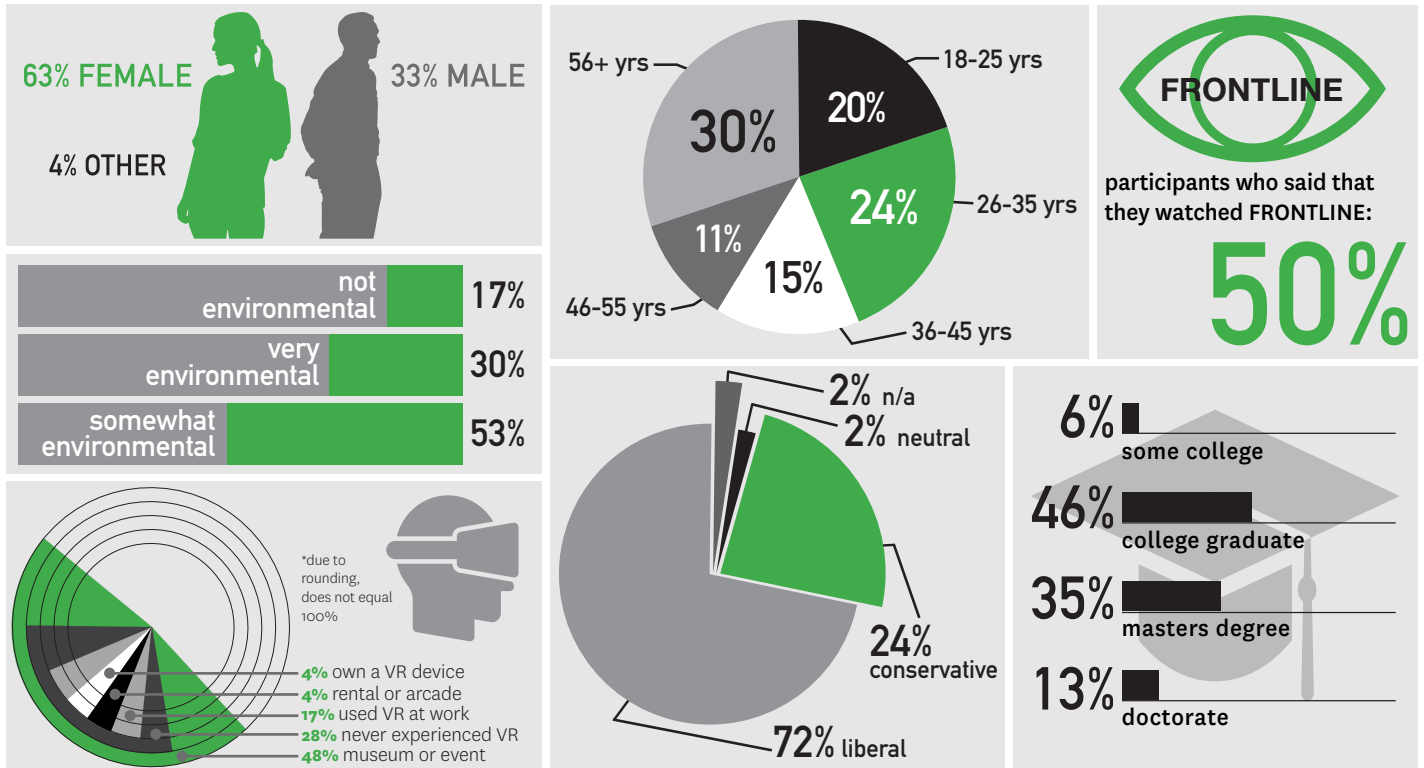
METHODS

PARTICIPANTS

Participants were recruited via email, online advertisement, and social media. A total of ninety-two (92) people participated in the study. All participants were compensated with a $20 online Amazon gift card.

63% FEMALE
33% MALE
4% OTHER

not environmental 17%
very environmental 30%
somewhat environmental 53%

56+ yrs 30%
18-25 yrs 20%
26-35 yrs 24%
36-45 yrs 15%
46-55 yrs 11%

participants who said that they watched FRONTLINE:
50%

*due to rounding, does not equal 100%

4% own a VR device
4% rental or arcade
17% used VR at work
28% never experienced VR
48% museum or event

2% n/a
2% neutral
24% conservative
72% liberal

6% some college
46% college graduate
35% masters degree
13% doctorate

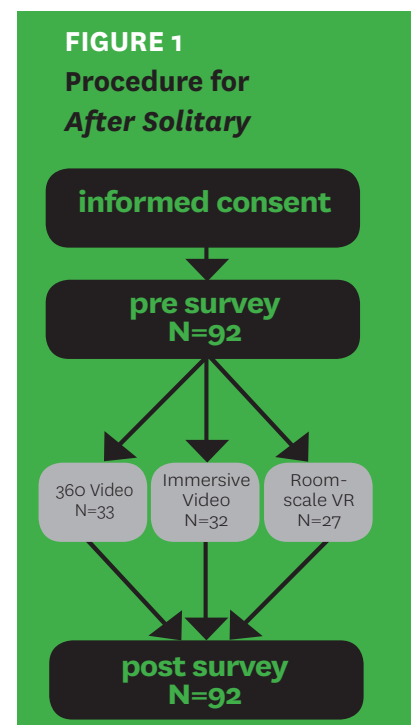*Note: Represents participants from both studies.*

PROCEDURES

Participants were randomly assigned to experience *After Solitary* using one of the three platforms:

1. 360 video (viewed on a laptop with headphones)
2. Immersive 360 video (using a Samsung Gear)
3. Room-scale virtual reality (using an HTC Vive)

We compared what participants thought, felt, and were likely to do in response to the story via surveys distributed before and after the experience (survey instruments available upon request). Each session took approximately 30 minutes per person (Figure 1).

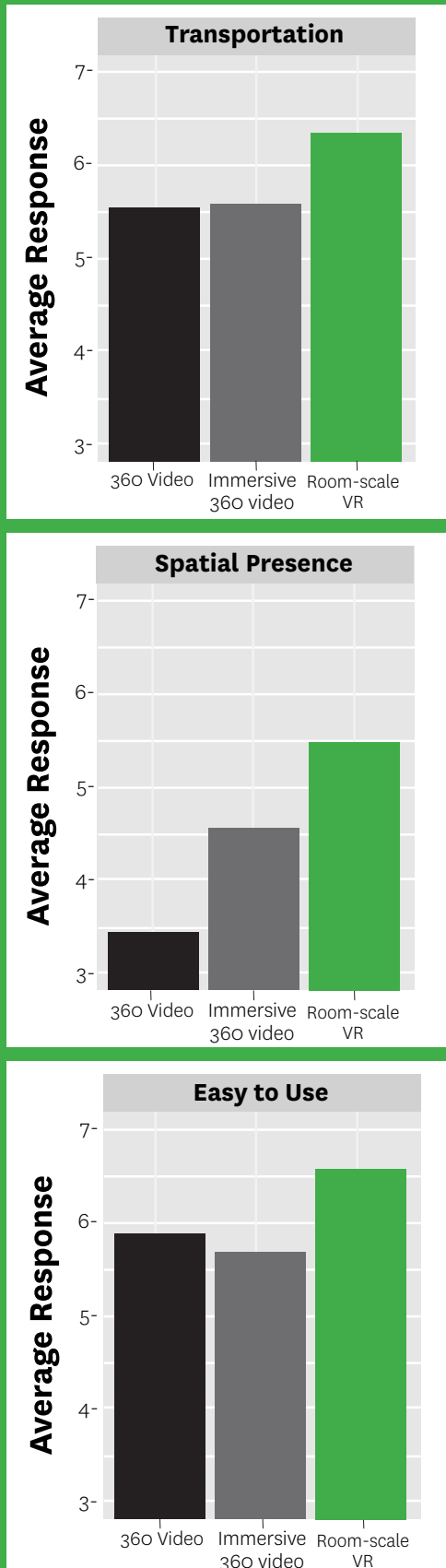Data was analyzed quantitatively using ANOVA (numerical variables) and Chi Squared (categorical variables) to assess differences between groups. Qualitative analysis of open-ended items allowed us to dig deeper into participants' responses.

FIGURE 1
Procedure for *After Solitary*

informed consent
→
pre survey
N=92
→
360 Video N=33 | Immersive Video N=32 | Room-scale VR N=27
→
post survey
N=92

FIGURE 2

Average Ratings of Transportation, Special Presence, and Ease of Use by Platform

PARTICIPANT EXPERIENCE

What is the general viewer response to the *After Solitary* experience?

- *After Solitary* inspired interest in VR journalism, even for VR novices.

- Participants who used 360 video took the perspective of outsiders looking in, and commented on details of Kenny's story. Participants using Room-scale VR focused on their own perspective and experiences.

- Participants thought *After Solitary* was credible on all platforms.

- Room-scale VR was easiest to use, and inspired feelings of transportation (the feeling of being absorbed into a story), and spatial presence (the feeling that one could carry out actions in the virtual environment); the 360 video was rated easier to use than the Immersive 360 video.

- Participants were critical of the fuzziness of Kenny's figure, which limited the feeling of immersion; the physical discomfort associated with wearing a VR headset; and at times not knowing where to look.

- The most frequently cited "best" feature of the experience involved some description of how it felt to "be there" in the cell with Kenny. ("The feeling of being inside the spaces — how claustrophobic they were and the bleak, institutional environment of the jail cell.")

- The second most popular feature involved empathy both for Kenny specifically, and for his time spent in solitary confinement. ("Getting even a little inside his world...gave a great foundation to really connect with the experience and empathize.")

- Other frequent responses include the realism of the experience, sharing the feeling of being in solitary confinement, and the ability to look around while watching the video. ("I couldn't stop looking around at what the spaces looked like.")
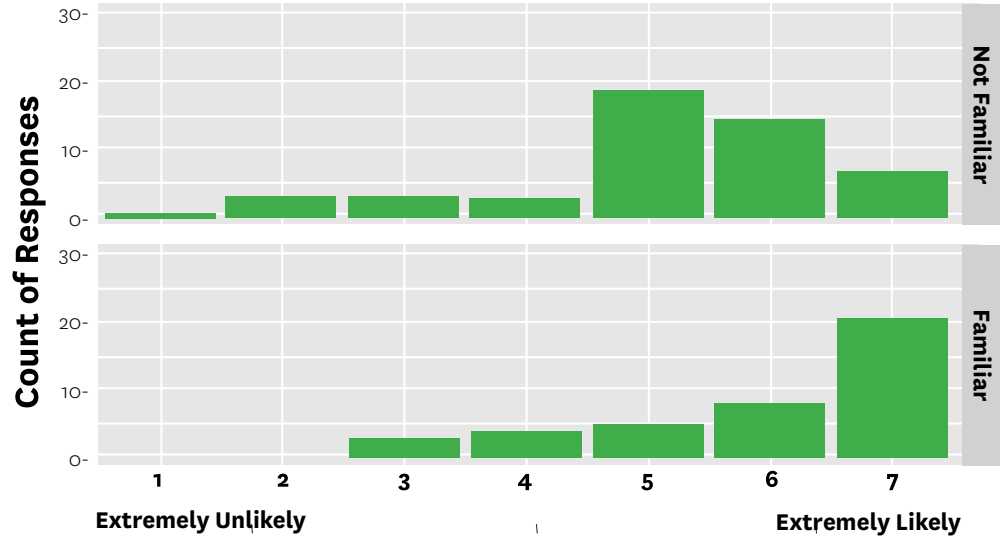

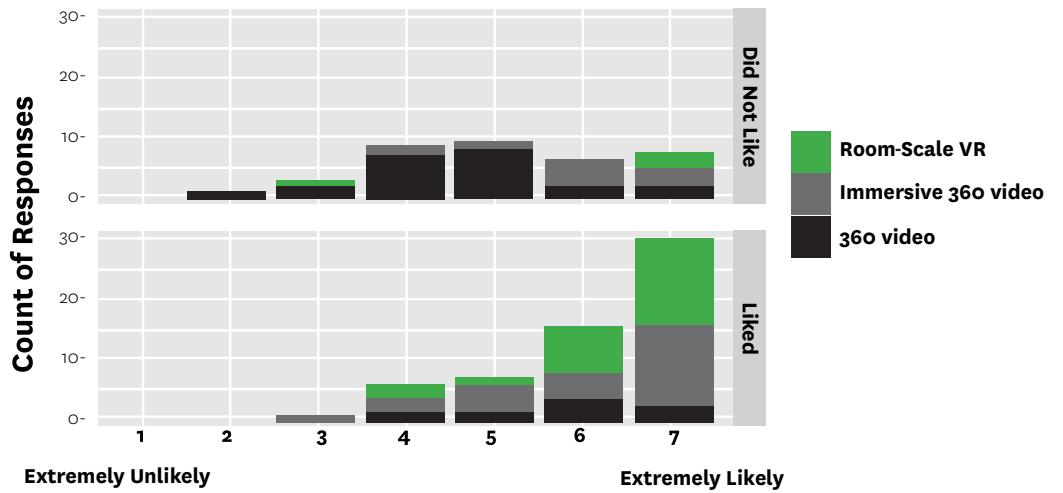**A participant experiencing *After Solitary***

FIGURE 3
(split by familiarity with
FRONTLINE)

HOW LIKELY ARE YOU TO:

Look for more reporting
about solitary confinement
or prison conditions?

Look for another
FRONTLINE experience
like this?

DIFFERENCES BETWEEN PLATFORMS

What (if any) differences are there between participants' experience, knowledge, attitudes, and behavioral intentions when viewing *After Solitary* based on the technology and platform used?

- Participants using Room-scale VR or Immersive 360 video were more likely to look for more reporting about solitary confinement or prison conditions, than those using 360 video. They were also more likely to look for "another FRONTLINE experience like this" and "other kinds of FRONTLINE content," compared to participants who saw the 360 video.

- Participants who used Room-scale VR reported higher feelings of narrative transportation and a greater sensation of spatial presence (the feeling that they could carry out actions in the virtual environment) than those who used the Immersive 360 video or 360 video. Participants also thought Room-scale VR, using the HTC Vive, was the easiest device to use, followed by the 360 video on the Laptop, and the Immersive 360 video. (See Figure 2)

- Participants watching the 360 video and in the Immersive 360 conditions were more likely to focus on the "plot points" of Kenny's story (i.e., sending kites, seeing Kenny's scars, seeking therapy after his release), and were more likely to say they learned something from this experience. Room-scale VR participants, on the other hand, were more likely to discuss their

own reflections of how it felt to be immersed in the experience (i.e., feeling how small the cell was, or feeling like they were "really there"), and to focus on the events from their own perspectives rather than Kenny's.

- Whereas 360 video participants were more likely to qualify the experience as depressing, and discuss their empathy towards Kenny, Room-scale VR presented participants with a "wowing" piece of technology that provided a unique experience engaging visual, auditory, and proprioceptive senses. ("You actually experience it. And when you're stuck in that little box, that's maddening for me just as a viewer, but you can imagine what it must have been like for those people who are stuck, first in a prison cell and then later in their own house, these prisons created in their minds." —Room-scale VR participant)

- Participants in the Room-scale VR condition gave the highest ratings for how likely they were to recommend this experience to a friend. Participants in the Room-scale VR condition were also more likely to share how the experience looked and sounded than participants using either Immersive 360 or 360 video.

- The platform used did not influence how likely participants were to "Talk with others about the information you heard during this experience," "Volunteer Time," "Donate Money" or "Sign a Petition." These items had average ratings in the 3-5 range, indicating a low to moderate likelihood to take these actions.

RESULTS

Overall, participants reported immersive and impactful experiences with *After Solitary*. Narrative and technical features of immersive technology contributed to users' physical and emotional proximity to Kenny's experience of living in solitary confinement, though individual differences influenced the degree of impact.

Our summary of findings revealed three key insights:

1. *After Solitary* inspired interest in VR journalism generally.

2. Use of different platforms cast participants as outsiders looking in, or having a unique experience of their own.

3. Implications of the "active" nature of the audience experience in VR for journalism requires further thinking.

Room-scale VR is the most effective way to create a feeling of "being there." For environments with unique spatial characteristics, it creates that feeling to a greater degree than Immersive 360 video or 360 video, leaving a bigger impression on novice users.

VR experiences absorb users' attention for short, intense periods of time. It inspires users to seek more information afterwards, but it is not the most effective medium to commit facts to memory. If participants in VR can control where to look, but cannot interact with objects in the environment, they have "presence" but not total "agency" — they have a limited ability to influence the environment. VR storytellers should leverage the user's role as an active viewer to reward curiosity about the environment. If participants miss explanatory text presented in the scene, the experience should not be compromised.

Participants in immersive experiences are not yet familiar with the conventions of this medium, so it is still important to clarify the "rules" of the environment. Visual cues about spatial environments, like where the horizon is or where the walls of a room meet, can be used to help participants stay oriented between scenes. Spatial cues in audio input should also be consistent. For example, participants expected Kenny's voice to align with his presence in the space. Naive users appreciate VR experiences and are inspired to look for more content after using it, but often do not have access to hardware in everyday life. Distribution remains a challenge; live events are an effective way to build excitement for VR experiences or capture gatekeepers' attention, but web-based, sharable content is still the bulk of any piece's audience.

STUDY 2: GREENLAND MELTING

BACKGROUND

Following our study of *After Solitary*, we built on its methods and preliminary findings to investigate and draw comparisons with the *Greenland Melting* content produced by FRONTLINE, Emblematic Group, and NOVA in association with xRez Stuidio and Realtra.

Although both pieces were optimized for Room-scale VR, the content and storytelling techniques used in *After Solitary* and *Greenland Melting* were quite different. *After Solitary* focused on one man's experiences in solitary confinement, and featured two main settings, both indoors; *Greenland Melting* followed two NASA scientists through indoor and outdoor environments and used a variety of visual cues to show how rapidly glaciers in Greenland are melting, why they are changing faster than expected, and how scientists study those changes.

These differences in content and structure provided an additional opportunity to study the unique aspects of *Greenland Melting*, and contribute to the body of knowledge about VR and environmental communication. Previous research studying the impact of a virtual experiences on participants' pro-environmental behavior demonstrated that feelings of agency mattered. For example, one study enabled people to grow trees in a virtual environment and that experience led to more positive pro-environmental behavioral intentions (Ahn et al., 2014). Visualizing and quantifying water consumption and waste similarly changed attitudes and conservation behaviors (Weisenstein, 2016).

Building on the research questions from *After Solitary*, we refined our methods to answer the following questions:

1. What is the general viewer response to the *Greenland Melting* experience?

2. What (if any) differences are there between participants' experience, knowledge, attitudes, and behavioral intentions when viewing *Greenland Melting* based on the platform used?

As noted earlier, changes in attitudes and behavioral intentions are situated in, and motivated by, both cognitive and emotional factors; in other words, individuals are spurred to change their thoughts and actions by both thinking and feeling (Edwards, 1990). Immersion in virtual reality is a more "active"

The filming of *Greenland Melting*

and "multi-dimensional" experience when compared to viewing the same content passively on a screen. Our preliminary results from *After Solitary* suggested the additional sensory information and embodied experience of immersive virtual reality do provide users with opportunities to deeply engage with the content. However, this may come at a cognitive cost — users may not absorb all the information they would otherwise learn.

Building on these findings, the present study inquires more deeply into the emotional responses of participants, examining changes in attitude and behavioral intentions within participants over time, and across different technology platforms, to further our understanding about audience responses to journalistic virtual reality.
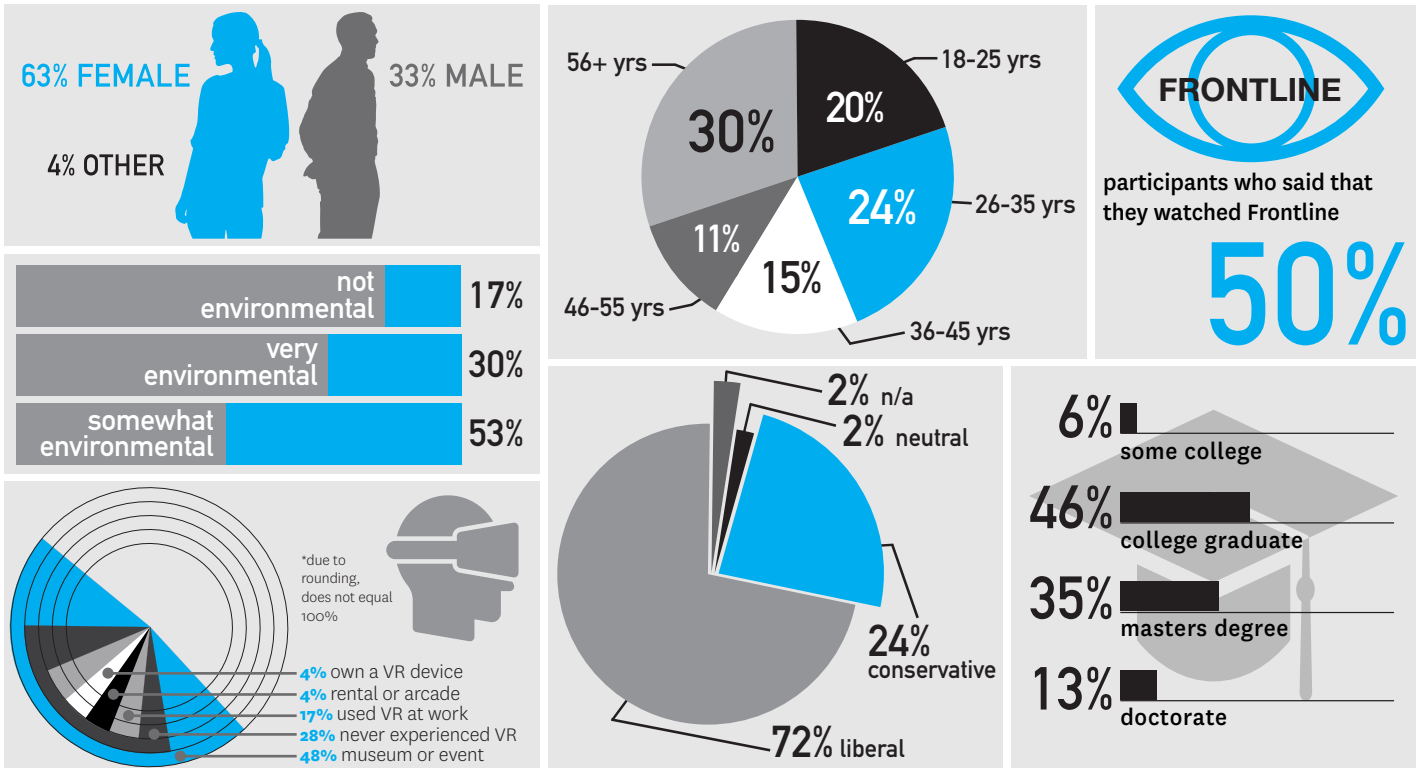
METHODS

PARTICIPANTS

Participants were recruited via email, online advertisements, and social media. A total of fifty-four (54) people participated in the study. All participants were compensated with either a $20 Amazon Gift Card or extra credit (for eligible USC students).

63% FEMALE **33% MALE** **4% OTHER**

not environmental **17%**
very environmental **30%**
somewhat environmental **53%**

*due to rounding, does not equal 100%

4% own a VR device
4% rental or arcade
17% used VR at work
28% never experienced VR
48% museum or event

56+ yrs **30%**
46-55 yrs **11%**
18-25 yrs **20%**
26-35 yrs **24%**
36-45 yrs **15%**

2% n/a
2% neutral
24% conservative
72% liberal

FRONTLINE
participants who said that they watched Frontline
50%

6% some college
46% college graduate
35% masters degree
13% doctorate

Note: Represents participants from both studies.

PROCEDURES

The study design included both a between-subjects and a within-subjects design comparing the experiences of Room-scale VR (using an HTC Vive) and a non-interactive video version of the same content (viewed on a laptop with headphones).

1. *Between Subjects*: Participants were randomly assigned to either the video or VR version first, and given a pre-survey and post-survey to compare experiences between the two (survey instruments available upon request).

2. *Within Subjects*: After completing the post-survey, participants were exposed to the second version and then interviews were conducted to ask about their perceptions and comparisons of the two.

We compared what participants thought, felt, and were likely to do in response to the story via surveys distributed before and after the experience and asked participants to compare the experiences in their own words during the post-session interviews. Each session took approximately 60 minutes per person (Figure 4).

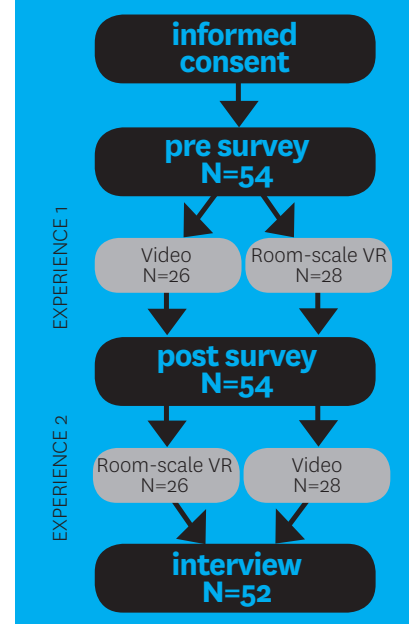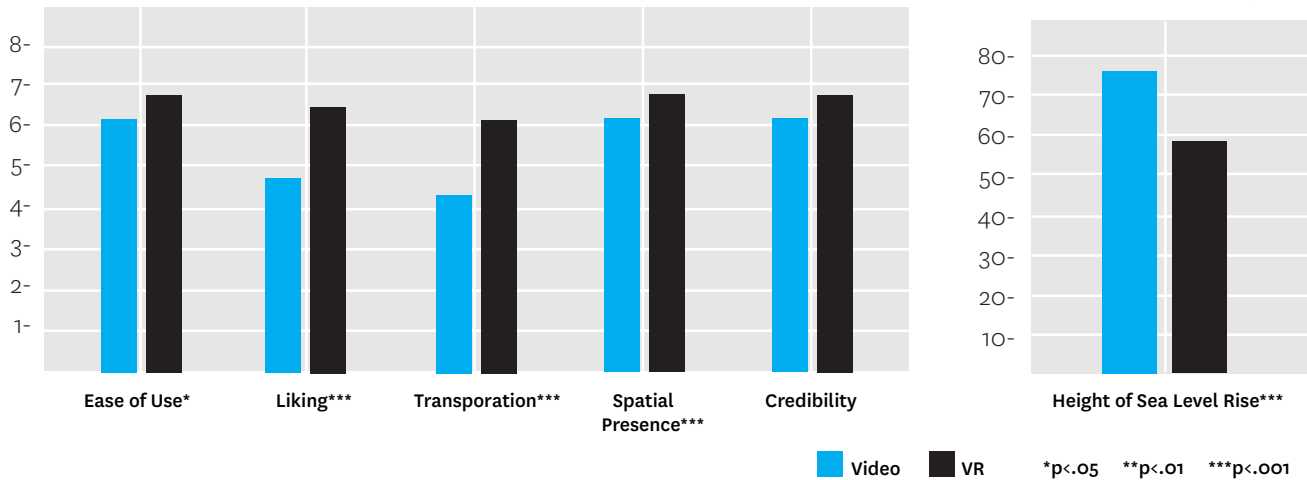**FIGURE 4**
Procedure for *Greenland Melting*

EXPERIENCE 1

informed consent
→ pre survey N=54
→ Video N=26 / Room-scale VR N=28
→ post survey N=54

EXPERIENCE 2

→ Room-scale VR N=26 / Video N=28
→ interview N=52

FIGURE 5

Participant Experience

Percent who answered knowledge question correctly

Video ■ VR *p<.05 **p<.01 ***p<.001

The results of this study were categorized along the following areas: Participant Experience, Knowledge, Attitudes, and Behavior. Where necessary, the impact of prior awareness and use of FRONTLINE and its content was also considered.

PARTICIPANT EXPERIENCE

How did viewers engage with the *Greenland Melting* content? Did the medium make a difference?

Yes, compared to participants who viewed the video, participants who viewed the VR experience:

- Provided more positive feedback on the experience

- Provided less negative feedback on the experience

- Reported more feelings of "spatial presence," where they felt engaged with the natural and artificial elements of the virtual environment

- Reported more feelings of "connectedness," where they felt like they had been physically transported to Greenland

- Liked the experience more

- Were more likely to experience spatial disorientation

Both the VR and video experiences were rated highly for ease of use, though the video was higher and the difference was statistically significant. Participants also found both versions of the experience credible, with no significant difference between the two platforms.
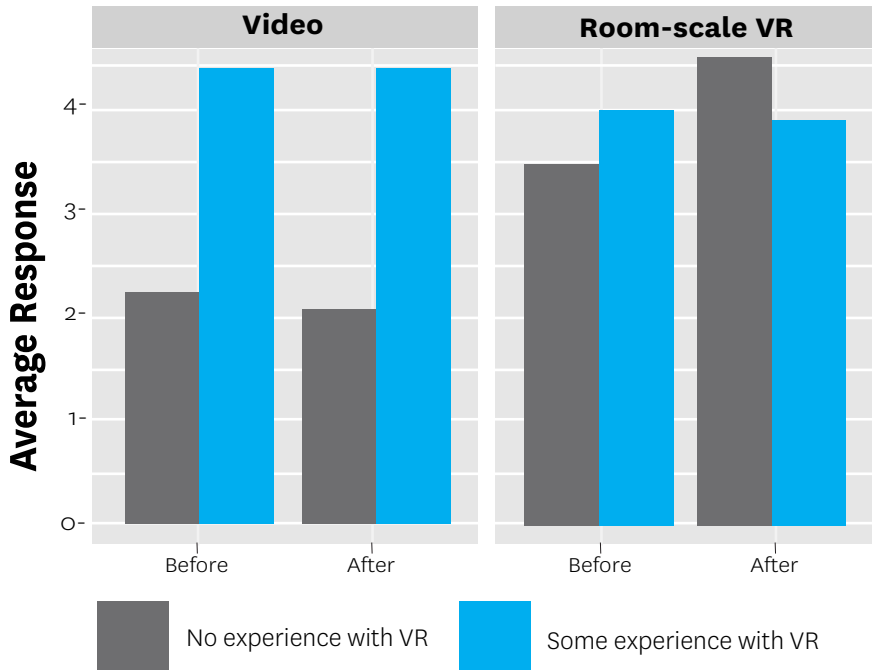
KNOWLEDGE

What was the impact of *Greenland Melting* content on viewers' knowledge? Did the medium make a difference?

Yes, compared to participants who viewed the VR experience, participants who viewed the video:

- Improved their likelihood of accurately estimating global sea level rise if all the ice in Greenland melted (76% answered this open-ended question correctly after the video and 59% answered correctly after VR, from less than 5% estimating correctly beforehand)

- Were more likely to report feeling "informed"

Video — **Room-scale VR**

■ No experience with VR   ■ Some experience with VR

Both the VR and video experiences increased the likelihood of accurately estimating the volume of sea level rise if all the ice in Greenland melted. Participants also retained key points of *Greenland Melting*, such as identifying the rate of glacier melt and its cause (warming ocean water), as well as stating that melting glaciers contribute to sea level rise after the experience, regardless of the platform.

ATTITUDES

What was the impact of *Greenland Melting* on viewers intent to take action? Did the medium make a difference?

In some cases. Compared to participants who viewed the video, participants who viewed the VR experience:

● Were more likely to report an emotional response to the material, usually negative, such as "unsettled," "concerned," "frightened"

● Were more likely to report that the experience "felt real"

However, there was no statistically significant difference between whether participants experienced the virtual reality or the video version of *Greenland Melting* with regard to:

● Belief in climate change and glacier melt — remained stable across both versions (this sample of individuals strongly agreed both before and after)

FIGURE 7
Ratings of likelihood participants will seek out more content on glaciers and rising sea levels, FRONTLINE content, or VR journalism

Glaciers/Sea Levels

FRONTLINE

VR Journalism

■ Do Not Watch FRONTLINE   ■ Watch FRONTLINE
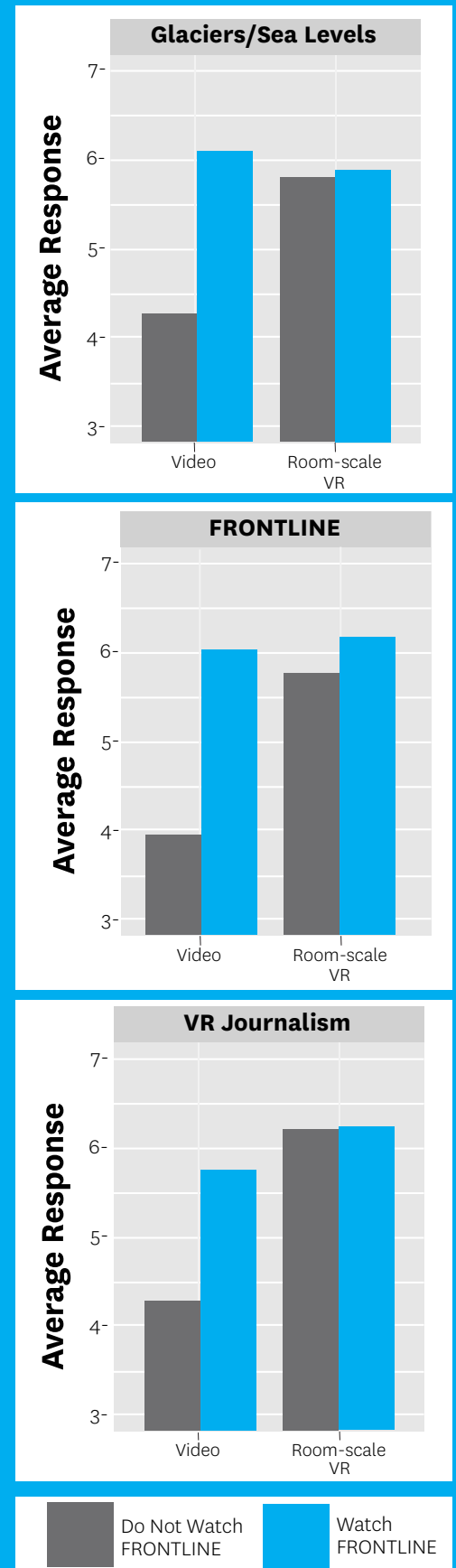
VIDEO (LAPTOP COMPUTER)

ROOM-SCALE VR (HTC VIVE)

> " *"[On the video] I felt like I was hearing a story; in the VR I felt like I was part of the story. I felt like I was out collecting this information. It draws you in, makes you feel connected, involved, engaged."*

> " *"If you want to simply absorb the facts, the computer version is the way to go...but if you want to get a feel for what scientists are feeling, then the VR is much more powerful."*

- Trust in science and scientists — increased after experiencing both versions, driven by increase in Room-scale VR
- Psychological distance of climate change — reduced after, across both versions
- Perceptions of risk — remained stable across both versions
- Environmentalism — remained stable across both versions
- Perceived self-efficacy — remained stable across both versions

BEHAVIORAL INTENT

Can *Greenland Melting* content change behavioral intentions of viewers on climate change? Did the medium make a difference?

Yes, compared to participants who viewed the video, participants who viewed the VR experience:

- Were more likely to report intent to seek out FRONTLINE and VR journalism content if they had not watched FRONTLINE in the last year
- Reported higher intention that they were likely to buy a VR device in the next year or two if this was their first VR experience (Figure 6)

There were no statistically significant differences between participants who experienced the virtual reality or the video version of *Greenland Melting* with regard to:

- Likelihood to "Ask your congressperson to support a strong climate change bill" — increased after, across both versions
- Llikelihood to "Join an environmental group" — increased after, across both versions
- Likelihood to "Choose a car that gets good fuel mileage" — remained stable across both versions
- Support for "policies to upgrade flood defenses to a higher standard" — increased after, across both versions
- Support for "teaching children about the causes, consequences, and potential solutions to climate change" — remained stable across both versions

RESULTS

Overall, participants reported *Greenland Melting* was an immersive and impactful experience. Participants learned about glacier melt and the scientists who study it, and intended to change specific behaviors in response to their emotional and educational experiences. While the video was easier to use, Room-scale VR provided the better user experience. Age and comfort with technology did not present significant barriers to this group. Our mixed method approach yielded five key insights:

Experiencing *Greenland Melting* in any form improved participants' comprehension of glacier melt and sea level rise, but participants were more likely to retain specific facts from the video version, rather than Room-scale VR.

The consensus from participants is that VR provides more of an impressive experience and emotional pull, but came at the expense of knowledge gain and retention. Exploring the experience from their own perspective took precedence over listening or watching for visual cues.

Participants' attitudes about climate change were relatively stable, but experiencing *Greenland Melting* increased trust for science and scientists. This may be a case of "preaching to the choir," for this sample; or it may be that an experience engaging with virtual characters lends itself to changing attitudes about people, rather than systems.

First, participants in this educated, liberal-leaning, Southern California sample may have taken a position about topics around climate change long ago, leaving little room for a brief media experience to influence attitudes further. In contrast, attitudes toward science and scientists did change as a result of experiencing *Greenland Melting*, a topic and group that participants may have felt more ambivalence for. Although the trend did not reach statistical significance, the virtual experience appears more impactful on attitudes towards scientists than the video experience. For topics where participants may be ambivalent, a virtual experience may be a catalyst for changing attitudes.

Second, attitude change for scientists rather than climate change may have been attributable to the content: spending time engaging with individuals, seeing how they live and what they value, even in a virtual space, may change attitudes toward that person and groups they represent. Attitudes about an abstract, large-scale issue like glacier melt might not change in response to an expertly-delivered explanation. Seeing the impact of glacier melt on individuals or communities may be an alternate path to attitude change about glacier melt and sea level rise.

Participants' behaviors regarding information search, sharing content, and interest in additional FRONTLINE content and virtual reality journalism was affected by experiencing *Greenland Melting* as Room-scale VR. Particularly for participants who were not regular FRONTLINE viewers, the virtual experience inspired interest in more content. However, intent to take actions related to climate change were affected no matter which version of the experience participants had.

For behaviors related to media consumption, the Room-scale virtual experience led to an increased interest in sharing the content, recommending it to friends, and seeking more, especially if they were not already regular FRONTLINE consumers.

> **"** *"[Room-scale VR] made the experience come to life in a way that was shocking...as an educational tool, [VR was] so much more impactful than looking at it on the computer screen or television."*

> "Just reading studies, it's hard to see the scientists behind the study. [In the VR] they seem like a regular person, more believable... to see the person gives [the information] new meaning."

Participants experiencing Greenland Melting

For behaviors that serve to adapt to or mitigate the influence of climate change and glacier melt, experiencing *Greenland Melting* in any form increased participants' intent to take specific actions. We did not see consistent differences based on version.

Sense of immersion was impacted by many different aspects of the experience, from the technical features, to the narrative, to individual differences in sense of embodiment and comfort in the environment. This resulted in very different experiences for some viewers, including "missing" content; changes to format and delivery of the content could reduce or eliminate the aspects of the experience that negatively impacted immersion.

Participants differed in willingness to explore the space, as well as experiencing negative physiological responses like nausea. Providing more control over the sensory experience and rate of information flow would help address these issues: Refining technical features like rendering figures in photogrammetry, providing consistent cues to where participants are in space, and providing mechanisms like responding to user signals to advance scenes for increased user control would help tailor this type of experience to each person's needs and level of comfort.

Lack of a call to action, or clear sense of what the viewer could do in the real world in response to *Greenland Melting* was frustrating to many participants. Participants sought action to alleviate their feelings of concern.

Addressing this audience desire should be a deliberate decision on the part of the content producers in the planning stage. Frustration for participants could be resolved by including resources or references to current calls to action, but this has broader implications for those using VR for journalism as opposed to advocacy. Such calls to action must be evaluated on a case-by-case basis; solutions journalism framings may provide a more satisfying user experience. Information about organizations working on issues related to the topic being covered without an explicit call to action could be shared in order to allow those who are interested in taking action to explore options for themselves as a potential "middle ground" approach.

As in the *After Solitary* study, when designing a VR experience, content makers should evaluate how to balance the user's need for guidance, and the opportunity to play a more active role as the editor and director of their experience.

DISCUSSION

Participants were deeply moved, and showed how engaged with the material they were by actively interrogating the facts and editorial process used to create the experience.

After Solitary's major success was in leveraging the feeling of being in a space to better understand Kenny's experience. Participants valued the sequence of moments they shared with Kenny, as well as the real-world footage included in the experience. The novelty of being in a space they would not otherwise encounter, paired with Kenny's presence as a guide to provide context and personal meaning to the objects in the space, made for an extremely effective experience.

The feature of being in a specific, sometimes impossible space was taken to extremes in *Greenland Melting*, to illuminating and challenging ends. Playing with the boundaries of the plane and helicopter, diving under the waterline, and watching the landscape transform over time delighted and impressed participants. The sensation of floating or flying over the glacier, and the view of Earth at the opening and close of the experience, offered no point of reference for participants' bodies in space, which could be disorienting. While some participants in *After Solitary* expressed a desire to see a reference to their own body in the space, the dimensions of a small room, furniture, and Kenny were familiar references for scale, and were stable over time, so the experience was not as disorienting. Although participants felt like they were in the environments

of *Greenland Melting*, these environments changed over time, and were unfamiliar, making them more challenging to perceive — but utterly transporting once participants were acclimated.

One of *Greenland Melting*'s strengths lay in communicating ideas with clever visual comparisons. Demonstrating the retreat of the glacier from 1900 to the present day had a huge impact on participants. The interactive feature of dipping below the waterline to observe changes due to warm water flow, and the demonstration of ice melting in a glass of water compared to ice melting on a table were also appreciated.

Navigating the immersive environments could take up cognitive resources, impeding the participant's likelihood of committing facts to memory. In a less immersive environment, participants could devote their full attention to absorbing and retaining the factual content of the experience. Responses to the survey items measuring details mentioned in *Greenland Melting*, and participants' own reflections during their interviews, supported this idea. While both versions were effective at communicating key points, more immersive experiences did not provide the easiest path to declarative knowledge, or learning facts and figures (Squire, 1987). However, immersive experiences that are

responsive or fully interactive may be ideal for procedural knowledge, or "learning how." Neither *After Solitary* nor *Greenland Melting* were intended to teach procedural knowledge, but the opportunity to develop this form of knowledge may inform future content development choices.

Future work that emphasizes showing how, or even enabling participants to take part in actions, would leverage the affordance of this medium. For example, one participant noted that he had spent time with the scientists but didn't really understand what they did or what the equipment in the plane was for, and mentioned wanting to follow the depth tracker to understand how it was used. Alternatively, participants left both virtual reality experiences interested in more content about the topic, more content from FRONTLINE, and more experiences in the burgeoning genre of virtual reality journalism. Generating the motivation to explore multimedia content on a variety of platforms, where specific pedagogical or informative goals can be fulfilled, may be a more impactful outcome for VR than short-term recall of facts.

Impactful moments from *After Solitary* and *Greenland Melting* also came from figures sharing personal stories. Moments like Kenny describing his scars and talking about therapy after his release formed the backbone of *After Solitary*. Eric Rignot's reflections that connected his work to his grandchildren's lives while VR participants stood next to him in the closing scenes of *Greenland Melting* was nearly always mentioned in the interviews that followed the experience. Participants said his story about his grandchildren helped them understand why Eric pursued this difficult work.

Much of the public conversation about virtual reality and empathy centers on how perspective-taking is a stepping stone to understanding another person's experience. For *After Solitary*, spending a few minutes in Kenny's shoes did help participants understand his experience. *Greenland Melting* focused on participants' own feelings of spatial presence, and a few personal connections to nearly the opposite effect: Eric's comments helped participants contextualize the variety of treacherous, impossible locations they had visited and information they had learned.

The personal connections to Kenny in *After Solitary* and Josh Willis or Eric Rignot in *Greenland Melting* were ultimately helped by the presence of these figures in each experience, but digital depictions of humans are notoriously difficult, and what they said left a more positive impression than how they looked. Participants noticed when these figures did not sound, move or make eye contact in a naturalistic way. Most negative reactions were related to the sense that the scientists did not know participants were there and did not respond to their presence in the simulation.

However, participants forgave technical artifacts when the content was emotionally engaging. Integrating lighting sources to more seamlessly blend figures rendered through photogrammetry with the landscape or set; using spatialized audio to match speakers' location; and innovations to enable responsive eye contact would have a positive impact on user experiences users.

Compared to *After Solitary*, the *Greenland Melting* experience rewarded and sometimes required participants' exploration in the virtual space, but not all participants felt comfortable performing these movements, or recognized the cues to do so. Other participants roamed extensively throughout the space and reported that this exploration and spatial processing usually came at the expense of attention to the informational content. Participants in both experiences reported "missing" some information or elements of the experience.

Finally, the opportunities for perspective-taking, connecting with the perspectives and experiences of the characters, and trust were very different in each study. The variety of reactions to the scientists as characters in *Greenland Melting*, and

> " *"[In* After Solitary*] the VR was cool but not very useful as a storytelling device; the narrative was like a video.Here [in* Greenland Melting*] the VR experience was much more substantial, because you got to experience the landscape via the VR."*

the resulting change in attitudes toward science and scientists, represents a promising avenue of future research. This stands in contrast with reactions to Kenny in *After Solitary*; while participants mentioned empathy for him specifically, it is unclear whether that extends to all prisoners or formerly incarcerated people. The scientists in *Greenland Melting* were representing a body of knowledge; Kenny was not. A deeper understanding of how much participants identify with key characters, and how their judgments and motivations rely on their feelings about the characters, would help clarify best practices for stories about individuals compared to stories about large-scale issues, and help forge connections between those levels of analysis.

It may not be surprising that Room-scale VR participants focused on what the technology was able to do, and how it made them feel, rather than reciting the contents of the story. These observations align with bodies of literature which outline the implications of limited cognitive resources, especially when applied to media contexts (Paas, Renkle & Sweller, 2003; Chen & Chaiken, 1999). We can think of these responses as a proxy for participants' memory across the different platforms. In a less immersive environment, participants devoted their full attention to absorbing and retaining the factual content of the experience. Since navigating the environment and processing spatial information is a more prominent part of the experience while using the Immersive 360 video and Room-scale VR, fewer cognitive resources are available for committing facts to memory than with the 360 video condition. However, this was a small study, and these observations would need to be more explicitly investigated to understand how availability of cognitive resources affects memory of an experience like *After Solitary* or *Greenland Melting*.

> **"**
> *"Whereas solitary confinement was a new experience — I never imagined myself to be in solitary confinement but the experience itself is just one setting. [Greenland Melting communicated] … information, numbers, data in a way that are not just told to you but you can experience them."*

RECOMMENDATIONS

- Room-scale VR is the most effective way to create a feeling of "being there." For environments with unique spatial characteristics, it creates that feeling to a greater degree than regular video, or even Immersive 360 video. However, the novelty of the medium creates incentives to explore the space rather than absorb information, and provides enormous potential for distraction from complex narratives or information-dense sequences. Balancing these characteristics is the key to developing journalistic content for this medium.

- If participants in virtual reality can control where to look, but cannot interact with objects in the environment, they have "presence" but not total "agency" — they have a limited ability to influence the environment. Leverage their role as an active viewer to reward curiosity about the environment. Designing the freedom to explore and discover information, rather than informational goals and user agency working at cross purposes, is the challenge of the medium.

- Participants in immersive experiences are not familiar with the meaning of editing conventions yet, so it is still important to clarify the "rules" of the environment. Visual cues about spatial environments, like where the horizon is or where the walls of a room meet, or using controllers to represent a participant's hands, can be used to help participants stay oriented between scenes. Spatial cues in audio input should also be consistent. Unusual spatial positioning or movement should not be deployed alongside crucial informational content in the event that the participant has an adverse physical reaction, or is too distracted by the unfamiliar experience to recognize, encode and retain information. For sequences that integrate significant movement into the experience, mechanisms to detect non-participation and prompting or alternative choices should be provided.

- Having a character in a virtual experience to provide guidance and context for information was extremely valuable. Although participants noticed artifacts of the photogrammetry process and wanted each figure's appearance to be more naturalistic, the benefits outweigh the costs and provided some of the most the most striking moments of both *After Solitary* and *Greenland Melting*.

- Improving technical and narrative aspects that contribute to or interfere with immersion could improve some outcomes. For example, using the wireless controllers to trigger the next scene, or tracking participants' gaze and creating variations in the execution of the content sequences based on attention, could improve participants' ability to stay with the flow of information and not feel like they were "missing out."

- VR experiences absorb users' attention for short, intense periods of time. It inspires users to seek more information afterwards, but is not the most effective medium to commit facts to memory.

- Naive users appreciate VR experiences and are inspired to look for more content after using it, but do not have access to hardware in everyday life. Distribution remains a challenge; live events are an effective way to build excitement for VR experiences or capture gatekeepers' attention, but web-based, sharable content is still the bulk of any piece's audience.

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