Exploration of Information Processing Outcomes in 360-Degree Video

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Abstract

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Exploration of Information Processing Outcomes in 360-Degree Video

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Based on previous research, this study explored the way in which visual verbal redundancy in virtual reality environments may be related to user performance. This study examines a person's ability to retain and recall information presented in a 360-degree video using an experimental approach. LC4MP was used as the theoretical foundation for the study. The three experimental conditions involved viewing a 360-degree video with voiceover, viewing the same video with voiceover and redundant text, and the same video with voiceover and non-redundant text. The findings indicate that memory performance for the condition with non-redundant text is stronger than the performance for the other two conditions. Implications and future directions for such research are also discussed.

Dedication

This thesis is dedicated to my grandfather, Donald Tinkey.

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Introduction

After decades of predicting the future of virtual reality (VR), the technology is starting to become a reality across industries including archeology, architecture, construction, computer sciences, communication sciences, engineering, entertainment, health sciences, psychology, and social sciences (Biocca, 1992, Claudio, 2014, Knabb 2014, Heydarian 2015).

Most recently, journalists have begun exploring the medium. Newsrooms are just beginning to adopt virtual reality (VR) in the form of 360-degree video as a story-telling platform. Included in the group of newsroom VR pioneers are The New York Times, The Associated Press, The Huffington Post, Vice News, USA Today, CNN and BBC (Owen, 2016). Some, like CNN, are creating entire departments for the technology ("CNNVR Puts Story First," 2016). The new trend in journalism has much to do with the push for 360-degree video on Facebook from the social media platform's creator, Mark Zuckerberg (Owen, 2015).

Social media giant Facebook is leading the way in 360-degree video efforts since acquiring a leading virtual reality technology company. Facebook, the social network with the most users worldwide, is taking the initiative in creating a platform that can sustain videos shot in 360-degrees (Owen, 2015).In March 2014, Facebook announced its plan to purchase Oculus VR, inc. for $2 billion. Oculus is described by Facebook as the leader in immersive virtual reality technology. At the time of Facebook's acquisition of Oculus, the company had already generated enough interest to receive more than 75,000 orders for its VR headset, the Oculus Rift, while still in its developmental stage ("Facebook steps toward," 2016). Since Facebook's Oculus software and Samsung

hardware-powered Samsung Gear VR launched in November, 2015, Facebook said Gear VR reached one million hours of 360-degree video views by February, 2016 ("Facebook steps toward," 2016). Videos available in 360-degree format on Facebook include news, entertainment, sports, fashion, nature, and advocacy, to name a few ("Most popular 360," 2016). The most viewed 360-degree video as of May, 2016 came from ABC News. The video showed viewers what it was like to be in Times Square in the middle of a blizzard. The video to reach the most views in one day was the opening credits of Game of Thrones at 5.3 million ("Most popular 360," 2016).

ESPN tested VR via Facebook 360-degree video during the 2016 Summer Olympics in Rio de Janeiro. A team of four sports journalists produced 360-degree content for the Mundo ESPN Facebook page. Between August 4 and 21, the team created a total of 32 videos were integrated into a 10-minute 360-degree documentary. According to Facebook, ESPN had the following three goals in mind with its 360-degree coverage. The first was bringing innovation to sports journalism by testing the narrative possibilities and advantages afforded by 360-degree video using the concept of "the game around the game" without infringing on broadcasting digital media rights. The second goal was to provide complementary TV coverage to attract the same television audience to interact with the Facebook Page format. The final goal was creating interactive content with a fresh and unique angle by delivering a first-person perspective to the TV audience. One video, a 360-degree interview with athlete Usain Bolt, received 950 million views ("ESPN immerses audience," 2016). By the winter of 2018, NBC Olympics launched a nationwide promotional campaign in partnership with Intel True VR to bring the Olympic action straight inside the homes of anyone with several compatible VR viewing devices.

For those without VR goggles, a 360-degree or 180-degree viewing experience was made available to viewers using the NBC VR app (Rottegers, 2018).

Journalism has evolved over time, adapting to newly available media technology or platforms. Rooted in print newspaper publications, journalists learned to tell their stories over the airwaves with the invention of radio, only to add visual elements to the audio stories with the innovation of television years later. The internet also provided an entirely new platform for journalists to learn (Owen, 2016). Even though empirical research on VR, especially in a news setting, is lacking, Biocca (1992) suggests previous research pertaining to the television industry will transfer to VR. Due to the void in research, there are many questions pertaining to VR and news. For the purposes of this paper, those questions are delimited to cognition and message recall. One of the main roles of journalism is to share information with the public. Even with new technologies and storytelling platforms that have emerged over the years, this is one facet of journalism that has not changed.

However, that does not mean mistakes have not been made along the way. For example, when television was at its peak in the 1980s, producers often overused the latest technology. During a time when additional layers of textual information were first introduced to television, the benefits of such visuals were unknown within the field. News consultants during the early 1980's stressed adding visual elements to newscasts, but the best way to implement additional visuals in a way that benefited the viewer was still unknown (Reese 1984). As these newly available resources were just beginning to be explored, producers often overused them, resulting in too many graphics on the screen in the form of bugs, tickers, crawls, and scrolls. Those variations of additional moving or

stagnant text on the screen proved to be distracting from the main content on the screen. Over the years, they learned, if not solely for design purposes, the practice was not effective. This has been proven through many studies over the years in which researchers found such edits to be distracting and impairing to the cognitive resources needed to focus on the information being presented and remember the message. (Lang, 1995, 1999, 2000, 2013; Potter, 2000; Thorsch, 1992).

It has become tradition for media researchers to study mediated messaging, and it is generally agreed that the complexity of the message affects how hard receivers must work to understand it (Lang, 2013). Based on Biocca's (1992) insight about predicting the future of virtual reality from previous television studies, it brings to question the limits of edits in 360-degree video before the user is overloaded with information and does not decode the message intended by the journalist. Lang (2013) found that edits in television content that are more rapid help to keep the viewer's attention, therefore increasing their ability to recall the message.

Using limited capacity theory and the limited capacity model of motivated mediated message processing [LC4MP], this study explores and predicts the potential message recall ability of 360-degree news video viewers. Limited capacity theory is used in media and communication studies to explain how media consumers encode messages of different mediated varieties. The LC4MP was intended to be applied to all types of contents, media, and goals (Lang, 2006), and therefore can be applied to virtual reality as a medium. Translated to 360-video, it would be valuable to know if findings from previous studies hold true. Specifically, the purpose of this study is to determine the way in which a viewer's recall ability is influenced by the number of edits in a 360-degree

video, the way a person's level of perceived immersion influences their recall ability and how a person's level of perceived distraction influences their recall ability. Edits are typically considered any alteration to the raw video content, including transitions and additional items. For the purpose of this study, edits are operationalized as narrative additions to video in the form of text and voiceover.

Literature Review

Understanding Limited Capacity Theory

The limited capacity approach to message processing uses the assumption that people are information processors who perceive stimuli and make mental representations of the stimuli, process the stimuli, and then recreate the stimuli in either the same or and altered form (Lang, 2000). The approach also views persons as limited capacity information processers who can only handle thinking about so many ideas at once before all their resources are used and they must let go of a previous thought before taking on another (Lang, 2000). Adding other variables to the approach such as user involvement, message complexity, emotion, arousal, and motivation, researchers have studied how message recall and learning changes. One study found that the more complex the information, the less a person learns (Bradley & Shapiro, 2004). Another study looks at user involvement in the narrative and concludes that when a person is less involved in the story, a person will learn better if the complexity of the message is low (Lowrey, 2006). Emotion is another factor in message recall (Hitchon & Thorson, 1995)- for example, looking at news stories with videos containing negative, graphic images of death, maiming, or injury tend to increase attention. They also result in an increased need for mental capacity in order to process the message while increasing a person's ability to retrieve and recognize the information presented in the negative video. This also makes it more difficult for a person to recall stories or messages presented prior to viewing negative video (Lang, Newhagen, & Reeves, 1996). Furthermore, Newhagen (1998) adds that images in the news that elicit the feeling of anger will be better remembered than those that cause a person to feel disgust or fear.

Another factor that increases the ability to remember messages at the highest level are elements classified as arousing and positive (Bolls, Lang, & Potter, 2001; Potter, 2012; Zhou 2005). Lang, Dhillon, and Dong (1995) conclude that people allocate the most cognitive capacity to such messages. Furthermore, using the limited capacity model of motivated mediated message processing [LC4MP], an additional factor of motivation is added to the ability to process messages.

Designed by Lang (2006), LC4MP operates under the five assumptions which include cognition, motivation, media, time, and communication. Cognition refers to the idea that humans are limited capacity information processors, meaning people naturally are limited to their cognitive resources available to process messages which includes perceiving, encoding, understanding, and remembering the world in which people live (Lang, 2006). When cognitive resources are not sufficient, information processing is hindered (Lang, 2006). The second assumption pertains to motivation, stating that people have two types of motivational systems- the appetitive (approach) system and the aversive (avoidance) system (Lang, 2006). These systems, according to Lang (2006), are automatic reactors to environmental stimuli. Both appetitive and aversive systems originated from survival responses. The appetitive motivational system evolved from the need to find food and mates to survive. The aversive motivational system evolved as a form of protection from danger (Lang, 2006). According to Lang (2006), these forms of primary motivation stimuli are the same for each individual, but can be learned differently in the same way people learn individually to respond to positive or negative consequences. The two systems ultimately influence cognitive processing (Lang, 2006). The third assumption, which pertains to media, states that media are made of variably

redundant information streams which are presented through the senses including sight, sound, and touch. This also includes formats of text, photos, and moving pictures. The fourth assumption in Lang's (2006) LC4MP model is human behavior having a constant occurrence over time, changing at every second. Lang credits Thelen and Smith (1994) for deducing human behavior and human cognition to be a dynamic process. The fifth and final assumption of the model regards communication as the interaction, over time, between a person's motivated information processing system and the message (Lang, 2006, Rafaeli, 1988). Lang (2006) calls this interaction truly interactive and continuous as the parts of the message influence the motivational and cognitive systems which influence message perception, encoding, storage, and retrieval.

The latter three parts of an interaction make up what is known as the three subprocesses of LC4MP (Lang, 2006). Lang (2006) would say encoding, storage, and retrieval occur constantly, continuously, and simultaneously. Encoding is when a person takes the stimulus and makes a mental representation, however, it will not be an exact replica of the original content as humans do not make exact copies of information in the world around them (Lang, 2006). Instead, what people do is encode the most salient parts of the message in an automatic and unconscious fashion (Lang, 2006). One way a person allocates cognitive resources to a piece of information is through controlled processing, or relating the allocation to the person's own interests and goals (Lang, 2006). Another way is through an automatic process prompted by aspects of a person's environment, similar to an orienting response in which people seek to answer the question "what is it?", typically in response to a change in the environment or in response to a signaled stimuli such as hearing a person's own name (Lang, 2006). Motivation stimuli (appetitive and

aversive) fall under this same sub-process. Once a person is alerted to stimuli in the environment, he/she can allocate resources to begin encoding information (Lang, 2006).

The second sub-process of LC4MP is storage. This occurs after a person makes a mental representation of the information recently encoded and then links it to information previously encoded (Lang, 2006). Storage works most efficiently when a person has a greater amount of old information to connect with the new information. Additionally, the more motivated the person is to learn the information, the more resources made available to allocate to storage (Lang, 2006).

The third and final sub-process of LC4MP is retrieval (Lang, 2006). In the same way resources need to be allocated for encoding and storage to occur, the same is necessary for retrieval to take place. It is first necessary to understand that memory is viewed as bits of stored information that spread activation to other related bits of information (Lang, 2006). This same process occurs when a person views television programming (Lang, Zhou, Schwartz, Bolls, & Potter, 2000). Just because a person is exposed to a program, does not mean they are motivated to process the information, which results in low television information retention (Lang, Zhou, Schwartz, Bolls, & Potter, 2000). Examining edits in video (cuts, transitions, edits, graphics, sound effects, voice over, etc.), Lang learned in 1990 that such edits can help increase resources allocated to information processing (Lang, Zhou, Schwartz, Bolls, & Potter, 2000). Lang et al. (2000) found that cuts in television programs, or transitions between unrelated scenes, introduce new information and make it more difficult to process information with the increased cognitive load. However, edits that were related to the scene increased viewers' autonomic and self-report arousal, as well as attention to the message, and

actually increased memory as the pace of the edits increased (Lang, Zhou, Schwartz, Bolls, & Potter, 2000). Further research (Lang, 2015) on pacing and arousal suggests that both fast-paced and arousing content can increase the allocation of resources to process messages, but when combined, it results in a content overload which inhibits the processing system, cued recall, and recognition of the message.

A Limited Capacity Approach to Audio Visual Redundancy

Another important aspect to consider in message recall is the concept of visual and audio redundancy. Visual, sometimes referred to as pictorial, redundancy and audio redundancy are measured by comparing the similarities in both channels. Most redundancy studies find that there is a positive correlation with the level of redundancy between channels and a person's learning or recall ability.

Annie Lang took a highly studied area of television research, audio visual redundancy, and applied to the LC4MP approach in her 1995 study.

Lang (1995) defines audio visual redundancy on a continuum using three separate definitions from literature:

1. The presence of two channels rather than a single channel
2. An exact match in content between the audio and video channels
3. A relationship in semantic meaning between the audio and visual channels.

According to Lang (1995), the first of the three definitions which focuses on the single channel is often considered to be least redundant on a continuum. Her reasoning is based on past studies which define single channels as having no redundancy or studies which use single channels as the control due to its lack of redundancy. Lang places the second definition of redundancy higher on the continuum, explaining that those messages

have two channels sharing similar information, but perhaps not totally in sync, and the third definition would be placed highest on the continuum due to the messages having the highest form of semantic redundancy between channels. Of course, there are points in between that vary, but the three definitions placed on the continuum serve as mile markers of sorts to indicate variance between definitions.

Applied to the limited capacity approach to message processing, Lang (1995) was able to determine that multiple-channel redundant messages require a higher amount of capacity to process information compared to single channel messages or "talking heads." However, the channels in which the messages were conflicting were most challenging capacity-wise because the messages were most complexly structured.

Reese (1984) concluded that learning improves as visual and audio channels reinforce another through redundancy, ultimately improving recall ability. Reese found that print information added to a visual channel in the form of captions on video impeded memory because the viewers found it to be distracting. Therefore, it was concluded that viewers are better able to process redundant information when the audio and visual channels are redundant, but less able when a print channel (captions) is included.

Furthering that study, Son, Reese and Davie (1987) examined television newscasts and redundancy effects by creating different versions of newscasts and manipulating conditions to reflect various levels of redundancy by re-editing the cover video to match or mismatch the anchor's voiceover. Results in this study affirm previous finding from Drew and Grimes (1986), as well as Reese (1984), which indicate redundancy between words and pictures significantly improve recall of information in television news stories, yet it does not translate to a better understanding of the content.

Additionally, Drew and Grimes (1987) studied the difference between various redundancy levels of voiceover news stories. They found that higher redundancy led to better recall and understanding of messages communicated through auditory channels compared to a reversal in recall ability in the visual channel, meaning higher recall scores when the redundancy levels were lower.

Looking at redundancy in the scope of multimedia learning, Adesope and Nesbit (2012) examined learning effectiveness in a multimedia environment by comparing retention ability between spoken-only, written-only, and spoken-written presentations. The findings showed that there was a difference in performance between students who learned from spoken-only presentations compared to spoken-written, in which the students in the spoken-written condition outperformed those in the spoken-only condition. The influencer of these results is believed to be the use of key terms pulled from the verbatim presentation to reinforce content.

Also studying multimedia learning environments, Ritzhaupt and Pastore (2015) looked into the use of video for teaching at the college level. The pair noted that students often viewed the videos at accelerated speeds and wanted to see how learning was affected by doing so. It was found that speed did not have an effect on learning ability, but there was a difference in learning satisfaction in favor of normal speed video. Furthermore, captions to reinforce the material in the video did not help students learn the content. In fact, captions were found to have a negative performance effect.

Mayer and Moreno (2003) took redundancy one step further and applied the concept to the innerworkings of the brain, much like previously mentioned limited capacity theory studies. Mayer and Moreno worked under the assumptions that humans

process pictorial (or visual) and verbal material through two separate systems and that, under the assumption of limited capacity, each channel has a limit to the amount of material it can process. They also assumed that meaningful learning requires dual processing of both pictorial and verbal channels while acknowledging that a person has a cognitive overload point. The results of their study were not conclusive by any means. What it did yield, is that to best teach a topic, the brain's functions must be taken into consideration, as well as a person's prior knowledge and interest in the subject matter. Combined, the teacher is better able to recognize a person's cognitive overload point and thus better tailor their message by adjusting channel uses, pictorial or audio.

Defining Virtual Reality

The definition of virtual reality has been revised and adapted over the years to meet the needs of various researchers across various disciplines. Early, popular conceptualizations of virtual reality tend to limit the definition to the physical appearance of the technology (Steuer, 1992). Steuer (1992) summarizes several early definitions of virtual reality as ones that refer to the technological system. He notes that components of those definitions typically involved a computer used to control real-time animation, wired gloves, position trackers, and a head-mounted, stereoscopic display. Falling in line with Steuer's claim, Biocca's (1992) definition of virtual reality included the hardware systems, but it also added a software component, saying VR is the sum of both the hardware and software systems in which the technology seeks to create an all-inclusive and immersive sensory illusion of another environment. Steuer (1992) argued that definitions related to the hardware limit any studies to the hardware. Instead, Steuer said it is possible to define VR without binding it to its hardware. He suggests the key is to

view the definition in terms of the human experience rather than the technology by focusing on presence. Presence being the perception of one's surroundings as mediated by automatic and controlled mental processes, not necessarily a person's world in its true, physical existence (Steuer, 1992).

A more recent definition of virtual reality describes VR as a mediated experience that immerses users in either real or fictional environments (Owen, 2015). Furthermore, Owen (2015) explains that access to such environments is a key component to virtual reality. According to Owen (2015), the first step to that access is the creation of the environment by means of video capturing a scene in physical existence, or by imagining and creating an environment using Computer Generated Imagery (CGI). Additionally, a second step involves access to a device, typically a head-mounted display or dedicated room, which affords the user the ability to immerse themselves in the aforementioned created environment (Owen, 2015).

Interactive and Immersive Nature of VR

Even in its early stages of development, virtual reality has been defined as an interactive medium. It was referred to by one researcher as the ultimate form of interactivity between humans and machines (Krueger, 1991, p. vii). Conceptualizations of virtual reality use words like "interactive" and "immersive" as descriptions but do not go any further in explaining what those terms mean. It is important to understand both concepts in terms of limited capacity research.

Interactivity is a rather under-developed concept as researchers have differing views of the term. First, interactivity, in communication, can take place in the form of interpersonal interactions or those which are mediated. For the purposes of this study and

the nature of 360-degree video, the focus is on mediated interactivity involving information and communication technology (Bucy, 2004). Existing definitions of interactivity from several researchers suggest variability, furthermore the idea of various existing degrees of interactivity, ranging from partial to full, based on perceptual and structural approaches (Bucy, Tao, 2007). Conceptually, interactivity is a combination of individual attributes of media (user control, visual and audio components, navigability, etc.) that result in placement on a spectrum of interactivity. To understand partial interactivity, full interactivity must first be defined. Many researchers refer to Rafaeli's 1988 definition of interactivity, which suggests interchangeable roles of communication. He refers to interactivity formally as the extent of communication exchanges in which a third or later transmission which relates to previous messages. Though this definition is conceptually achievable, it is an ambitious concept since common perceptions of interactivity are much less complex. Rafaeli (1988) suggests some perceptions of interactivity are close to its definition, but do not quite meet the requirements to be truly interactive. Some misconceptions of interactivity, according to Rafaeli (1988), include human-like machines, social presence, quick responses, bandwidth, user control and activity, feedback, and artificial intelligence. Regarding mediated interactivity, he argues some would perceive responding to newspapers through letters to the editor, calling into radio talk shows, and emailing news anchors as being interactive, but are not truly. Virtual reality, specifically 360-degree videos, would most likely fall under Rafaeli's list of interactive characteristics. However, because these interactions are not guaranteed to be generative of recursive responses, they are not fully interactive. Just because these stated interactions with media do not necessarily meet Rafaeli's (1988) definition of full

interactivity, it does not mean they should be dismissed. Bucy (2004) would argue that trying to reach an exact definition of interactivity takes away from the goal of advancing research. He attempts to instead look at interactivity on a broader level, trying to locate where it exists and observe its media effects. Interactivity exists in user perception as a subjective experience, in communication setting through the exchange of messages, and in technology through interface actions (Bucy, 2004). He states that although user perceptions of interactivity do not necessarily match researcher definitions, it would be foolish to dismiss their validity. When Rafaeli (1988) says the perceived level of interactivity reached through responding to news media are is not truly interactive, Bucy (2004) argues there is some significance in such misconceptions that should not be dismissed without further thought. Para-social perceptions of interactions through a specified medium play roles in interactivity (Bucy & Newhagen, 1999). Bucy and Newhagen's (1999) study found that close-up shots of on-screen characters achieve higher levels of perceived interactivity as opposed to wider shots (Bucy, Tao, 2007). In his 2003 research, William Eveland seemingly argues different forms of media are cause for various levels of perceived interactivity, both intentionally by their designers and perceptually by their consumers. Additionally, some types of media naturally contain more characteristics of interactivity. For example, the internet as a medium is more affording to characteristics of interactivity compared with other media (Eveland, 2003).

Using Eveland's description of interactivity, virtual reality is on the higher-end of the spectrum of interactivity because it puts users in the virtual environment. Users have the control to look around the environment and choose where they want to focus their attention. Additional elements added to 360-degree video such as graphics, voice over,

text, and audio can increase the user's perception of the interactive experience. Just as Bucy suggests interactivity to be comprised of variables, which is concurred in this study and suggested that immersion could be viewed as one of those components.

Immersive has been a term to describe virtual reality by researchers for decades (Biocca, 1992; Owen, 2015). It's generally agreed that immersion has to do with an individually perceptive feeling that a person has exited their physical environment and has mentally entered the virtual world of their stimuli (Biocca, 1992; Owen, 2015). Similar to interactivity, Biocca (1992) indicates that immersion is also on a spectrum in which the more the perceptual system causes the user to block out stimuli from the physical world, the more immersive the degree of the experience.

Improved technology, such as stereoscopic 360-degree cameras, give the user a better feeling of presence when viewing 360-degree videos because of the greater depth perception. Additionally, better resolution spatially and temporally gives the user a greater sense of presence (Owen, 2015).

Owen (2015) views virtual reality very much in line with the conceptualizations of interactivity and immersion. He says VR affords viewers an increased sense of user control as far as what they choose to pay attention to in any scene.

Connecting the Dots

Interactivity, virtual reality, and limited capacity theory may seem like individual concepts, but this study proposes they are very much related and, when viewed together and not separately, strengthen the potential predict the message recall outcomes in 360-degree videos used by journalists.

First, 360-degree videos can be classified as interactive and immersive (Owen,

2015; Biocca, 1992). Over the years, one could argue virtual reality has become more interactive due to improvements in hardware and software. VR is now advanced enough in its computational power, resolution, and load rate that it can be displayed through smaller devices than ever before, such as the Oculus Rift used by Facebook (Owen, 2015, Bucy, 2004; McMillan & Hwang, 2002). While viewing a 360-degree video through a VR headset or on a mobile device or computer, the user has the ability to look around and make choices of what they would like to see. The more control a user has over the medium, the more likely they are to perceive it as interactive (McMillan & Hwang, 2002).

In the context of serious games, such as simulators and training devices similar to virtual reality, Raybourn (2007) refers to the achievement of interactivity as being credible, engaging, and adaptable. Users perceive interactivity in a virtually reality setting when it is believable and realistic. When they are engaged or immersed in the game, their level of interactivity increases. Lastly, if the game changes based off the user's decisions, it also increases its degree of interactivity. It could also be interpreted as the choices afforded to users.

Ha and James (1999) view interactivity as having five dimensions: playfulness, choice, connectedness, information collection, and reciprocal communication. Playfulness refers to the user experience and entertainment value of the medium (Ha, James, 1999). With an increased level of entertainment, it can be predicted that the level of engagement also increases, resulting in a higher level of interactivity. Connectedness, in the case of webpages, refers to the feeling a user has that tabs, links, and images can influence the user's perception of connectedness to the outside world (Ha, James, 1999).

Simply stated, the webpage allows for the user to imagine themselves wherever the content is intended to take them. Applying this dimension of connectedness to Raybourn's serious gaming, connectedness adds to a level of credibility or believability, allowing the user to enter a deeper layer of virtual reality. This sense of connectedness is even more so increased with 360-degree video because instead of clicking tabs to open portals of information, users can look around with their eyes to seek the information they desire and experience the virtual environment.

Liu and Shrum (2009) developed a dual-process model of interactivity. In their research, the duo proposed a model to measure interactivity based on involvement, low and high. In terms of a website, their model suggests that when a high level of user control sparks a high level of user engagement, the consumer is more likely to be afforded a personalized browsing experience, which is cause for a high level of interactivity (Liu, Shrum, 2009). On the other hand, such high levels of cognitive stimulation may prove to be challenging to the user, possibly resulting in frustration and distraction from that website intended to be interactive. In terms of low interaction, if a website is not characterized as interactive, the consumer cognitively will not have the motivation to complete the task intended compared to a highly interactive website, in other words, the consumer is not engaged enough (Liu, Shrum, 2009). However, low interaction and simple design may also produce a higher level of enjoyment. Even though these conclusions were based around websites, the principles can be applied to 360-degree videos. A 360-degree video viewed through a headset will give the user more control and a stronger feeling of presence, therefore making the experience more interactive.

Thus, the user will be more motivated to complete the task, which in news, is gaining information.

This concept is very similar to Bucy's (2004) curvilinear model of interactivity, which suggests a curved measurement of levels of interactivity. For the best results, a moderate level of intensity is ideal. A level too low, both personally and socially, could result in conflict and social discord. When levels are too high, it can lead to frustration, withdrawal, information overload, and irritation (Bucy, 2004). A balance of the previously suggested attributes of interactivity is needed in order to create the best resulting user experience. The medium cannot be overly-interactive, because it can cause overstimulation, causing the brain to shut down. Similarly, if it lacks interactivity, the brain's level of engagement will drop, resulting in a negatively perceived user experience with interactivity.

Controlling the level of interactivity in a video and designing for the device is key to message recall (Lang, 2006). If the device and 360-degree video are on the higher end of the interactivity spectrum and the user is more involved in the story, the message has the ability to be more complex (Lowrey, 2006).

In addition to understanding the nature of interactivity, producers of 360-degree video can use previous limited capacity studies to learn more about message processing and recall in a virtual reality setting despite the lack of current available studies. Based on Bucy's curvilinear model and the presumed interactive nature of a 360-degree video, this study hypothesizes the more immersed a person becomes in the video, the lower their ability to recall the video's message. Additionally, the more a person finds the interactive elements of the video to be a distraction, the less they will remember about the message.

Given the combination of literature regarding interactivity, limited capacity theory, and virtual reality, this proposed study seeks to answer the following research objectives:

RQ1: How does the addition of voiceover narration and textual narration channels to a 360-degree video influence a person's message recall ability?

RQ2: How does the level of redundancy between channels influence a person's recall ability?

RQ3: If a viewer perceives edits in a 360-degree video to be distracting, will that influence their recall ability?

RQ4: Does a person's level of immersion in a 360-degree video influence their message recall ability?

Method

Design

In order to find answers to these research questions, an experiment was designed using 360-degree video from a recycling facility presented in the way a standard news package runs on television news programs. Throughout the video, a reporter takes viewers through the facility, explaining how the equipment works and the environmental and cost effects it has on the local community.

In order to choose a topic that was not too familiar to the potential participant pool and to ensure the content was interesting enough to hold their attention, a pre-test was conducted using a small sample of ten participants.

The video was edited for three conditions, each gradually designed to be more interactive than the last. They are as follows:

1. Voiceover- The narrative is told by the video using voiceover similar to what can be found in a television news story. The audio information matches the video being shown.
2. Voiceover plus text- In this condition, the same video and voiceover are used as in the first condition, but an additional textual element is added to reinforce the voiceover narration. The text can be considered redundant, though it is not a complete transcription of the entire story. While the textual information is not as common in television news, it is ever-popular with internet news, especially on social media platforms.
3. Voiceover plus supplemental text- This third condition is intended to be the most interactive of the three because while it is similar to the second condition

with voiceover and text, the information in text does not match the voiceover. Instead, it introduces additional information to the voiceover narrative, challenging the viewer to process even more information than in the previous conditions.

The supplemental information used in the third condition was determined by results from the pretest which gauged a person's interest level in the supplemental topic compared to their interest level in the narrative topic. The topic that yielded the closest interest results to the narrative topic was then used.

Dependent Measures

Memory in the form of message recall and recognition was one of the measures in this study. Memory was split into two categories: scenic and narrative. Scenic recognition refers to message recognition involving the raw video, or without any of the edits/manipulations. For example, remembering details about the video scene such as the color of recycling equipment in the foreground. Scenic recognition was measured using a recognition questionnaire comprised of true and false questions. Narrative recall refers to the information a participant remembers from the story accompanying the video. This could be from both the text and the voiceover manipulations. Participants were given 30 seconds to complete the scenic recognition questionnaire and 60 seconds to complete the aided recall questionnaire (Srivastava, 2010). The reason for time limits was to control how long a person could spend thinking about questions, creating equality in memory.

Distraction was also measured as a manipulation check to see how participants in each condition perceived the edits. It was measured with a questionnaire following the video and memory questionnaires, and it asked participants about their perceptions of the

voiceover and text manipulations as distractions from the video. This same questionnaire inversely measured immersion by giving insight on how the participants watched the video- for the purpose of the environment or the story.

Participants

A total of 93 participants, 20 males and 73 females, were recruited from a mid-size, Midwestern university. The average age was 21 years old. The students were given extra credit for their participation, and those who chose not to participate were offered an alternative opportunity to earn extra credit. To make the convenience sample more generalizable, the participants were randomly assigned to experimental conditions.

Procedure

Participants were randomly assigned into groups for one of three conditions: 360-degree video with voiceover, 360-degree video with voiceover and redundant text and 360-degree video with voiceover and supplemental text. The experimental session was held in a room with five desktop computers and headphones, separated by wallboards for increased privacy. All participants viewed the video on a smartphone followed by a questionnaire at the computer station where they were assigned to sit. Before beginning the experiment, participants were given an example 360-degree video to watch and verbal instructions how to activate the 360-degree viewing function in order to ensure they knew how to view a 360-degree video. A video without text, voiceover or any story narrative was selected in order to avoid any priming effect.

Results

ANOVA comparing recognition scores and aided recall scores between groups

Addressing the first research question which seeks to answer whether or not a viewer's message recall ability is influenced by the number of edits in a 360-degree video, it was necessary to analyze between group variances.

In order to see how aided recall scores and recognition scores varied between groups, analysis of variance (ANOVA) was run. The difference between groups in the aided recall score category can be classified as statistically significant as determined by one-way ANOVA [$F(2,90) = 6.718$, $p = .002$]

Furthermore, after running a Bonferroni post hoc test for comparison of means across groups, it became apparent that the mean for the third condition (voiceover plus supplemental text) was significantly higher than the means for the first condition (voiceover) and second condition (voiceover plus redundant text) (See table 1). This means that participants who were assigned to the third condition performed significantly better in the aided recall category.

What can be concluded from this test is that a person's message recall ability is influenced by the number of edits in the video. In this study specifically, edits were the addition of voiceover and textual narration. Those additional edits resulted in a higher recall ability. That result was what the researcher predicted, but not to this extent. The researcher presumed a limit to the number of edits exists before a person's recall ability is negatively impacted. This test showed that there was no difference between recall ability when moderate edits were made, but there was at the most interactively designed condition in the experiment. When these results are examined through the lens of

redundancy, the findings become surprising because previous research by Annie Lang (1995) suggests that the less redundant messages channels are, the more complex the message becomes due to a higher demand of resources for processing. In this study, the third condition was the least redundant because the voiceover did not match the supplemental text. Using redundancy research applied to LC4MP alone, these results did yield the predictable outcome of a lower recall score for the third condition.

Table 1

Oneway ANOVA with ----as Independent and -------as the dependent variable

	Sum of squares	df	Mean square	F	Sig.
Recognition Score	.695	2	.348	.506	.604
	61.778	90	.686		
	62.473	92			
Aided Recall Score	69.016	2	34.508	6.718	.002
	462.295	90	5.137		
	531.312	92			

Table 2

Multiple Comparisons- Bonferroni

Dependent Variable	(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	95 % Confidence Interval	
						Lower Bound	Upper Bound
Recognition Score	VO	Text	-.119	.204	1.000	-.62	.38
		Supplemental	-.216	.217	.960	-.74	.31
	Text	VO	.119	.204	1.000	-.38	.62
		Supplemental	-.097	.214	1.000	-.62	.42
	Supplemental	VO	.216	.217	.960	-.31	.74
		Text	.097	.214	1.000	-.42	.62
Aided Recall Score	VO	Text	-.099	.558	1.000	-1.46	1.26
		Supplemental	-1.947*	.592	.004	-3.39	-.50
	Text	VO	.099	.558	1.000	-1.26	1.46
		Supplemental	-1.847*	.584	.006	-3.27	-.42
	Supplemental	VO	1.947*	.592	.004	.50	3.39
		Text	1.847*	.584	.006	.42	3.27

* The mean difference is significant at the .05 level

Correlation Comparing Distraction to Aided Recall Score

The second and third research questions in this study are essentially two sides to the same coin. One seeks to answer whether a person's level of immersion in 360-degree video can influence their message recall ability, and the other examines how a person's perceived level of distraction can influence their recall ability.

Those questions were measured through manipulation check questions during the questionnaire portion of the experiment. Participants were asked on a scale of 1-7 how

distracting they found each element (text, voiceover, and video) to be as they viewed the 360-degree video. From there, a scale was made to compare the participant's overall level of perceived distraction to their aided recall and recognition scores. In the aided recall category, significance was found at the .05 level, where r=.205, n=92, and p=.049. No significance was found in the recognition category (See Tables 3 and 4).

Table 3

Correlation coefficients between aided recall scores and perceived distraction

		Distraction Scale	Aided Recall Score
Distraction Scale	Pearson	1	.205*
	N	92	92
Aided Recall Score	Pearson	.205*	1
	N	92	93

* Correlation is significant at the 0.05 level (2-tailed)

Table 4

Correlation coefficients between recognition scores and perceived distraction

		Distraction Scale	Recognition Score
Distraction Scale	Pearson Correlation	1	.090
	N	92	92
Recognition Score	Pearson Correlation	.090 .393	1
	N	92	93

* Correlation is significant at the 0.05 level (2-tailed)

One-way ANOVA Comparing Distraction Scale between Conditions

Further exploring a person's perceived level of distraction when watching the 360-degree video, a one-way ANOVA was performed to compare the distraction level between conditions (See Table 5). The results indicate that significance exists between two of the three conditions [$F(2,89) = 7.330$, $p = .001$].

Furthermore, a Bonferroni post hoc test showed that the significance lies between the first condition of voiceover and third of voiceover and non-redundant supplemental text in terms of perceived distraction levels (See Table 6). The condition with voiceover

and non-redundant supplemental text yielded the higher mean average. According to the post hoc test, significance lies at the .05 level, suggesting that participants in the third condition with voiceover and text with supplemental information that did not match the information in the verbal story said tended to say they were more distracted than the participants in the first condition with only voiceover and no text.

Table 5

ANOVA with the condition as the independent and distraction as the dependent variable

	Sum of squares	df	Mean square	F	Sig.
Between Groups	376.014	2	188.007	7.330	.001
Within Groups	2282.899	89	25.651		
Total	2658.913	91			

Table 6

Multiple comparisons- Bonferroni

(I) Researcher Data Entry	(J) Researcher Data Entry	Mean Difference (I-J)	Std. Error	Sig.	95 % Confidence Interval	
					Lower Bound	Upper Bound
VO	Text	-2.34659	1.25653	.195	-5.4126	.7194
	Supplemental	-5.06713*	1.32348	.001	-8.2965	-1.8377
Text	VO	2.34659	1.25653	.195	-.7194	5.4126
	Supplemental	-2.72054	1.31427	.124	-5.9275	.4864
Supplemental	VO	5.06713*	1.32348	.001	1.8377	8.2965
	Text	2.72054	1.31427	.124	-.4864	5.9275

* The mean difference is significant at the .05 level

Discussion

This study sought to explore message recall and recognition ability after viewing 360-degree news videos using a limited capacity for mediate message processing, interactivity and audio-visual redundancy approach. The following research questions served as the main objectives of the study:

RQ1: How does the addition of voiceover narration and textual narration channels to a 360-degree video influence a person's message recall ability?

RQ2: How does the level of redundancy between channels influence a person's recall ability?

RQ3: If a viewer perceives edits in a 360-degree video to be distracting, will that influence their recall ability?

RQ4: Does a person's level of immersion in a 360-degree video influence their message recall ability?

The results of this study indicated that recall ability is strongest when the interactive medium, 360-degree video, utilizes non-redundant features to deliver a narrative, but further research is necessary to address some still unanswered questions.

Based on previous literature regarding the spectrum of interactivity, the results involving distraction are in line with the findings of past studies. Literature suggests that the more information that is added to a video, the more distracted the viewers would find themselves while watching the 360-degree video. The condition designed to have the most overwhelming interactive features, voiceover and supplemental, non-redundant text, was likely to be the most distracting category, so the results showing participants in that

condition were significantly more distracted than the first condition designed to secure the least amount of resources for cognitive processing were right on target.

What did not fall in line with previous research were the aided recall score results between conditions. If the experiment were designed correctly using the spectrum of interactivity, the first condition would have been the lowest level of interactivity, the second condition would have been the ideal level of interactivity, and the third condition would have been the highest level of interactivity. The expected results would have shown the second condition yielding better recall and recognition scores than the first and third conditions. However, in this study, the third condition resulted in significantly higher aided recall scores compared to both the first and second conditions.

One explanation for those results is that a flaw existed in the experimental design. In this case, it is likely that there was not enough variation among conditions to truly create a difference in interactivity levels between conditions.

However, when reviewing the distraction scores, it was apparent that is not actually the case. Distraction levels can reversely be viewed as perceived levels of interactivity. In that case, the participants in the third condition, the one designed to be most interactive, found their video to be the most interactive of the three conditions. Through informal interactions with the participants following their experimental sessions, many participants expressed frustration with their predicted performance, attributing it to being overwhelmed by information, regardless of assigned condition. From the perspective of the limited capacity theory for mediated message processing, one explanation of these results is that viewers were more motivated to learn the information presented in the 360-degree video when the information was presented in different ways,

meaning with voiceover and supplemental text. Because the viewer was more entertained and thus, motivated to take in the information, the supply of available resources in the brain increased, thus amplifying the ability to process and recall the messages.

Alternatively, the viewer may have felt challenged and needed to focus more with the non-redundant text in anticipation of evaluation, which also causes the viewer to be more motivated.

Yet, what is most puzzling is that the third condition group, who viewed the most complicated version of the 360-degree video, yielded the best results despite what the concept of redundancy applied to LC4MP would predict. As previously mentioned, past research would suggest participants in the third condition should have performed poorly in recall ability due to the least redundant message channels in their video and the higher demand of resources to process those conflicting messages. However, the third condition group ultimately performed the highest in recall ability, suggesting the possibility that the level of perceived interactivity in the third condition had a stronger influence on better recall ability than the low level of channel redundancy had on a lesser recall ability.

Using redundancy studies to understand this result, it is also possible to assume the textual element may not have had a strong effect on viewers. Ritzhaupt and Pastore (2015) determined captions do not have much influence on learning ability. However, it is not possible to directly apply that finding to the finding of this study because Ritzhaupt and Pastore only examined redundant captions, not supplemental as used in the third condition of this study. Additionally, this particular study contradicts previous redundancy studies which determined a positive correlation with redundancy levels and recall ability, regardless of channels.

Since the outcomes of this study did not affirm previous findings regarding audio-visual redundancy and message retention in television, it could be concluded that 360-degree video should not be treated the same way as broadcast video.

If that is the case, future studies should take a different approach when examining virtual reality. VR and 360-degree video may lie closer in relation to video game and online media studies than to broadcast television.

This interpretation could also suggest there is a generational change to consider. As younger generations begin to adopt new technology and obtain information in innovative ways, their video consumption habits should also by analyzed.

According to a 2018 Pew Research study, the younger generation is most inclined to consume news video online, saying nine out of ten adults between the ages of 18 and 29 watch online videos and nearly half of which are news related. Those ages 30-49 also consume the same amount of news videos, but there is a significant difference when compared to older demographics. The study found that 27% of 50-64 year-olds consume online news videos, while just 11% in the 65 and older category watch news videos online (Olmstead, et al., 2018). Had this study been applied to an older generation, it is predicted that performance results would be even lower due to the unfamiliarity with the platform.

It can be assumed through LC4MP framework that those who are more familiar with 360-degree video would out-perform those who are less familiar since it requires fewer resources to obtain the information presented.

Therefore, distracting features of 360-degree video should also be isolated in future studies to determine how familiarity with the medium influences distractibility

levels. Additionally, the impact of distractibility on memory and motivation in situations where performance matters should also be examined. For example, 360-degree video used in an educational setting where students are graded based on what they learn from the video, students may be more motivated to retain the information compared to an entertainment environment.

Other possible limitations in this study include the lack of research available on 360-degree video in any context, not just news. The technology is so new that it has not been widely adopted, making it difficult for researchers to gain access to data from the field. A more professionally polished video that better encompasses what might be produced for a company such as USA Today or The New York Times might reflect more accurate results for the news industry. Additionally, a good starting point for this study would have been a comparison of recall ability between the same news video presented in 360-degree format and traditional, two-dimensional video. Had such research existed before the completion of this study, then some of the questions regarding recall ability and channel complexity could have been more easily explained.

One last limitation that must be considered is the age of the participants involved in this study. As Annie Lang in her 2015 study on age and pacing notes, age is a factor in learning ability, which indicates the results of this study may be different when older viewers outside of the 18-30 age range are introduced. It is something to be considered when producing content for different audiences.

As virtual reality technology becomes more available in the professional and consumer markets, the emergence of 360-degree videos has become apparent in many newsrooms. Included in the group of newsroom VR pioneers are The New York Times,

Associated Press, The Huffington Post, Vice News, CNN and BBC (Owen, 2016). Some are creating entire departments for the technology ("CNNVR Puts Story First," 2016).

The new trend in journalism has much to do with the push for 360-degree video on Facebook from the social media platform's creator, Mark Zuckerberg (Owen, 2015). Facebook has made it possible for news organizations to test the waters in 360-degree video, and many have taken advantage of that opportunity. With nearly 20 million views, the New York Times video of a blizzard in Times Square is one of the many news stories being told in 360-degrees (Lee, 2016). Even more recently, USA Today took the lead in the VR race, broadcasting Donald Trump's presidential inauguration by livestreaming a multi-camera production in 360-degrees. USA Today was the first to try any such production. And while the company views it as a success, there were still some risks taken by trying such a new and untested approach during an event of such scope. Major investments in the technology from some of technology's biggest firms says otherwise. Facebook was an early frontrunner in VR support. YouTube now has its own 360-degree channel Twitter now supports VR, too. All of the mentioned social media platforms have great potential for news producers to distribute their 360-degree videos. Those websites are user-generated and do not cost producers to share their content. They also allow for widespread sharing. Research has found that using social media websites like Twitter can lead to an increase in readership (Hong, 2012). That known, producers could reach more people and increase their viewership by posting 360-degree videos to social media websites.

Originally, video games were expected to take off in the world of virtual reality, but Samsung producers actually found 360-degree video to be the one consumers demanded the most (Baumgartner, 2016).

Baumgartner suggests that because video was proven to be an early driver of Samsung's Oculus-powered Gear VR, then it might be the solution to making virtual reality a mainstream market. Samsung ran a promotion to introduce customers to its virtual reality efforts by giving away free Gear VR headsets to those who pre-ordered Galaxy S7 and S7 Edge smartphones (Baumgartner, 2016).

The New York Times and Google ran a similar promotion by giving away Google Cardboard devices (Fisher, 2016). It is reported that Google had distributed 2 million google cardboard devices by 2016. Half of those were given away for free to subscribers of The New York Times.

In addition to the investments made to ensure viewers have the capability to view 360-degree video in the form it was intended to be seen, producers of the videos spend a significant amount of money just to create the video. According to a Forbes.com article, the cost for USA Today to produce one video in its series "VRtually There" is around $500,000 (Fink, 2017). With such a costly investment so early on in the adoption stages of VR, it is important that the videos produced must be carefully planned and intentional. 360-degree videos at such a high level of production must be reserved for special occasions, such as USA Today's coverage of the presidential inauguration. In order to make the viewing experience memorable for viewers, the results of the study could benefit producers as they decide which visual and audio elements to add to the video. As concluded, such productions would benefit from the addition of non-redundant,

supplemental text to increase recall and recognition ability. Additionally, local news can implement this information as they begin to explore 360-degree storytelling as a way to gain new audiences. The same applies outside of the news industry, too. As mentioned in the introduction, fields such as archeology, architecture, construction, computer sciences, communication sciences, engineering, entertainment, health sciences, psychology, and social sciences, are just some of the industries utilizing VR to educate (Biocca, 1992, Claudio, 2014, Knabb 2014, Heydarian 2015). In order to get the message across to their audiences, producers of 360-degree video in these mentioned fields would also benefit from this findings of this study since such little research about the effectiveness of VR is available.

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Appendix

360-Degree News Study

Start of Block: Condition

Data Researcher Data Entry

_____

End of Block: Condition

Start of Block: Default Question Block

Instructions **Welcome to the questionnaire portion of the study. Now that you have viewed the 360-degree video, you will now be asked to answer some questions regarding your experience. This portion of the study should take between 10-20 minutes to complete. You may now begin.**

End of Block: Default Question Block

Start of Block: Block 1

Instructions Now you're going to see a series of true or false statement. Please choose your answers to your best memory. You have 8 seconds to complete each question.

End of Block: Block 1

Start of Block: Block 2

Q1 The reporter was a woman.

- ❍ True (1)
- ❍ False (2)

Q2 The reporter was speaking from inside a garbage truck.

- ❍ True (1)
- ❍ False (2)

Q3 The outdoor shots were filmed on a rainy day.

- ❍ True (1)
- ❍ False (2)

Q4 The machinery was green and yellow.

- ❍ True (1)
- ❍ False (2)

Q5 The people in the shots were wearing business suits.

- ❍ True (1)
- ❍ False (2)

Q6 A front loader pushed recyclables into a bunker in the warehouse floor.

- ❍ True (1)
- ❍ False (2)

Q7 There was a pile of tires in the back of the warehouse.

- ❍ True (1)
- ❍ False (2)

Q8 There was a pile of old bicycles in the back of the warehouse.

- ❍ True (1)
- ❍ False (2)

Instructions Now you're going to see a series of fill-in-the-blank questions. Please choose your answers to your best memory. You have 2 minutes and 40 seconds to complete this section. Do not worry about grammar or spelling.

Q9 The county recently introduced a new, _____ stream recycling program.

Q10 The county features a total of _____ recycling collection sites.

Q11 The new recycling program was introduced in _____ County.

Q12 Materials are hauled away _____ time(s) per week to the county's transfer station.

Q13 Materials are transported and sorted at the _____(city) recycling and disposable site.

Q14 Both residents and county officials are giving the new program positive/negative reviews.

Q15 The county is spending _____(fraction) as much money on waste management with the new program.

Q16 It costs less/more money to haul away a ton of recycling compared to a ton of trash.

Q17 The new system allows for _____ to separate recyclables instead of workers.

Q18 Cardboard, _____ containers, and laundry detergent containers are collected separately.

Q19 The state of _____ offered grants to encourage recycling to three of its counties.

Q20 The county featured in this story decided to go high-_____ with its grant money.

Q21 Other recipients used the money to hire more labor to _____ recyclables.

Q22 _____ -like machines replace most manual labor positions to make the process quicker.

Q23 The county's high school _____ students helped design the new machinery.

Q24 The technology was inspired by a similar program introduced in _____.

Q25 A combination of magnets, high pressure air _____ and optical sorters separate items.

Q26 The machinery cuts the average time spent sorting materials by _____ hours per week.

Q27 Those whose _____ jobs were eliminated now work at other capacities.

Q28 After shifting positions, the county can now focus on cleaning its _____.

Q29 **Choose an answer for the following statements:** As I watched this video...

	Strongly Disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I found myself following the text. (1)	❍	❍	❍	❍	❍	❍	❍
I focused on the narration. (2)	❍	❍	❍	❍	❍	❍	❍
I focused on the machinery. (3)	❍	❍	❍	❍	❍	❍	❍
I looked around to see the whole environment. (4)	❍	❍	❍	❍	❍	❍	❍
I found the text to be distracting from the narration. (5)	❍	❍	❍	❍	❍	❍	❍
I found the narration to be distracting from the text. (6)	❍	❍	❍	❍	❍	❍	❍
I found the text to be distracting from the video. (7)	❍	❍	❍	❍	❍	❍	❍
I found the narration to be distracting from the video. (8)	❍	❍	❍	❍	❍	❍	❍

Instructions **You will now be asked to describe yourself in a series of questions…**

Q30 What is your age?

Q31 What is your gender?

- ❍ Male (1)
- ❍ Female (2)
- ❍ Neither/Prefer not to answer (3)

Instructions **For the following questions, please select the answer that best reflects your personal media consumption habits.**

Q32 Was today your first experience viewing 360-degree video?

- ❍ Yes (1)
- ❍ No (2)

Q33 How familiar are you with 360-degree video and virtual reality?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
Not at all familiar	❍	❍	❍	❍	❍	❍	❍	Very familiar

Q34 **Thinking about news (by news we mean information about events and issues that involve more than just your friends and family), how often do you get news...**

	Never (1)	Sometimes (2)	Neutral (3)	Somewhat Often (4)	Very Often (5)
On a desktop or laptop computer (1)	❍	❍	❍	❍	❍
On a mobile device (such as a smartphone or tablet) (2)	❍	❍	❍	❍	❍
Through a virtual reality headset (such as Oculus Rift, Google Cardboard, or Samsung Gear) (3)	❍	❍	❍	❍	❍

Q35 **How often do you...**

	Never (1)	Sometimes (2)	Neutral (3)	Somewhat Often (4)	Very Often (5)
Read any newspapers in print? (1)	❍	❍	❍	❍	❍
Listen to news on the radio? (2)	❍	❍	❍	❍	❍
Watch local television news? (3)	❍	❍	❍	❍	❍
Watch national evening network television news (such as ABC World News, CBS Evening News, or NBC Nightly News)? (4)	❍	❍	❍	❍	❍
Watch cable television news (such as CNN, The Fox News cable channel, or MSNBC)? (5)	❍	❍	❍	❍	❍
Get news from a social networking site (such as Facebook or Twitter)? (6)	❍	❍	❍	❍	❍
Get news from a website or app? (7)	❍	❍	❍	❍	❍

Q38 **Which of these describes you when it comes to technology?**

- ❍ Usually try new products before others do (1)
- ❍ Prefer my tried and trusted brands (2)
- ❍ Like being able to tell others about new brands and products I have tried (3)
- ❍ Like the variety of trying new products (4)
- ❍ Feel more comfortable using familiar brands and products (5)
- ❍ Wait until I hear others' experiences before I try new products (6)

End You have completed the study. Please see the researcher before leaving the lab. Thank you for your participation!

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