360º Videos of Natural Scenery Delivered Via Virtual Reality Devices and its Effect on Mood

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ABSTRACT

Nature has long been touted as a method to alleviate the symptoms of stressful modern life and introduce some aesthetic novelty. For those individuals for whom access to nature is in some way limited, especially older adults facing poor physical or mental health, novel approaches to bring the outside world in are necessary to help enhance quality of life. This pilot study endeavors to help improve the mood of a sample of 43 older adults by testing a new intervention – using smart phones to deliver 360-degree videos of nature. Results of the study provide evidence that the intervention may improve older adults' mood, and that age may have a moderating effect on that relationship. Though the study suffers from significant limitations related to sample size and technological problems, this is an important first step to a program of research that has exciting possibilities as a highly portable and customizable treatment.

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CHAPTER ONE
INTRODUCTION AND GENERAL INFORMATION

Under normal circumstances, the average person experiences a variety of sights and sounds as they navigate through daily life. Physical environments change, from the comforts of home, to the interior of chosen transport, to the settings in which we work. Weather patterns change, we meet and interact with different people, and we listen to different music. Each day brings something new; new problems to solve, new memories to make. These variations in daily life help us retrospectively differentiate one day from another and develop a sense of forward purpose, built on past experiences.

The human brain thrives on novelty, in fact. It's why we might perk up when hearing someone speaking with an unexpected accent, or why we like to try new foods. It's why we pause to watch the sun rise and set, why we hike different trails, and why we long for vacations to the beach or to the mountains, or even to major cities. We feel compelled to see new things and to have new experiences. Underneath it all, what we really want is to put our brains to work. More specifically, we are looking for activation of the dopamine pathways (hippocampus, amygdala, nucleus accumbens, among others), which occurs for many reasons, including during novel experiences (Düzel et al., 2010; Murty et al., 2017; O'Carroll et al., 2006; Schomaker & Meeter, 2015).

The English language has a couple of phrases for what tends to happen when we are kept within confined spaces for periods of time, such as during a blizzard, or when writing a dissertation. We can go *stir* crazy or get *cabin fever* – both terms are related to restlessness and irritability due in large part due to lack of variety and an overwhelming

sense of confinement. As soon as is possible, we free ourselves from those experiences, and we head outdoors to feel the sun shining on our faces, to see the bright blue sky, and to hear the birds chirping away.

Nature has been touted as a get-away – a method to alleviate the symptoms of stressful modern life and introduce some aesthetic novelty – for an untold number of years, and certainly long before the age we now consider to be "modern." Glacken (1967) wrote about ancient Romans escaping the crowded cities for time away in nature as a stress-reducing mechanism. Forest-bathing, or *shinrin-yoku,* is a traditional Japanese practice consisting of immersion in a forest and using all sensory modalities to experience the environment – it is considered a type of meditation as well as an art (Miyazaki, 2018; Park et al., 2010). Fast-forwarding to the 19th Century, Frederick Law Olmsted, co-developer of New York's Central Park, echoed the sentiments of ancient Romans in an 1865 report about the Yosemite Valley, the area to later become America's most popular national park (Olmstead, 1952). Similarly, Sir Ebenezer Howard, best-known as the founder of the English garden city movement, recognized the negative effects of increased disconnection from nature. In 1898, he published *To-Morrow: A Peaceful Path to Real Reform,* in which a city is described that is built upon a balance of nature and modernity. His approach was in part informed by a belief that reconnecting with nature improved overall health, and that various social problems of big city life contributed to ill health. In post-war Britain, some of the new towns constructed were based on Howard's principles of harmony with nature. Greenspace has been a topic of some concern in the United States more recently, with an increase in presence boasted by

cities from coast to coast, although access to said spaces generally tends to increase inequitably for those with higher SES (Nesbitt et al., 2019).

Lack of access – or at least, reduced access – to greenspace is one aspect of a greater problem of connectivity with the outdoors. Another, certainly more pressing, factor is the current climate crisis, which is producing an increasing number of natural disasters and raising temperatures around the world (Salas et al., 2020; Walsh et al., 2016). The present COVID-19 pandemic has more people around the world staying close to home, if not completely isolating at home, than in recent human history. The negative mental health aspects of staying home due to COVID-19 are currently being studied, and early indications from the literature don't paint a necessarily positive outlook (Russell et al., 2020). A connection exists between exposure to nature and mood, with findings tending towards the positive – nature improves feelings of well-being, decreases anxiety, and improves overall mood (Beil & Hanes, 2013; Frumkin, 2001; Grinde & Grindal Patil, 2009). Access to nature for older adults has been affected by the COVID-19 pandemic with many people choosing to stay at home, possibly compounding poor outcomes, such as depressive symptoms, already present and that are related to aging-related dysfunction and limitation (ambulation, in particular). Technology, particularly virtual reality and 360º video, can act as something of a stopgap for those temporarily limited in access to nature, and as a substitute for those who are unable to experience the real thing.

360° video

Virtual reality (VR) technology can safely deliver novel experiences of the outside world to people the world over; all one needs is a connection to the internet and a

display capable of handling VR/360º videos. VR has been a persistent presence for decades but has never before reached the level of popularity it currently enjoys. Most recently, VR systems such as the Oculus Rift and HTC Vive have made the VR experience more immersive than ever before. As smaller and more powerful computing technologies flourished in the 21st Century, these advancements have made possible the development of portable virtual reality systems. These modern systems are not dependent on connections to a computer. The first of such unattached VR systems were headsets modelled to accept smartphones, but the quality of the mobile phone and data transmission speeds can have an effect on streaming VR experiences. Recently, standalone virtual headsets were released (Lenovo Mirage and others), completely changing the accessibility landscape – highly portable, self-contained, and easy to use.

Achieving a sense of presence (the sense of "being there") is dependent on the realism of a virtual environment. Everything within the must be to scale, or close enough to it so as to lend acceptability to the overall experience. Virtual reality experiences are mostly an audiovisual process at their core, although physical movement has been increasingly adopted. Human vision is a complex phenomenon that involves several areas of the brain, with the occipital lobe (the brain's visual processing center) playing a major role. The parahippocampal place area (PPA), for example, is a portion of the brain along the visual pathway that is involved in the recognition of the surrounding environment and specific places, including nature (mountains, beaches, deserts), houses (interiors and exteriors), and planned areas (cities, parks), and functions similarly in virtual environments as it does in "the real world" (Maguire et al., 1998; Köhler, Crane, &

Milner, 2002). Also heavily involved in the process of seeing is the hippocampus. The hippocampus is an important area of the brain that is involved in the creation of memories, including finding one's way around in new environments.

Novelty and the brain

The brain is a highly complex and fascinating structure and is the platform from which we perceive and interact with the world. The visual aspect of the brain is among the most interesting. What we see is, in our individual experience, *what the world is*, and our individual perceptions differ – sometimes substantially – on the basis of neurochemistry and neuroarchitecture. Visual processing allows surveilling the immediate environment for what is beneficial and what might harm, and aids in spatial orientation and wayfinding. Among other important factors, visual processing also plays a crucial role in object and environment recognition, and the detection of novelty.

Schomaker and Meeter (2015) describe five concepts related to novelty: 1) Stimulus novelty, in which the stimulus is brand-new to the observer and a representation of which is not stored in long-term memory; 2) Contextual novelty, which concerns stimuli that are previously known to the observer, but occur in an unexpected situation that seems "out of place"; 3) Deviance, which is linked to error processing and concerns detection of pattern mismatches and the like; 4) Surprise/unexpectedness, which involves the observing of stimuli in some unanticipated way, violating expectations derived from explicit predictions from experience; and 5) Spatial/environmental novelty, in which the scene as a whole is unfamiliar rather than its individual parts.

Nature

It wasn't until industrialization that modern people in developed nations began to become overwhelmingly incorporated in cities, away from less populated and greener areas. Sir Ebenezer Howard, best-known as the founder of the English garden city movement, recognized very early the negative effects of increased disconnection from nature. In 1898, he published *To-Morrow: A Peaceful Path to Real Reform,* in which a city is described that is built upon a balance of nature and modernity. His approach was in part informed by a belief that reconnecting with nature improved overall health, and that various social problems of big city life contributed to ill health. In post-war Britain, some of the new towns constructed were based on Howard's principles of harmony with nature.

Relatively recently, a selection from a collection of essays by Oliver Sacks was published in the *New York Times*, concerning the effect exposure to nature had upon his patients (2019). In the essay, Sacks describes his own feelings toward nature, and in particular botanical gardens, and the restorative effect they had on his emotional well-being. He mentions notably that while hiking with a friend in a desert, the friend's severe Tourette's symptoms had been eased, a phenomenon Sacks in part attributes to the calming effect of nature. Furthermore, the positive effect of nature on the lives of those living with other neurological conditions (including various forms of dementia), including people living in care homes, is a central piece to the article. While the evidence here is anecdotal, there are many research articles in the published literature that investigate the effects of nature in closer detail. Notable examples include Dadvand et al. (2015; 2018) who found greater total brain volume in children with continual exposure to

green spaces than those without, and Bratman et al. (2015), who found decreased rumination and prefrontal cortex activity in participants after a 90-minute walk in nature, but not after a 90-minute urban walk. Countless other studies tout the positive emotional effects on exposure to nature, but how this translates to nature exposure via virtual reality has not been particularly well-researched.

Moving forward

Virtual reality and 360-degree video have the proven potential to be a useful therapeutic tool. It has been introduced in a variety of settings and for a number of uses, including as an anxiolytic measure in dentists' offices (Tanja-Dijkstra et al., 2014), as an emotionally restorative exercise for healthy adults using 360° video of nature (Chung, Lee, & Park, 2018) and as a tool to give caregivers a first-hand perspective of the daily life of dementia sufferers (Wijma et al., 2017).

To the best of my knowledge, no studies in the social work literature are applying the immersive technology of 360-degree video to gage improvement in the mood of older adults. Therefore, a systematic literature review beyond the boundaries of social work is undertaken (Chapter II). Chapters III & IV contain methods and results of the intervention phase of this project, with Chapter III focused on outcomes related solely to mood and with Part IV analyzing the effect of age on average mood outcomes.

CHAPTER TWO

360º VIDEOS OF NATURAL SCENERY DELIVERED VIA VIRTUAL REALITY DEVICES AND ITS EFFECT ON MOOD: A SYSTEMATIC LITERATURE REVIEW

ABSTRACT

Lack of access to nature is a problem that touches on several causative areas, including an individual's own reduced physical capabilities, and can be part of an overall dampening of mood. Technology such as virtual reality and 360-degree videos are widely available for viewing, often requiring little more than an individual's smart phone. This review of the literature seeks to describe the state of the literature as it relates to the use of 360-degree videos of natural environments delivered by virtual reality technology. Specifically, the focus of this review is on the emotional outcomes as a result of spending time in virtual nature and particularly focuses on older adult participants. Ten articles in total were included, all published within the last four years: Five of the articles dealt with the restorative effects of nature and another three dealt with anxiety (two of these also focused on pain). The remaining two articles were concerned with comparisons of virtual reality depictions of nature vs. real nature. Primary findings indicate that 360-degree video is a safe and well-tolerated experience and is recommended for further study.

Nature has been touted as a method to alleviate the symptoms of stressful modern life for an untold number of years – certainly long before the age we now consider to be "modern." Glacken (1967) wrote about ancient Romans escaping the crowded cities for time away in nature as a stress-reducing mechanism. Forest-bathing, or *shinrin-yoku,* is a traditional Japanese practice of immersing oneself in a forest and using all sensory modalities to experience the environment – it is considered a type of meditation as well as an art (Miyazaki, 2018; Park et al., 2010). Fast-forwarding to the 19th Century, Frederick Law Olmsted, co-developer of New York's Central Park, echoed the sentiments of ancient Romans in an 1865 report about the Yosemite Valley, the area to later become America's most popular national park (Olmstead, 1952). Similarly, Sir Ebenezer Howard, best-known as the founder of the English garden city movement, recognized the negative effects of increased disconnection from nature. In 1898, he published *To-Morrow: A Peaceful Path to Real Reform*, in which a city is described that is built upon a balance of nature and modernity. His approach was in part informed by a belief that reconnecting with nature improved overall health, and that various social problems of big city life contributed to ill health. In post-war Britain, some of the new towns constructed were based on Howard's principles of harmony with nature. Greenspace has been a topic of some concern in the United States more recently, with an increase in presence boasted by cities from coast to coast, although access to said spaces generally tends to increase inequitably for those with higher SES (Nesbitt et al., 2019).

Lack of access – or at least, reduced access – to greenspace is one aspect of a greater problem of connectivity with the outdoors. Another, certainly more pressing,

factor is the current climate crisis, which is producing an increasing number of natural disasters and raising temperatures around the world (Salas et al., 2020; Walsh et al., 2016). The present COVID-19 pandemic has more people around the world staying close to home, if not completely isolating at home, than in recent human history. The negative mental health aspects of staying home due to COVID-19 are currently being studied, and early indications from the literature do not paint a necessarily positive outlook (Russell et al., 2020). It is well understood that the human brain thrives on novelty (Schomaker & Meeter, 2015). Lack of variety of experience leads to irritability and depressed mood (Han et al., 2018; Rosenblatt et al., 1984; Wang et al., 2014). Other findings indicate that a connection exists between exposure to nature and mood, with findings tending towards the positive – nature improves feelings of well-being, decreases anxiety, and improves overall mood (Beil & Hanes, 2013; Frumkin, 2001; Grinde & Grindal Patil, 2009). Access to nature for older adults has been affected by the COVID-19 pandemic with many people choosing to stay at home, possibly compounding poor outcomes, such as depressive symptoms, already present and that are related to aging-related dysfunction and limitation (ambulation, in particular). Virtual reality can act as something of a stopgap for those temporarily limited in access to nature, and as a substitute for those who are unable to experience the real thing.

Virtual reality

Virtual reality (VR) technology can safely deliver novel experiences of the outside world to people the world over; all one needs is a connection to the internet and a display capable of handling VR/360º videos. As discussed in the introduction, VR has

been around for decades and continues to mature in the user experience, including more immersive and more realistic graphics. Standalone headsets have eliminated the need for extra equipment (computers, connection cables) and allow for portability with decent battery longevity.

Immersive virtual reality lends itself handily to many clinical applications, and the literature has numerous examples of the versatility of the technology. For example, VR has been used as an anxiolytic for dental patients (Tanja-Dijkstra et al., 2014), as a first-person perspective of a person suffering with dementia to help family and caregivers understand and empathize (Wijma et al., 2017), as well as in conjunction with an overall wellness initiative (Platoni, 2016). VR is gaining ground in social work practice and research, too, with an entire lab at Texas State University's School of Social Work that develops and tests practice-based interventions (Beal, 2017; Texas State University, n.d.).

Immersiveness, as defined by Slater et al. (1998), is a description of a virtual reality system's functional capabilities; hardware specifications, isolation from the world around, ability to interact with the environment, and field of view are among the most critical characteristics (Dargar et al., 2015). Field of view has become an increasingly important factor in VR because it determines the amount of the visual field taken up by the virtual environment. Traquair (1949) defines the human binocular field of view as being oval-shaped, extending to 200° (horizontal) and 130° (vertical). Increasing fidelity of VR systems is related to the accuracy in which field of view within the technology encapsulates human binocular vision (Dahai et al., 2009). Immersiveness, in part,

depends on how much of the human visual field is occupied by the virtual, and as immersiveness increases, it leads to a greater sense of presence.

Slater et al. (1998) defines presence as being related to both the behavioral and/or subjective response of users to VR. The important consideration when discussing presence is how the VR user *feels* or *behaves* in the VR environment as compared to the natural world. As immersiveness increases, the chance of VR users achieving a sense of presence – or "being there" – also increases as a function of the brain's processing of the virtual world vs. the default natural world (Slater er al., 1998).

Much of the literature concerning virtual reality has dealt with computer-generated graphics; while offering a high degree of customizable features and despite extraordinary advances in graphic technology, computer-generated VR environments are easily identified as such upon visual inspection. The distinguishable difference between computer-generated graphics and digital video can pose problems for the user experience, particularly in terms of realism. Cameras capable of 360° photography aren't new but have historically proven to be rather expensive for the average person. Shooting video in 360° was a difficult task prior to the 2010s but several affordable and purpose-built 360° cameras came to market as interest in VR began to rise once again, thanks in large part to the original Oculus system. In 2015, the popular video sharing site, YouTube, announced support for 360° videos and other similar sites were soon to follow. More recently, news networks from around the world, including the BBC and PBS, have made considerable use of 360° videos on their online platforms. Visitors to those platforms can watch 360° videos with their smart phone, on their computer, or through a VR headset. 360° video

can be made by anyone with access to the technology and afford the unique opportunity of representing the world as it (more or less) actually appears. The level of realism 360° video brings over its computer-generated counterpart is unmatched.

With the increased accessibility, affordability, and portability of VR systems, and with the wide array of 360° videos freely available online, this technology has surpassed its previous reputation as a fun novelty and has become an exciting new research frontier. Combining the now easier-to-access VR equipment and the abundant supply of virtual depictions of natural environments available, researchers in a variety of fields have begun publishing preliminary works concerning the effects of these environments on the brain (Bratman et al., 2015; Dadvand et al., 2015, 2018). This research follows a wide range of findings that indicate that being physically present in nature has a number of positive emotional and cognitive effects. This review of the literature therefore seeks to describe the state of the literature as it relates to the use of 360° videos of natural environments delivered by virtual reality technology. Specifically, the focus of this review is on the emotional outcomes as a result of spending time in virtual nature. Due to the fact that this area of research is still relatively new, it is important to review findings from all of the published research and without restriction on factors such as age. This review does, however, proceed with a special interest placed on identifying research articles pertaining to older adults as limitations on access to nature are more likely in this population, generally owing to factors related to overall health and mobility.

Methods

Article collection took place between 12 – 18 June 2020. It was important to collect articles from a diverse range of disciplines, including social work, so the search was conducted in the following databases: CINAHL Complete, PsycINFO, and PubMed. The search string used was "360 video OR virtual reality AND nature." Anything other than peer-reviewed articles written in English were filtered out of the search results. Article publication dates were not restricted because it was important to locate all articles relating to the use of nature-oriented experiences in 360° video as this branch of research is relatively new. It is often the case that 360° video is used with a VR headset, making necessary the inclusion of the "virtual reality" search term. A total of 1511 articles were returned (114 from CINAHL Complete, 568 from PsycINFO, and 829 from PubMed). Only articles containing "360° video" or "virtual reality," and "nature" in either the title, abstract, or keywords were allowed. Duplicates and study protocols were not collected. In total, 68 articles were collected from this search (10 from CINAHL Complete, 32 from PsycINFO, and 26 from PubMed). Rules for exclusion by abstract were as follows: 1) Non-empirical articles; 2) Not specifically described as being concerned with depictions of nature (360° video or virtual reality); and 3) Not specifically described as relating to the effects of nature on some aspect of mood (including as an anxiolytic or anti-depressive). After exclusion by abstract, 30 articles remained. During the data extraction process, a total of 20 articles were eliminated from the article pool. Thirteen of the articles were eliminated for using computer-generated graphics for the VR experience, not 360° video. Four other articles were eliminated because they made use of projections

or display screens that rely on external controllers to move about in the environment, rather than the user moving their own head/body to explore. Of the other three articles that were eliminated at this stage, one was found to not deal directly with mood, another did not specify the device used in the study, and the other used 360° photographs (static images), not videos. After these exclusions, 10 articles remained.

Results

Five of the articles dealt with the restorative effects of nature and another three dealt with anxiety (two of these also focused on pain). The remaining two articles were concerned with comparisons of virtual reality depictions of nature vs. real nature. See Table A-1.

Across the 10 included articles, the average sample size was 42.2, with a median sample size of 40, and a range of 4-98. Most of the included studies had average participant ages in the low-to-mid 20s. Four studies featured an average age of participants above 30 (Andersson et al., 2017; Appel et al., 2020; Schebella et al., 2019; Tarrant et al., 2018). Appel et al. (2020) is notable for being the only article included in this review that specifically targeted older adults (average participant age of 80.5). Seven of the studies used a smartphone + VR headset equipment option, with the Samsung Gear VR system being the most popular. The other three studies used either standalone VR headsets or those tethered to a desktop or laptop computer.

Restorative effects

Anderson et al. (2017) evaluated the restorative effects of two different natural scenes presented through an Oculus Rift VR headset. Participants' electrodermal and

EKG data were collected throughout the experiment. Before viewing each of the three fifteen-minute VR scenes, participants were first mentally stressed by an observed arithmetic test that lasted for two minutes. Data collected along the way included the Positive and Negative Affect Schedule (PANAS), the Modified Reality Judgement and Presence Questionnaire (MRJPQ), and the Value of VR Questionnaire (VVR). Both of the natural scenes (a beach scene and one of various locations in Ireland), when compared to the indoor control scene, demonstrated a relaxing effect on participants. Electrodermal activity (EDA) showed greater decreases over time for both of the natural scenes when compared to the indoor control scene – in fact, EDA levels during the natural videos fell below baseline values, while remaining more or less at baseline during the control video. Negative affect, as measured by the PANAS, was also reduced following viewing of the two natural scenes. The authors concluded that natural scenery in VR can have a positive effect on stress levels and on mood.

Litleskare & Calogiuri (2019) were primarily concerned with image stabilization in 360° videos and its effect on cyber sickness (a type of motion sickness that occurs in some individuals while using VR equipment; it is thought to be a result of a disconnect between the visual and vestibular senses). Reducing the risk of cybersickness is an important consideration in VR, whether computer-generated or 360° video, for a variety of reasons, many of which are immediately obvious – in particular, improving the user experience to maximize positive effect in interventions related to improving mood. Two ten-minute 360° videos showing a point-of-view walk down nature trails were used in this study and were displayed on a Samsung S7 phone in conjunction with a Samsung

Gear VR headset. The authors assessed the psychophysiological responses (by recorded heartrate and the use of the Physical Activity Affect Scale) in low-image stability and high-image stability states and found that while the high-image stability condition held more favorable outcomes for participants, the differences between the two states were not statistically significant.

Schebella et al. (2019) used an Oculus Rift VR headset to examine the restorative effects of different types of scenery (urban vs. low/moderate/high biodiversity) on participants. Interestingly in this study, the authors went a step beyond the audio-visual realm and incorporated an olfactory component (comprised of "urban" and "nature" scents – for example, dust and turpentine for the former, and grasses and flowers for the latter) for an added degree of realism. Furthermore, to induce stress in participants and maintain the connection to VR, the authors made use of a virtual reality (filmed in 360° video) Trier Social Stress Test. EDA and heartrate were recorded, and psychological data were collected via a series of visual analogue scales (VAS), for the purposes of recording perceived stress, anxiety, insecurity, calmness, and happiness. Results indicated that the urban environment had the least restorative properties of all of the presented scenes, but somewhat surprisingly, the low biodiversity scene had the highest. Several theories as to why the moderate or high biodiversity scenes did not rank higher are put forth, but further research is needed to more completely understand the observed phenomenon. Participants exposed to the multisensory VR experience showed improved stress recovery over participants who received a visual-only VR experience, but multisensory VR *did not* have an effect on participants' sense of immersion.

Browning et al. (2020) used a Galaxy Note 5 mobile phone in conjunction with the Samsung Gear VR headset to deliver 6-minute 360° videos of natural scenery to a sample of 98 university students and compared that experience to 6 minutes in outdoor nature in the same spot as the 360° video was recorded. One of the main findings of the study was that both the outdoor and nature VR conditions were rated by participants as equally restorative and resulted in increased positive affect.

Chung et al. (2018) used an LG G5 smartphone in conjunction with a set of LG 360° VR glasses to examine the effects of approximately 6 minutes of natural scenery on involuntary attention restoration in 40 healthy adult participants, aged 19-36. Participants were measured using an electroencephalogram (EEG) and MMN/p3a amplitude was calculated through data extracted from the EEG, making this novel in studies focused on Attention Restoration Therapy (ART). MMN is related to pre-attentive information processing, while P3a is related to attention orienting processing. Prior to this study, restorative effects of natural scenery were usually measured by only subjective and objective methods. P3a amplitudes were significantly reduced in the high restorative group when compared to the low, and a negative correlation exists between self-reported restorativeness and fronto-central P3a amplitudes.

Anxiolytic effects

Kucher et al. (2020) used an Oculus Rift HMD in concert with a Samsung Galaxy 7 phone to test effects of virtually-delivered nature as a means to reduce nausea, pain, and anxiety in a sample of 6 children and adolescents who underwent a Total Pancreatectomy Islet Auto-Transplant (TPIAT). The authors noted that this study is a proof of concept

upon which more sophisticated studies can be built in future. Pre/post data were collected using the revised Wong-Baker Pain Rating Scale (FACES), Baxter Retching Faces Scale (BARF), and a novel nature-based anxiety scale featuring a rabbit depicted in varying stages of anxiety (Calm, no anxiety to Running, worst possible anxiety). The authors reported a decrease in all three dimensions, but also note that only 4 of the 6 participants actually used the VR device and, as such, no statistical analysis was undertaken. The authors recommend further study using nature-based VR.

Tarrant et al. (2018) used a Samsung Gear VR headset with the Samsung S7 phone to measure anxiety reduction through the use of a nature-based mindfulness meditation scenario in a sample of 21 participants (with an average age of approximately 47 years) with moderate generalized anxiety (a GAD-7 score of 8 or higher). The authors found reduced anxiety reported in both participants who received the VR intervention and those in the control group. Specific only to the experimental group, EEG data showed reduced Beta wave activity regionally and globally, indicative of a decrease in anxiety. This pilot study was reportedly the first to study the effects of a nature-based VR intervention designed specifically for persons suffering from moderate-to-high levels of general anxiety.

Appel et al. (2020) conducted a feasibility study on older adults with cognitive and/or physical impairments to determine if, and how, that population might benefit from exposure to nature-based VR. The authors used the Samsung S7 phone along with the Gear VR headset and made use of VR content freely available on YouTube and other platforms. Pre- and post-intervention data relating to anxiety (by using the State-Trait

Anxiety Inventory – STAI) was collected, as well as feedback related to tolerability and enjoyment of the VR experience. The authors found that the apparatus was well-tolerated across the board, and most importantly by those who have sensory or cognitive deficits to varying degrees. Furthermore, when compared to pre-intervention data, participants reported an improvement (positive change) in several domains, including energy levels, contentedness, relaxation, feelings of adventurousness, and a reduction in anxiousness, worry, and stress levels. Overall, participants enjoyed the experience and stated that they would be interested in continuing to use VR. The importance of this particular study cannot be overstated. It is, as mentioned previously, the only study included in this review that is focused solely on older adults, and particularly those with some evidence of cognitive decline. Studies of this nature are few and far between in the literature.

Comparison

Chirico and Gaggioli (2019) compared the emotional responses and sense of presence in VR and natural environments in a study of 50 participants. The authors used the Samsung Gear VR headset with a Galaxy Note 4 mobile phone. A lakefront panorama was used for the VR scenario, the very same locale to which participants in the *in vivo* exposure group were tested. The authors report no statistically significant difference in the experiences of participants in the *in vivo* and *in virtuo* groups, concluding that the VR experience is a reliable model of being physically present in nature. This claim, of course, would need to be backed with results from an equivalence test before it can be considered as worthwhile evidence from a statistical perspective.

Calogiuri et al. (2018), in a sample of 26 participants, used the popular Samsung S7 and Gear VR headset combination to compare three conditions featuring exposure to green space – a walk in nature, a 360° video shown while participants were at rest, and a 360° video shown while participants walked on a treadmill. The reported restorativeness and physical engagement of each condition was of interest here, with the primary goal of determining how a VR condition stacks up against a real-world nature walk. The authors found that heart rate, in terms of beats per minute, were similar between the real-world walk and the treadmill + VR condition. They also found that there were significant problems related to the treadmill + VR condition, most notably that the combination of walking on the treadmill and viewing the moving 360° video through the VR headset induced cybersickness in 19 out of 26 participants. Furthermore, 21 of 26 participants found the quality of the video to be poor, particularly in terms of clarity. The authors of this study filmed and processed the 360° video themselves, including the use of a mechanical stabilizer during filming and stabilization software in post-production, but due to the limitations of equipment were not able to link the speed at which the video moves to the speed of the subjects on the treadmill. This is surely the number one contributing factor to such a high prevalence of cybersickness in this study.

Discussion

The use of 360° nature video is limited in the literature, and a lot of the studies are pilot tests/feasibility studies and feature small sample sizes, but early results are promising. In terms of the restorative, anxiolytic, and mood-improving aspects of nature and how that translates when using 360º, the literature indicates that virtual depictions of

nature can be an acceptable substitute for the real thing in certain applications. In total, six of the ten articles included in this review focused on the anxiolytic or mood-boosting effects of nature VR. Appel et al. (2020), in a sample of older adults with cognitive and/or physical impairments, found that VR had beneficial effects on participants' anxiety, therefore providing crucial early evidence that this intervention could be beneficial. Naturally, more studies are required to duplicate these findings, but it is an exciting and promising start.

Realism is an important factor in VR, so researchers working in this medium must take care to utilize 360º videos shot at the highest possible level of quality, and that the display device has a sufficient set of display capabilities, including modernized screen refresh rates. The bright side in terms of technology is that most devices, including mobile phones, produced over the last several years have displays high enough in quality for this to not really be an issue. Also on the technical front, making sure that the videos used are smooth and stable is extremely important – as Litleskare & Calogiuri (2019) note – to avoid, or severely minimize, the risk of cybersickness in study participants.

There is little evidence in the literature about whether participants prefer stationary or moving 360º videos (a guided tour, if you will, in which the camera moves through an environment at a perspective mimicking that which a person actually in the environment might see) during interventions intended to have a positive emotional or restorative effect. It is known – again, thanks to Liteleskare & Calogiuri (2019) – that participants in a VR exergaming (the combination of exercise and gaming) scenario prefer stationary scenery, as the speed of movement in a "guided tour"-style environment

rarely matches the speed at which participants themselves move (usually on a treadmill). This mismatch results in an almost certain case of cybersickness. It is an open question as to whether participants who are seated during the VR experience find one or the other more useful in terms of restoration or improvement in mood.

As it relates to the content of 360º videos themselves, preference in general is variable among study participants. What is known is that limiting, or entirely omitting, evidence of human presence (man-made structures, people milling about in the scenery, hearing peoples' voices, etc.) typically improves the experience for VR users. Forest scenery is a popular choice, but not as popular overall as are scenes from beaches and the mountains. Water features tend to rank highly in terms of VR user preference, from babbling mountain brooks to lapping ocean waves, though this is certainly an unsurprising finding as the soothing qualities of flowing water have been known for a very, very long time.

It is worth noting that all of the articles included in this review were published in the last four years. To further clarify, just one article from 2017 was included here, and the years 2018, 2019, and 2020 were represented by the publication of three articles each. The increasing availability and decreasing costs for this technology is likely the driving force behind this. The Samsung Gear VR system, which only needs a compatible smartphone, was released in late 2015 at a cost of $99. VR headsets into which users insert a smartphone of any make can be found these days for around $20. Stand-alone VR headsets that require neither a high-end computer nor a smartphone offer an attractive middle ground between state-of-the-art VR systems and the modern equivalent of a dime

store novelty. They're priced approximately in that mid-range level, as well, with the Lenovo Mirage Solo, released in 2018, set at a price of $299.

All of the studies included in this review delivered 360° video through a VR headset, and the smartphone + accessory headset option was utilized in 7 out of the 10 articles. Many modern smartphones offer extraordinary image quality and are equipped to receive and transmit data, whether over the wireless provider's network or a wi-fi network, at speeds that allow for the streaming of high-quality 4K video.

Together with lower barriers to entry on the equipment side of the equation, 360° videos have exploded in popularity and thousands upon thousands of them can be found on YouTube alone, all freely available in the public domain. Natural scenery, from sunny beaches, tubing down a lazy river, to star-filled night skies, represents a large portion of the virtual experiences available. Many of these virtual experiences are short in duration (less than ten minutes) – easily digestible and ideal for human subjects research, as 5-10 minutes has consistently been found to be the ideal video length in studies of this nature, including most of those included in this review.

Next steps

Research using VR and 360º video is relatively new and there is much still to be learned. Studies with cognitively healthy older adults as the population of interest are practically non-existent – this review found only one (Appel et al., 2020). The appeal of returning to nature has reached heights unmatched in recent years, particularly in the wake of the COVID-19 pandemic. The time is ripe for studying nature VR's effects but conducting non-essential face-to-face research at this time is not practical. However,

returning to an earlier point, modern smartphones by themselves are quite capable devices, and it is possible that some of the same benefits of VR can be conferred with 360° videos viewed on them, provided the study participants are able to hold and rotate the phone around them to explore the environment. It is, after all, these same movements that help usher in a sense of presence in a VR simulation. While many people, particularly older adults, continue to limit contact with the general public but still yearn for outdoor adventures, 360° videos viewed on a smartphone might be a reasonable substitution. A thorough look at the benefits of viewing 360° videos on smartphones is necessary, both to confirm empirically that which seems apparent, as well as to uncover novel alternative uses this versatile and powerful technology.

CHAPTER THREE

CAN 360º NATURE VIDEOS IMPROVE MOOD OUTCOMES FOR OLDER ADULTS?

ABSTRACT

Social isolation has become a topic of considerable focus given its relationship to poor physical and mental health outcomes. Mental health apps have become increasingly popular, particularly those in the areas of guided and mindfulness mediation, such as Headspace which handily offers both. A considerable amount of ground has been covered in this new frontier, but there are plenty of relatively untapped areas to consider. 360º videos on a smart phone allow a user to look around an environment without needing a virtual reality headset and other related equipment. Millions of 360º videos are freely available for viewing, from thrilling first-person perspectives of parasailing or riding rollercoasters, to on-rail diving excursions, and even stationary videos of beautiful natural scenery. Being in nature is well-documented as having many positive effects on people, so the next logical question is to wonder if some of those positive emotional benefits may be conveyed after viewing 360º videos of nature. A sample of 43 older adults watched two different 360-degree nature videos and reported various aspects of their mood at each interval. Results indicate that the nature videos may have had some positive affect on participants' mood, a promising finding, but the study was limited by methodological problems, including small sample size.

An untold number of things can lead to an older adult being isolated from the outside world. Illness and injury are logical first thoughts – after all, health and mobility do naturally decline in later life. Social isolation is another factor – losing a partner/spouse, losing or being distant from children, losing friends and acquaintances, for instance – and is a major area of study in the social sciences (Blazer, 2020; Morgan et al., 2020; Quach and Burr, 2021). Social isolation has become a topic of considerable focus given its relationship to poor physical and mental health outcomes. The COVID-19 pandemic has been another isolating phenomenon, and not just for older adults. Early research on the pandemic's mental health effects is becoming available (Brooke, 2020; Ingram et al., 2021). In the face of isolation for any reason, several established suggestions for creating connections with others are often spoken of – join a club, attend classes or events at a local senior center, get involved with volunteer work, etc. However, many older adults may find this advice impractical. For instance, transportation to such experiences is not available, the community itself may be isolated and have little social activities on offer, or the individual may be faced with health or safety concerns that do not permit participation in such things. What are social workers doing to help people like this?

Creating human connections through technology is obviously nothing new, and neither is bridging physical distances in this manner. Modern smart phones have the ability to reach nearly anybody, nearly instantly, and at nearly any time – and what's more, you can video chat. This is revolutionary technology and has, for many people, increased their ability to feel connected to others, no matter the physical distance between

them. Furthermore, a tidal wave of apps dedicated to whiling away your time are available at no cost to smart phone users – games, puzzles, video apps (such as YouTube or a television network) – and items such as those may be of some benefit to older adults. Mental health apps have become increasingly popular, particularly those in the areas of guided and mindfulness mediation, such as Headspace which handily offers both. A considerable amount of ground has been covered in this new frontier, but there are plenty of relatively untapped areas to consider. 360º videos on a smart phone allow a user to look around an environment without needing a virtual reality headset and other related equipment – all you have to do is move the phone about your person to look at the scene from different angles. Millions of 360º videos are freely available for viewing, from thrilling first-person perspectives of parasailing or riding rollercoasters, to on-rail diving excursions, and even stationary videos of beautiful natural scenery. Being in nature is well-documented as having many positive effects on people, so the next logical question is to wonder if some of those positive emotional benefits may be conveyed after viewing 360º videos of nature. The preceding literature review provided some early evidence of effectiveness, and with the world in the grips of a pandemic in which many people have minimized their contact with the outside world, the time seems ripe to test this phenomenon further.

The objective of this study is to observe how the self-reported emotions of older adults are affected by viewing 360º videos of natural scenery. It is hypothesized that participants will demonstrate a positive emotional change after viewing the two videos,

one of which is set in a forest and the other is on the beach, but a two-tailed test is used because results in either direction will be important.

Methods

Recruitment

Participants were originally recruited from a national organisation with a population of over 10,000 and is comprised entirely of older adult members. Unfortunately, the organisation did not fulfill all of their obligations with our agreement, resulting in an estimated 100 people or fewer receiving the invitation to participate. A revision to the research approval application through the Institutional Review Board was approved, thereby opening the data collection possibilities to participants on various social media networks (Facebook and Reddit, in particular). Advertising posts were made on each site, along with requests to share the invitation with others who may be interested in participating. In total, the survey received 190 attempted completions combined from these sources. No identifying data was collected on participants, including how they discovered the research study. Inclusion criteria included being aged 55 or older and possessing a smart phone with the YouTube app installed.

Survey

This survey was constructed in and delivered via REDCap, a secure survey software hosted by the University of Tennessee Health Sciences Center (Harris et al., 2009; Harris et al., 2019). The survey contained a total of 169 prompts for response – 9 of these prompts were conditional, depending on a participants' response to a previous question. For example, if someone selected the option "Other" for the categorical variable

gender, a follow-up question requesting text input to describe their gender identity appeared. General demographic information (age, household income, living arrangement, relationship status, etc.) was requested at the start of the survey.

Video Selection

The videos used in this study were chosen based on several factors: Video quality, video duration (between 2-3 minutes was ideal), and absence of sounds other than those naturally occurring in the depicted environments. Another important consideration when choosing the videos for this study was that the camera used to record them needed to have been stationary. This was done in an effort to provide a stabilized, steady scene and minimize the risk of simulator sickness. Furthermore, the ideal video would be from a perspective similar to an individual sitting or standing within the environment, to mimic how a person might take in the surroundings if physically present.

The first video shown to participants was 1:17 in duration and was set in a forest next to a running stream. Trees, bushes/shrubbery, and stones are all visible. The sounds of birds chirping and the stream gently moving creates the soundscape. The video was playable in quality ranging from 144s up to 2880s (5K). The second video was 3:29 in duration and was set on a beach located in Hawaii. The video was shot at sunrise and showcases a colorful sky with a strong presence of clouds. Waves from the sea gently roll in for the duration. Rotating the scene 180º reveals an expanse of sandy beach, leading to trees and shrubbery in the distance that partially obscures a dwelling. The only sound heard was the waves rolling in. The video was playable in quality ranging from 144s up to 2160s (4K).

Visual Analogue Scales

Participants completed visual analogue sub-scales to represent different aspects of their mood profile at three stages: baseline, post-video 1, and post-video 2. Each of these 16 sub-scales feature antonyms (for example, *Relaxed* and *Tense*) placed on both sides of a 100-millimeter horizontal line. The electronic version used in this study makes use of a sliding scale, centered at the 50mm mark. Moving the slider to the right scores between 51-100; moving the slider to the left scores between 0-49. Participants are asked to move the slider along the scale to the point which best represents their current feeling between the two terms. If, for instance, a participant is completing the *Tense-Relaxed* sub-scale and they feel relaxed but not entirely, they might move the slider towards *Relaxed* and stop at a number around 80. This would represent a feeling of relaxation that is substantial, but also reflects that an element of tenseness is still present. The sub-scales used in this study are based on the Bond & Lader Visual Analogue Scales (Bond and Lader, 1974).

Administration of the sub-scales takes mere minutes and has the advantage of being able to be used multiple times daily. Five of the VAS sub-scales were selected for this study: *Troubled-Tranquil, Tense-Relaxed, Sad-Happy, Hostile-Peaceful,* and *Bored-Interested.* The other sub-scales, such as *Incompetent-Capable,* had no particular relevance to the outcomes of interest and were ignored for this study.

Reliability and Validity.

Bond and Lader (1974) first examined the VAS by testing 500 employees of technical colleges, universities, and hospitals, all aged between 16 and 64. From this, they

identified three main factors from the individual scales: alertness, contentedness, and calmness (Bond & Lader, 1974). They next tested the scales on a small sample of eight subjects who received a barbiturate, flurazepam, and a placebo during the course of the experiment. The VAS was administered 12, 15, and 18 hours after the participant had received the medication and was found to be statistically significantly sensitive to changes in the contentedness and calmness factors. Determining validity of a set of scales designed to capture a picture of subjective mood is difficult, if not impossible. Other types of visual analogue scales, such as those designed to diagnose depression, have been shown to be valid (see Davies et al., 1975 for example). Armitage, Conner, and Norman (1999) used the VAS to assess mood in a study of 97 undergraduate students and found all scales to have internal consistency indicated by Cronbach's alphas between 0.77 and 0.93. To date, there have been no studies that specifically assess the validity of the Bond & Lader VAS in a population solely comprised of older adults, but they have been represented in samples of varied ages previously (Bond & Lader, 1974) without any reported issues.

Results

Demographics

The total sample size, after filtering by completed pre-video and post-video variables, equated to 43, with a mean age of 64.42 years (SD = 6.05) and a median age of 64. This sample contained 31 female participants (72.1%) and 12 male participants (27.9%). The majority of participants in this sample identified as White or Caucasian (N = 37; 86%) and were married (N = 31; 72.1%).

Over half of participants in this subsample had obtained at least a 4-year college degree (N = 24; 55.8%) – 9 completed a bachelor's degree (20.9%), 11 completed a master's degree (25.6%), and 4 completed a Ph.D. or other professional degree (9.3%). Annual household income for the subsample was concentrated in the $80,001+ bracket (N = 27; 62.8%).

As might be expected based on reported education and income, self-reported health for this subsample overwhelmingly tended towards the positive. Thirteen participants stated that they were in excellent health (30.2%), 20 indicated that they were in very good health (46.5%), and 6 were in good health (14%).

See Table A-2 for complete demographic characteristics.

Mood outcomes

Linear regression models containing the baseline VAS scores were run using the respective post-test mood outcomes as the dependent variable. Two regression models were run per VAS outcome measure – one concerning the effect of the first video shown, and the other concerning the second video shown. The VAS sub-scales *Troubled-Tranquil, Tense-Relaxed, Sad-Happy, Hostile-Peaceful,* and *Bored-Interested* were selected for analysis. Cronbach's alpha for baseline response to these sub-scales was 0.817. Cronbach's alpha for post-video 1 response to these sub-scales was 0.905, and for post-video 2 was 0.69. Means and standard deviations for outcomes from the VAS sub-scale scores can be found in Table A-3.

Troubled-Tranquil

Post-Video 1.

Results indicated that the model accounted for 41.8% of the variance. Linear regression results predict an increase in participants' feeling of tranquility after watching the first 360º video (B = 0.523, 95% CI [0.328, 0.717], $t(41) = 5.422$, $p < 0.001$).

Post-Video 2.

Results of this analysis indicated that the model accounted for 32.9% of the variance. Once again, linear regression results predict an increase in participants' feeling of tranquility after watching the second 360º video (B = 0.407, 95% CI [0.223, 0.590], $t(41) = 4.484$, $p < 0.001$).

Tense-Relaxed

Post-Video 1.

In this model, 56.5% of the variance was accounted for. Linear regression results predict an increase in participants' feeling of relaxation after watching the first 360º video (B = 0.621, 95% CI [0.449, 0.793], $t(41) = 7.293$, $p < 0.001$).

Post-Video 2.

Results indicated that the model accounted for 40% of the variance. Similarly to post-video 1 analysis, linear regression results once again predict an increase in participants' feeling of relaxation after watching the second 360º video (B = 0.491, 95% CI [0.301, 0.681], $t(41) = 5.224$, $p < 0.001$).

Sad-Happy

Post-Video 1.

Results indicated that the model accounted for 23.1% of the variance. Linear regression results predict an increase in participants' feeling of happiness after watching the first 360º video (B = 0.47, 95% CI [0.203, 0.738], $t(41) = 3.554$, $p = 0.001$).

Post-Video 2.

Over half of the variance (53.6%) was accounted for by this model. As before, linear regression results predict an increase in participants' feeling of happiness after watching the second 360º video (B = 0.539, 95% CI [0.381, 0.696], $t(41) = 6.889$, $p < 0.001$).

Hostile-Peaceful

Post-Video 1.

Results indicated that the model accounted for 30.2% of the variance. Linear regression results predict an increase in participants' feeling of peacefulness after watching the first 360º video (B = 0.377, 95% CI [0.196, 0.558], $t(41) = 4.212$, $p < 0.001$).

Post-Video 2.

Results indicated that the model accounted for 26.7% of the variance. Similarly to post-video 1, linear regression results predict an increase in participants' feeling of peacefulness after watching the first 360º video (B = 0.323, 95% CI [0.154, 0.492], $t(41) = 3.866$, $p < 0.001$).

Bored-Interested

Post-Video 1.

Results indicated that the model accounted for 22.2% of the variance. Linear regression results predict an increase in participants' feeling of being interested after watching the first 360º video (B = 0.31, 95% CI [0.127, 0.492], $t(41) = 3.442$, $p = 0.001$).

Post-Video 2.

Results indicated that the model accounted for 6.6% of the variance. Linear regression results *did not* reveal a statistically significant relationship between baseline and post-video 2 VAS sub-scale scores.

Discussion

Results from analyses almost entirely matched the hypothesis – these 360º nature videos do appear to have a positive influence on mood. Regression analysis demonstrated a statistically significant positive relationship between baseline and post-video VAS scores for each of the sub-scales, except for *Bored-Interested* after video 2. Results for the *Bored-Interested* sub-scale after video 1 shows that only 22.2% of the variance in that model was accounted for, suggesting that there may be some problem with that sub-scale itself. It is possible that the antonym pair might not have been a logical fit – perhaps substituting another word for "Interested" could have helped participants articulate the effect they felt after viewing the video. The videos, after all, are meant to be relaxing and promote a sense of ease and a term such as "interested" might be perceived as reflecting a level of activity or stimulation that participants just weren't feeling – but they certainly weren't bored, either.

While it is not possible to say that there is definitive proof of the positive mood effect of 360º videos – haven't ruled out the role of chance or of plausible alternative explanations – the results shown here are enough to advance this line of research to the next level. This is, after all, a pilot study with a primary purpose of looking for any evidence at all of improvement after the intervention.

Limitations

The most immediately obvious limitation to this study is sample size. While the original research plan was to run multiple regression analyses using demographic variables as independent variables, this study's small sample size prevented that approached. Many of the demographic variables were categorical and pre-analyses review of data distribution revealed a risk of problems with sparse data erroneous returning statistically significant results. Naturally, absence of these control variables increases the likelihood of confounding results in linear regression analyses. While it is true that some positive effect of the videos in this intervention was observed, the circumstances under which that effect is affected by other factors is not yet understood.

As mentioned previously, sample size became a problem after a national organisation that agreed to host the research did not completely follow through with the distribution of invitations to this study. The IRB application for this study was therefore amended to allow for an altogether different sampling method – recruitment through social media (Facebook and Reddit). While this did increase the total response rate (at the study's conclusion, there were 190 attempts), it also began to highlight another issue: the technology itself.

The survey was constructed in REDCap, and prior to moving the project to production, a problem with the 360º videos emerged. YouTube, the video hosting service on which the videos for this study were located, disallows embedding 360º videos in other software or applications – users *must* view the video with the YouTube app. A requirement had to be enacted that indicated that participants must have the YouTube app installed on their smart phone prior to engagement with the study. This may have reduced reach due to an unwillingness to install the YouTube app (possibly due to privacy concerns because Google owns YouTube). This also meant that participants would have to leave the survey site, view the video on the YouTube app, and return to the browser to complete the survey – less than ideal research circumstances, to say the least. An analysis of overall survey completion clearly shows that most participants who started the survey stopped answering questions after the first video was shown. Furthermore, it became apparent during the course of data collection that many participants using Android-based phones were unable to return to the survey site from the YouTube app; the reason(s) for this is/are not clear as some Android users were able to successfully complete the survey. Differences in Android operating system and in web browsers may be the culprits; Android devices are heavily customizable, whereas Apple's iPhones are famously not, so user experience and capability is far more uniform in the latter. Indeed, an overwhelming majority of successful survey completers reported that they were using an iPhone to take the survey.

Another limitation worthy of note is the length of the survey itself. It is comprised of 169 questions and was expected to take about 30 minutes to complete. Longer surveys

are known to have lower engagement to completion when compared to surveys with less questions and that require less time to complete. A number of participants stopped during the personality inventory, before ever getting to the first video. The personality inventory is comprised of 80 prompts for response – quite a big ask for anyone, especially older adults who may tire, for a variety of reasons, of the survey before younger people might. Factors related to vision, dexterity, and other health-related matters may well have played a role in some participants opting to drop out. It is also possible that a phone call, text message, or some other notification (or some combination thereof) lead participants away from the study and they simply forgot to return before the study timed out.

Methodological problems are also present here. To be fair, this is a pilot study, and this area of research is in its relative infancy – this is a novel intervention. One problem that originated during study planning and has persisted to present time is accounting for carry-over or additive effect in VAS scores in going from the first video to the second. Due to the study's design, there is no way to know for sure how this factors into the results.

Future Research

Increasing sample size for future studies is a top priority, and with that, every attempt should be made at diversifying participant demographic characteristics. Another pilot study, implementing the aforementioned changes, would be a valuable addition to the progression of this area of research. Moving forward from there, the next obvious choice is to introduce more sophisticated research design. Experimental studies, featuring random assignment to groups (including a control group), will be necessary to gain a

better understanding of the effect 360º nature videos might have on the emotions of older adults. It would also be necessary to only expose participants to one video at a time to control for any additive effect of watching multiple 360º videos during the intervention phase. A longitudinal study to assess the effect of these videos over time would also eventually be necessary, after having established a strong evidence base from the steps described previously.

In terms of the technology, self-hosting the 360º videos would be of utmost importance. This would allow for the videos to be embedded directly in the survey software and eliminate the cumbersome task of switching between the YouTube app and the phone's mobile browser to continue the survey. Doing so would go a long way towards increasing participation and capturing useful data. Depending on how the intervention is delivered (in a physical setting, such as a care home) or remotely (strictly online, as in this study), it may be worthwhile for future researchers to develop their own app that simultaneously hosts the survey *and* the 360º videos. This might be particularly useful in the context of a longitudinal study for the purposes of setting alerts to remind participants to check in at each required interval.

Conclusion

Despite this pilot study facing a number of limitations, it is an important step in social work researchers and practitioners embracing the advancement of technological interventions for cognitively healthy older adults. Various interventions and services targeting older adults already make use of mobile technology, including telehealth services, which received a tremendous boost in usage as a result of the COVID-19

pandemic, but the future is still wide open and full of possibilities in this domain. The positive impact social work-led interventions and services for people who are physically and/or socially isolated, for any reason, can't be assigned a value. In the midst of this aging bubble, innovation in serving our client populations is an absolute must, and technological interventions such as the one tested in this study have the potential to make a big difference in the lives of our clients. Particularly in gerontological social work, with so many older people cut off from society due to health and/or safety concerns (in the case of a person with dementia, for instance), technology used in this way can bring the world to people – to meet them where they are.

Looking solely at the reported scores on various aspects of mood as participants moved from baseline through the two videos, there is generally an upward, positive trend. This is an important finding: Participants did report an increase in positive emotions after viewing each of the two videos. Natural scenery has been known to positively effect human emotion for a very long time – it's old news, in fact – but there is burgeoning evidence that digital depictions of nature may convey some of the same benefits. Smart phones are ubiquitous in our society and have been for approximately a decade, but new and beneficial uses in social work practice and research continue to be identified. This study flings open the doors on this area of research, giving future studies a lot to build upon, from future behavioural health studies to advocacy and other macro-related social work endeavors. Specifically, environmental activism and preservation efforts can be enhanced by providing brief, 360º videos of the subject matter in question, for instance.

Social work is a profession uniquely poised to invent, adopt, and distribute innovative technological interventions such as this; we are, after all, tasked with meeting the needs of the day and being "change agents" on the forefront of care services for our society's most vulnerable people. Combatting such devastating modern problems like social isolation, shown time and time again to have a serious negative impact on the health of older adults, is a top concern in social work today. Adopting technology to bridge those gaps is one of the best feasible solutions we have at present, and this study's modest findings contributes to the next wave of evolution in that regard.

CHAPTER FOUR

HOW DOES AGE AFFECT AVERAGE MOOD OUTCOMES OF OLDER ADULTS AFTER VIEWING 360º NATURE VIDEOS?

ABSTRACT

The previous study uncovered statistically significant differences in mood outcome scores for a sample of 43 older adult participants after viewing two different 360-degree videos on their smart phones. This early evidence that the intervention may have a positive effect is a promising start but leaves many questions unanswered. In particular, questions relating to how the characteristics of older adults may mediate or moderate the effect of the intervention are important to consider. This study originally endeavored to explore the effects of preferences for natural scenery, personality traits, and technological use/adoption but had to change course due to small sample size. Instead, the effect of age on average change scores between baseline and each of the videos is assessed. Results indicate that, contrary to the hypothesis, increased age may reduce the intervention's effectiveness. These results are interesting and may be explained in part by aging-related differences in physiology, including increased fatigue and audiovisual capabilities. The study's small sample size, however, demands further investigation with a larger sample.

The previous study uncovered statistically significant differences in baseline and post-intervention scores after two different videos on five visual analogue scale (VAS) sub-scales: *Troubled-Tranquil*, *Tense-Relaxed, Sad-Happy*, *Hostile-Peaceful,* and *Bored-Interested*. While the sample size for that study was small (N = 43), these results provide some early evidence that this intervention may convey therapeutic benefit to older adults. This is important evidence that using technology in this way can improve mood outcomes for older adults, but it leaves many questions unanswered. Particularly, questions relating to characteristics of individuals are raised – do people who are more technology-oriented get more out of the 360º video experience than people who aren't so technology oriented? Or perhaps the novelty factor of using technology to view 360º videos shows a greater positive effect in the less technologically inclined than it does in people who are technology enthusiasts. Further, the age of participants may play some role in the intervention's effectiveness – physiological functionality decreases over time, including changes to vision and increased fatigue, which may affect a person's ability to extract maximum benefit from the videos. Gerontological social work practitioners who are considering a 360º video intervention such as this one will clearly want to know more about how client preference plays a role. It is, after all, not worth the time and energy if the client won't stand to gain anything from the intervention.

With positive early results in hand, this study intended to build on the previous step of this research by investigating the effects of explanatory factors of the intervention's effects on mood, such as natural scenery preferences and personality characteristics, and in particular, those related to emotionality and openness to

experiences. However, small sample size quickly became an apparent roadblock. For instance, ordinal logistic regression was planned for use in the present study, but inadequate sample size meant that 75% of the cells required for analysis were blank. From the perspective of the study overall, a problem with type II error emerged – the problem of "false negatives," or in other words, reaching conclusions of no statistically significant relationships when there actually is an effect present. An increase in power would be necessary to correct this problem, and one of the best ways to do that is to increase sample size. That, unfortunately, is no longer possible in this study. In addition, reliability analyses of the scales intended for use in some aspects of this study returned unfavorable results. The choice was now obvious: Find a new analytical approach.

The previous study provided a good basis from which to work. The degree to which participants changed from baseline score to each of the post-video scores is an important consideration. The overall effect of the intervention is of primary importance, so the average value of change across the five previously mentioned VAS sub-scales was calculated for this study. Furthermore, determining if a participants' age affects mood-related outcomes is another important consideration, particularly in the context of older adults' technological adoption and literacy (Arcury et al., 2020; Kim et al., 2021; Wildenbos et al., 2019). Specifically, this study examines the relationships between participants' age and their average VAS change scores.

Methods

Recruitment

The original sample was intended to come from a national organisation for older adults; however, within a week of launch it became apparent that the organisation did not distribute the study's invitation to the entirety of their membership population (approximately 10,000 people) and had instead sent it to only a handful of chapter leaders representing various American states who then had the choice of whether or not to send it on to their membership. At this stage, an amendment was made to the IRB application to begin collecting data via social media (Facebook and Reddit), at which point the participation rate climbed steadily. Data collection ended on 24 May 2021 with a grand total of 190 records.

Survey

This survey was constructed in and delivered via REDCap, a secure survey software hosted by the University of Tennessee Health Sciences Center (Harris et al., 2009; Harris et al., 2019). The survey contained a total of 169 prompts for response – 9 of these prompts were conditional, depending on a participants' response to a previous question. In addition to visual analogue scales to measure different aspects of mood, participants were instructed to complete questionnaires to gauge their attitudes towards and current use of technology, as well as attitudes towards and preferences for natural environments. Elements from the HEXACO Personality Inventory (Lee & Ashton, 2004) were also included. Furthermore, several statements relating to perceived experiences while viewing 360º videos were presented, to which participants were asked to rate their

level of agreement on a Likert-type scale. Topics covered include the length of the video, whether the participant wanted to see more 360º videos like those just viewed, and the degree to which participants found the video relaxing. At the end of the survey, participants were asked a final series of questions about the intervention, including the degree to which they enjoyed each of the 360º videos and the process of viewing them on their smart phones.

Video Selection

The videos used in this study were chosen based on several factors: Video quality, video duration (between 2-3 minutes was ideal), and absence of sounds other than those naturally occurring in the depicted environments. Another important consideration when choosing the videos for this study was that the camera used to record them needed to have been stationary. This was done to provide a stabilized, steady scene and minimize the risk of simulator sickness. Furthermore, the ideal video would be from a perspective similar to an individual sitting or standing within the environment, to mimic how a person might take in the surroundings if physically present.

The first video shown to participants was 1:17 in duration and was set in a forest next to a running stream. Trees, bushes/shrubbery, and stones are all visible. The sounds of birds chirping and the stream gently moving creates the soundscape. The video was playable in quality ranging from 144s up to 2880s (5K). The second video was 3:29 in duration and was set on a beach located in Hawaii. The video was shot at sunrise and showcases a colorful sky with a strong presence of clouds. Waves from the sea gently roll in for the duration. Rotating the scene 180º reveals an expanse of sandy beach, leading to

trees and shrubbery in the distance that partially obscures a dwelling. The only sound heard was the waves rolling in. The video was playable in quality ranging from 144s up to 2160s (4K).

Visual Analogue Scales

Participants completed visual analogue sub-scales to represent different aspects of their mood profile at three stages: baseline, post-video 1, and post-video 2. Each of these 16 sub-scales feature antonyms (for example, *Relaxed* and *Tense*) placed on both sides of a 100-millimeter horizontal line. The electronic version used in this study makes use of a sliding scale, centered at the 50mm mark. Moving the slider to the right scores between 51-100; moving the slider to the left scores between 0-49. Participants are asked to move the slider along the scale to the point which best represents their current feeling between the two terms. If, for instance, a participant is completing the *Tense-Relaxed* sub-scale and they feel relaxed but not entirely, they might move the slider towards *Relaxed* and stop at a number around 80. This would represent a feeling of relaxation that is substantial, but also reflects that an element of tenseness is still present. The sub-scales used in this study are based on the Bond & Lader Visual Analogue Scales (Bond and Lader, 1974). Administration of the sub-scales takes mere minutes and has the advantage of being able to be used multiple times daily. Five of the VAS sub-scales were selected for this study: *Troubled-Tranquil, Tense-Relaxed, Sad-Happy, Hostile-Peaceful,* and *Bored-Interested.* The other sub-scales, such as *Incompetent-Capable,* had no particular relevance to the outcomes of interest and were ignored for this study.

Reliability and Validity.

Bond and Lader (1974) first examined the VAS by testing 500 employees of technical colleges, universities, and hospitals, all aged between 16 and 64. From this, they identified three main factors from the individual scales: alertness, contentedness, and calmness (Bond & Lader, 1974). They next tested the scales on a small sample of eight subjects who received a barbiturate, flurazepam, and a placebo during the course of the experiment. The VAS was administered 12, 15, and 18 hours after the participant had received the medication and was found to be statistically significantly sensitive to changes in the contentedness and calmness factors. Determining validity of a set of scales designed to capture a picture of subjective mood is difficult, if not impossible. Other types of visual analogue scales, such as those designed to diagnose depression, have been shown to be valid (see Davies et al., 1975 for example). Armitage, Conner, and Norman (1999) used the VAS to assess mood in a study of 97 undergraduate students and found all scales to have internal consistency indicated by Cronbach's alphas between 0.77 and 0.93. To date, there have been no studies that specifically assess the validity of the Bond & Lader VAS in a population solely comprised of older adults, but they have been represented in samples of varied ages previously (Bond & Lader, 1974) without any reported issues.

In this study, Cronbach's alpha for baseline response to these sub-scales was 0.817. Cronbach's alpha for post-video 1 response to these sub-scales was 0.905, and for post-video 2 was 0.69. Means and standard deviations for outcomes from the VAS sub-scale scores can be found in Table A-3.

Change Scores.

For purposes of analysis in this study, change scores were calculated for each participant between their baseline scores and post-video1 and post-video2 scores, thus creating two new variables. The sum of change scores for each participant was calculated next, which was then divided by the number of VAS sub-scales used (5). This resulted in two new variables that contained the average change score for each participant across the five VAS sub-scales after each video. These two average change score variables served as the dependent variables in this study. The mean average change score for post-video1 is 6.51 (SD = 11.03) and 8.27 (SD = 13.00) for post-video2.

Analysis Plan

Linear regression is used to determine the effect of age on how participants changed emotionally, on average, between baseline and each of the two 360º videos of natural scenery. It is hypothesized that age will have an increased average change effect after viewing the two videos, but a two-tailed test is used because results in either direction will be important.

Results

Demographics

The sample in this study is precisely the same as in the previous study. See Table A-2 for complete demographic characteristics.

Analysis

All variables used in this analysis are continuous. The variable *age* was centered on 55, which was the minimum participant age. Reviewing the scatterplots of

participants' age vs. post-video1 and 2 change scores revealed that linear relationships are present. Further analysis of the scatterplots revealed a small number of potential outliers, particularly in the average change scores for post-video1. In assessing the normality of the data, results of the Shapiro-Wilk test for post-video1 showed a statistically significant departure from normality, $W(43) = 0.89$, $p = 0.001$. However, upon visual analysis of the Q-Q plot for post-video1, the data looked reasonably normally distributed, with the exception of two extreme scores – the potential outliers previously identified in the scatterplot. Analysis of the histogram for these data also appear to be reasonably normally distributed. Based on these findings, it was deemed unnecessary to address the outliers. Furthermore, removing or otherwise altering the outlying scores would be detrimental to understanding the full range of effects of this intervention at this early stage of development.

SPSS version 27 for Macintosh (IBM Corp., 2020) was used for analysis.

Correlations

Both Pearson's r and Spearman's r_s were analyzed for each set of correlations. Spearman's r_s is recommended when data are not normally distributed and was included here for the sake of completeness given the previously discussed question of normality of the post-video1 average change scores.

Pearson's *r*.

Post-video1: A Pearson's product-moment correlation was run to examine the relationship between participants' age and average VAS change scores after viewing the first 360º video. There was a statistically significant moderate negative correlation

between age and post-video1 change scores, $r(41) = -0.31$, $p < 0.05$, with age explaining 9.4% of the variance in post-video1 change scores.

Post-video2: As before, a Pearson's product-moment correlation was run, but this time to examine the relationship between participants' age and average VAS change scores after viewing the second 360º video. Again, a statistically significant moderate negative correlation was found between age and post-video2 change scores, $r(41) = -0.30$, $p < 0.05$, with age explaining 9.2% of the variance in post-video2 change scores.

Spearman's r_s.

Post-video1: A Spearman's rank-order correlation was run to examine the relationship between participants' age and average VAS change scores after viewing the first 360º video. There was a statistically significant moderate negative correlation between age and post-video1 change scores, $r_s(41) = -0.40$, $p < 0.01$.

Post-video2: As before, a Spearman's rank-order correlation was run, but this time to examine the relationship between participants' age and average VAS change scores after viewing the second 360º video. Again, a statistically significant moderate negative correlation was found between age and post-video2 change scores, $r_s(41) = -0.36$, $p < 0.05$.

Linear Regression

Linear relationship between the variables of interest were previously discussed. Further assessment of these data in the context of linear regression assumptions revealed that there was homoscedasticity and normality of the residuals. Cook's Distance was used

to detect the presence of influential outliers; none were found for either post-video average change scores.

Post-video1.

Age was a statistically significant predictor of average change VAS scores after watching the first 360º video, $F(1, 41) = 4.23$, $p < 0.05$, accounting for 9.3% of the variance in the model. Specifically, each additional year of age beyond 55 was related to a 0.56-point decrease in average VAS change scores (95% CI [-1.11, -0.01], $p < 0.05$).

Post-video2.

Once again, age was a statistically significant predictor of average change VAS scores after watching the second 360º video, $F(1, 41) = 4.18$, $p < 0.05$, accounting for 9.2% of the variance in the model. Specifically, each additional year of age beyond 55 was related to a 0.65-point decrease in average VAS change scores (95% CI [-1.30, -0.01], $p < 0.05$).

Discussion

Results of the analyses indicated that increasing age beyond 55 years is associated with a decrease in average change scores, an effect that was demonstrated across both post-video outcomes. These results are contrary to the research hypothesis; a positive effect with increasing age was expected. These results suggest that the effect of the intervention may work differently for older adults of differing ages, and that the "youngest old" category of people in this study (approximately aged 55-65) tend to have larger demonstrated changes in outcome scores. These results may also reflect a decrease in positive smartphone use outcomes beyond a set "comfort zone" of regularly-used

functions and apps in older adults. Whatever the case may be, all signs seem to be pointing to the possibility of age moderating the extent to which participants' VAS sub-scale scores change as a result of the intervention. Further research is necessary to investigate this possibility.

Limitations

The most immediately obvious limitation to this study is sample size, and the explanation for this problem is discussed previously in this paper. As discussed before, small sample size was an obstacle preventing the more in-depth analyses originally planned for this study. There is a high possibility of type II error here, leading to false conclusions of no statistically significant relationships being present. This, naturally, limited the extent to which further analysis could be conducted using these data.

Another limitation, as discussed in the previous study, was the technological constraints on the survey itself. In short, YouTube, the video hosting service on which the videos for this study were located, disallows embedding 360º videos in other software or applications. This means that users *must* view the video with the YouTube app, and it introduced a cumbersome additional step for participants. Analysis of overall survey completion clearly shows that most participants who started the survey stopped answering questions after the first video was shown. Furthermore, many participants who were using Android-based smart phones were unable to return to the survey site from the YouTube app; the reason(s) for this is/are not clear as some Android users were able to successfully complete the survey. Participants who were using an Apple iPhone appeared

to not have had a similar problem – the overwhelming majority of successful survey completers reported that they were using an iPhone.

Another limitation worthy of note is the length of the survey itself. It is comprised of 169 questions and was expected to take approximately 30 minutes to complete. Longer surveys are known to have lower engagement to completion when compared to surveys with less questions and that require less time to complete. A number of participants stopped during the 80-question personality inventory and before ever getting to the first video. The personality inventory is comprised of 80 prompts for response – quite a big ask for anyone, especially older adults who may tire, for a variety of reasons, of the survey before younger people might. Factors related to vision, dexterity, and other health-related matters may well have played a role in some participants opting to drop out. It is also possible that a phone call, text message, or some other notification (or some combination thereof) lead participants away from the study and they simply forgot to return before the study timed out.

Future Research

Increasing sample size for future studies is a top priority, and with that, every attempt should be made at diversifying participant demographic characteristics and targeting an increased presence of people aged 75+. The present study likely suffered from the fact that the majority of participants fell between the 55-65 age range. Addressing the technological limitations should also be given some serious time and energy.

Extension of findings in this pilot study could take the research in some interesting directions. For instance, comparing outcome results among participants grouped by age (e.g., 55-64, 65-74, etc.), as well as comparing against younger adults, could further clarify the relationship between age and the effects of the intervention. The inclusion of other related variables, such as comfort with smartphone usage and with technology in general, can also help formalize understanding of how this intervention works, and for whom it works best. Furthermore, capturing and including other participant characteristics, such as data concerning environmental preferences could be used to provide a somewhat personalized experience to participants, while also comparing it to the experience of receiving a randomly-picked 360º video environment. Personalization of an intervention of this kind has the potential of being a key appealing aspect that could drive widespread adoption, much like the iPod did for music therapy in the early 2000s.

Conclusion

Despite this pilot study facing a number of limitations, it is an important step in social work researchers and practitioners embracing the advancement of technological interventions for cognitively healthy older adults. This pilot study is the first of its kind in social work research. More broadly, this study is an early step to discovering how increased age might affect outcomes in interventions involving 360º videos. Various interventions and services targeting older adults already make use of mobile technology, including telehealth services, which have received a tremendous boost in usage as a result of the COVID-19 pandemic, but the future is still wide open and full of possibilities in

this domain. Personalized interventions in other areas of social work practice have been around for a long time – music therapy is a perfect example, especially after iPods and other devices became available and the practice became more widely known and implemented.

The positive impact social work-led interventions and services for people who are physically and/or socially isolated, for any reason, can't be assigned a value. In the midst of this aging bubble, innovation in serving our client populations is an absolute must, and technological interventions such as the one tested in this study have the potential to make a big difference in the lives of our clients. Particularly in gerontological social work, with so many older people cut off from society due to health and/or safety concerns (in the case of a person with dementia, for instance), technology used in this way can bring the world to people – to meet them where they are. There may also be an added or enhanced effect of these types of interventions by being tailored to an individual's preferences. The wealth of available 360º video scenery truly offers something for everyone and the ease of access of such videos (on hosting sites such as YouTube, or in an any number of dedicated smart phone apps, such as VeeR) would make short work of setup between clients.

Social work is a profession uniquely poised to invent, adopt, and distribute innovative technological interventions such as this; we are, after all, tasked with meeting the needs of the day and being "change agents" on the forefront of care services for our society's most vulnerable people. Combatting such devastating modern problems like social isolation, shown time and time again to have a serious negative impact on the

health of older adults, is a top concern in social work today. Adopting technology to bridge those gaps is one of the best feasible solutions we have at present, and this study's modest findings contributes to the next wave of evolution in that regard.

CHAPTER FIVE
CONCLUSION

This pilot study was undertaken during a period of extraordinary circumstances – initially devised during the height of the COVID-19 pandemic in the United States, data collection commenced in the Spring of 2021 after the roll-out of vaccines to protect against the virus had been made available. Though life as we knew it prior to the pandemic did not immediately return – and indeed, the presence of the delta variant is now presenting a new challenge – the state of lockdown in the United States at this study's inception was no more. People had begun getting out more, and in doing so, introducing greater variety into their routines once again. As a result, the captive audience of older adults spending their days at home has now dwindled down to a much smaller group of people.

This study's small sample size presented both challenges and unique opportunities. At its best, the small sample size provided an opportunity to truly work with these data as a pilot study and served as a constant reminder to focus on the small details to build a sturdy foundation for the research to follow. At its worst, the small sample size in this study limited the ability to test the more sophisticated planned hypotheses and does not quite advance the knowledge base as far forward as one would have hoped. So, what exactly was learned here?

First, and most importantly, Chapter Three demonstrated a positive effect on participants' mood. Looking solely at the reported scores on various aspects of mood as

participants moved from baseline through the two videos, there is generally an upward, positive trend. This is an important finding: Participants did report an increase in positive emotions after viewing each of the two videos. Natural scenery has been known to positively effect human emotion for a very long time – it's old news, in fact – but there is burgeoning evidence that digital depictions of nature may convey some of the same benefits. Smart phones are ubiquitous in our society and have been for approximately a decade, but new and beneficial uses in social work practice and research continue to be identified. The evidence presented here is not sufficient to see widespread adoption and use of this intervention tomorrow, but it is enough of a finding to indicate that there is *some* effect and that it is worthy of further study.

Second, Chapter Four built on the previous chapter's findings and demonstrated that age is a factor in how older adults respond to this intervention. Specifically, and against the research hypothesis, increasing age may actually *reduce* the effect of the intervention. Several possible explanations come to mind, such as decreasing physiological condition and limited technological interest/know-how. As discussed within the chapter, these factors were originally slated for exploration in this study, but the plans were foiled by small sample size. While that is something of a tragedy for this study, exploration of the effectives of such variables will certainly be part the research equation in future studies.

Lastly, this study provided ample opportunities to learn lessons related to the use of pre-existing technology to develop novel interventions. Yes, it is possible, and yes, it is often far more convenient (and inexpensive!) to use what already exists, but sometimes

custom-designed equipment provides unmistakable advantages. Not having the ability to present the 360º videos within the survey software was a major blow – many people dropped out of the survey after viewing the first video, and for reasons that appear to be related to phones using Android operating systems. At the very least, new data collection software that can bypass factors forbidding the embedding of 360º videos is needed, or perhaps software plus web hosting space that can store the required videos. Developing and disseminating a smart phone app is another possible route, though it could be costly.

To recap, we know that the intervention may work as intended, that it may work differently for people depending on their age, and that it probably needs to run on its own dedicated software. Not to make mountains out of molehills, but these findings are quite useful – and the first of their kind in the social work sphere. Various interventions and services targeting older adults already make use of mobile technology, including telehealth services, which received a tremendous boost in usage as a result of the COVID-19 pandemic, but the future is still wide open and full of possibilities in this domain. This study flings open the doors on this area of research, giving future studies a foundation to build upon, from future behavioural health studies to advocacy and other macro-related social work endeavors.

The future seems bright for an intervention of this kind, with a variety of possible uses across the social work spectrum. Personalized interventions in other areas of social work practice have been around for a long time – music therapy is a perfect example, especially after iPods and other devices became available and the practice became more widely known and implemented. This intervention readily lends itself to personalization –

imagine a digital library of thousands of 360º videos from across the globe, all ready for viewing on a moment's notice. Virtual tourism has already gained some traction with older adults in care homes, so this intervention is ripe for adoption there. Further still, the adoption and use of devices, such as immersive virtual reality headsets, that display 360º videos might find use in nursing homes, hospitals, and hospice settings, providing relaxing and comforting distractions for clients facing some of the most difficult points in their lives. Another possible application of this intervention could be as a distraction or anxiolytic during dialysis, chemotherapy, or other time-consuming medical procedures, where again, being completely immersed in a virtual environment could be a very powerful experience. Having the ability to view 360º videos that last half an hour or more would likely be useful in such scenarios, and indeed, there are many videos available that last several hours. The videos may also be used in conjunction with different forms of guided therapies, including meditation, for a possible boost in effectiveness. These are but a few of the possible uses of this technology. It truly is an area with plenty of room for exploration and growth.

So, as the world rushes itself back to some semblance of pre-COVID normality, the fact remains that some segment of the population is constantly isolated from the greater world, due to physical or mental illness, physical limitations, and even geographic or economic reasons. People in such circumstances are deserving of any attempt to bring the outside world to them, and it should in fact be high on the list of a gerontological social worker's priorities to deliver. As previously discussed, connectedness is a protective factor against a variety of avoidable maladies. This pilot study is the first

(small, but important) step in a much larger effort to keep our most vulnerable populations engaged and uphold their dignity and worth as individuals.

REFERENCES

Anderson, A.P., Mayer, M.D., Fellows, A.M., Cowan, D.R., Hegel, M.T., & Buckey, J.C. (2017). Relaxation with immersive natural scenes presented using virtual reality. *Aerospace Medicine and Human Performance, 88*(6), 520-526.

Appel, L., Appel, E., Bogler, O., Wiseman, M., Cohen, L., Ein, N., Abrams, H.B., & Campos, J.L. (2020). Older adults with cognitive and/or physical impairments can benefit from immersive virtual reality experiences: A feasibility study. *Frontiers in Medicine, 6,* 1-13.

Arcury, T.A., Sandberg, J.C., Melius, K.P., Quandt, S.A., Leng, X., Latulipe, C., Miller Jr., D.P., Smith, D.A., & Bertoni, A.G. (2020). Older adult internet use and eHealth literacy. *Journal of Applied Gerontology, 39*(2), 141-150.

Armitage, C.J., Conner, M., & Norman, P. (1999). Differential effects of mood on information processing: Evidence from the theories of reasoned action and planned behaviour. *European Journal of Social Psychology, 29,* 419-433.

Beal, B. (2017). *Teaching group dynamics using virtual reality.* Retrieved from http://www.socialworker.com/feature-articles/technology-articles/teaching-group-dynamics-using-virtual-reality/

Beil, K., & Hanes, D. (2013). The influence of urban natural and built environments on physiological and psychological measures of stress: A pilot study. *International Journal of Environmental Research and Public Health, 10,* 1250-1267.

Blazer, D. (2020). Social isolation and loneliness in older adults: A mental health/public health challenge. *JAMA Psychiatry, 77*(10), 990-991.

Bond, A., & Lader, M. (1974). The use of analogue scales in rating subjective feelings. *British Journal of Medical Psychology, 47*, 211-218.

Bratman, G.N., Hamilton, J.P., Hahn, K.S., Daily, G.C., & Gross, J.T. (2015). Nature experience reduces rumination and subgenual prefrontal cortex activation. *Proceedings of the National Academy of Sciences of the United States of America, 112*(28), 8567-8572.

Brooke, J. (2020). Older people's early experience of household isolation and social distancing during COVID-19. *Journal of Clinical Nursing, 29*(21-22), 4387-4402.

Browning, M.H.E.M., Mimnaugh, K.J., van Riper, C.J., Laurent, H.K., & LaVelle, S.M. (2020). Can simulated nature support mental health? Comparing short, single-doses of 360-degree nature videos in virtual reality with the outdoors. *Frontiers in Psychology, 10*, 1-14.

Calogiuri, G., Litleskare, S., Fagerheim, K.A., Rydgre, T.L., Brambilla, E., & Thurston, M. (2018). Experiencing nature through immersive virtual environments: Environmental perceptions, physical engagement, and affective responses during a simulated nature walk. *Frontiers in Psychology*, *8*, 1-14.

Chirico, A., & Gaggioli, A. (2019). When virtual feels real: Comparing emotional responses and presence in virtual and natural environments. *Cyberpsychology, Behavior, and Social Networking, 22*(3), 220-226.

Chung, K., Lee, D., & Park, J.Y. (2018). Involuntary attention restoration during exposure to mobile-based 360° virtual nature in healthy adults with different

levels of restorative experience: Event-related potential study. *Journal of Medical Internet Research, 20*(11), e11152.

Dadvand, P., Nieuwenhuijsen, M.J., Esnaola, M., Forns, J., Basagaña, X., Alvarez-Pedrerol, M., … Sunyer, J. (2015). Green spaces and cognitive development in primary school children. *Proceedings of the National Academy of Sciences of the United States of America, 112*(26), 7937-7942.

Dadvand, P., Pujol, J., Macià, D., Martínez-Vilavella, G., Blanco-Hinojo, L., Mortamais, M., … Sunyer, J. (2018). The association between lifelong greenspace exposure and 3-dimensional brain magnetic resonance imaging in Barcelona schoolchildren. *Environmental Health Perspectives, 126*, 1-8.

Dahai, L., Machiarella, N.D., & Vincenzi, D.A. (2009). Simulation fidelity. In D.A. Vincenzi, J.A. Wise, M. Mouloua, & P.A. Hancock (Eds.), *Human factors in simulation and training* (pp. 61-73). Boca Raton, FL: CRC Press.

Dargar, S., Kennedy, R., Lai, W., Arikatla, V., & De, S. (2015). Towards immersive virtual reality (iVR): A route to surgical expertise. *Journal of Computational Surgery, 2*(2), 1-26.

Frumkin, H. (2001). Beyond toxicity: Human health and the natural environment. *American Journal of Preventive Medicine, 20*(3), 234-240.

Glacken, C.J. (1967). *Traces on the Rhodian shore: Nature and culture in western thought from ancient times to the end of the eighteenth century.* University of California Press.

Grinde, B., & Grindal Patil, G. (2009). Biophilia: Does visual contact with nature impact on health and well-being? *International Journal of Environmental Research and Public Health, 6,* 2332-2343.

Han, R.T., Kim, Y.B., Park, E.H., Kim, J.Y., Ryu, C., Kim, H.Y., Lee, J., Pahk, K., Shanyu, C., Kim, H., Back, S.K., Kim, H.J., Kim, Y.I., & Na, H.S. (2018). Long-term isolation elicits depression and anxiety-related behaviors by reducing oxytocin-induced GABAergic transmission in central amygdala. *Frontiers in Molecular Neuroscience, 11*, 1-12.

Harris, P.A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J.G. (2009). Research electronic data capture (REDCap) – A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics, 42(2), 377-81.*

Harris, P.A., Taylor, R., Minor, B.L., Elliott, V., Fernandez, M., O'Neal, L., McLeod, L., Delacqua, G., Delacqua, F., Kirby, J., & Duda, S.N. (2019). The REDCap consortium: Building an international community of software partners. *Journal of Biomedical Informatics, 95, 1-24.*

Howard, E. (1898). *To-Morrow: A peaceful path to real reform.* Swan Sonnenschein.

IBM Corp. (2020). *IBM SPSS Statistics for Macintosh* (Version 27.0). IBM Corp. https://www.ibm.com/products/spss-statistics

Ingram, J., Hand, C.J., & Maciejewski, G. (2021). Social isolation during COVID-19 lockdown impairs cognitive function. *Applied Cognitive Psychology*, 1-13.

Köhler, S., Crane, J., & Milner, B. (2002). Differential contributions of the parahippocampal place area and the anterior hippocampus to human memory for scenes. *Hippocampus, 12*(6), 718-723.

Kucher, N., Larson, J.M., Fischer, G., Mertaugh, M., Peterson, L., & Gershan, L.A. (2020). 3-dimensional nature-based therapeutics in pediatric patients with total pancreatectomy and islet autotranspant. *Complementary Therapies in Medicine, 48,* 1-4.

Lee, K., & Ashton, M.C. (2004). Psychometric properties of the HEXACO personality inventory. *Multivariate Behavioral Research, 39*(2), 329-358.

Litleskare, S., & Calogiuri, G. (2019). Camera stabilization in 360° videos and its impact on cyber sickness, environmental perceptions, and psychophysiological responses to a simulated nature walk: A single-blinded randomized trial. *Frontiers in Psychology, 10,* 1-13.

Maguire, E.A., Frith, C.D., Burgess, N., Donnet, J.G., & O'Keefe, J. (1998). Knowing where things are: Parahippocampal involvement in encoding object locations in virtual large-scale space. *Journal of Cognitive Neuroscience, 10*(1), 61-76.

Miyazaki, Y. (2018). *Shinrin Yoku: The Japanese art of forest bathing.* Timber Press.

Morgan, T., Wiles, J., Moeke-Maxwell, T., Black, S., Park, H.J., Dewes, O., Williams, L.A., & Gott, M. (2020). "People haven't got that close connection": Meanings of loneliness and social isolation to culturally diverse older people. *Aging & Mental Health, 24*(10), 1627-1635.

Nesbitt, L., Meitner, M.J., Girling, C., Sheppard, S.R.J., & Lu, Y. (2019). Who has access to urban vegetation? A spatial analysis of distributional green equity in 10 US cities. *Landscape and Urban Planning, 181*, 51-79.

Olmsted, F.L. (1952). The Yosemite Valley and the Mariposa Big Trees. *Landscape Architecture, 17*, 20-23.

Park, B.J., Tsunetsugu, Y., Kasetani, T., Kagawa, T., & Miyazaki, Y. (2010). The physiological effects of Shinrin-yoku (taking in the atmosphere or forest bathing): Evidence from field experiments in 24 forests across Japan. *Environmental Health and Preventative Medicine, 15*(1), 18-26.

Platoni, K. (2016). Virtual reality aimed at the elderly finds new fans. *Shots: Health News from NPR*. Retrieved from https://www.npr.org/sections/health-shots/2016/06/29/483790504/virtual-reality-aimed-at-the-elderly-finds-new-fans/

Quach, L.T., & Burr, J.A. (2021). Perceived social isolation, social disconnectedness and falls: The mediating role of depression. *Aging & Mental Health, 25*(6), 1029-1034.

Russell, B.S., Hutchison, M., Tambling, R., Tomkunas, A.J., & Horton, A.L. (2020). Initial challenges of caregiving during COVID-19: Caregiver burden, mental health, and the parent-child relationship. *Child Psychiatry & Human Development*, 1-12.

Salas, R.N., Schultz, J.M., & Solomon, C.G. (2020). The climate crisis and Covid-19 – A major threat to the pandemic response. *New England Journal of Medicine, 383*(11), 1-3.

Schebella, M.F., Weber, D., Schultz, L., & Weinstein, P. (2019). The nature of reality: Human stress recovery during exposure to biodiverse, multisensory virtual environments. *International Journal of Environmental Research and Public Health, 17*(56), 1-24.

Slater, M., Steed, A. McCarthy, J., & Maringelli, F. (1998). The influence of body movement on subjective presence in virtual environments. *Human Factors, 40*(3), 469-477.

Tanja-Dijkstra, K., Pahl, S., White, M.P., Andrade, J., Qian, C., Bruce, M., May, J., & Moles, D.R. (2014). Improving dental experiences by using virtual reality distraction: A simulation study. *PLoS ONE, 9*(3), 1-10.

Tarrant, J., Viczko, J., & Cope, H. (2018). Virtual reality for anxiety reduction demonstrated by quantitative EEG: A pilot study. *Frontiers in Psychology, 9*, 1-15.

Texas State University School of Social Work. (n.d.). *Virtual reality technology lab*. Retrieved from http://www.socialwork.txstate.edu/centers-institutes/VRTL.html/

Traquair, H.M. (1949). *An introduction to clinical perimetry* (6th ed.). St. Louis: C.V. Mosby Company.

Walsh, K.J.E., McBride, J.L., Klotzbach, P.J., Balachandran, S., Camargo, S.J., Holland, G., Knutson, T.R., Kossin, J.P., Lee, T., Sobel, A., & Sugi, M. (2016). Tropical cyclones and climate change. *WIREs Climate Change, 7*, 65-89.

Wang, X., Cai, L., Qian, J., & Peng, J. (2014). Social support moderates stress effects on depression. *International Journal of Mental Health Systems, 8*, 1-5.

Wijma, E.M., Veerbeek, M.A., Prins, M., Pot, A.M., & Willemse, B.M. (2017). A virtual reality intervention to improve the understanding and empathy for people with dementia in informal caregivers: Results of a pilot study. *Aging & Mental Health,* 1-9.

Wildenbos, G.A., Jaspers, M.W.M., Schijven, M.P., & Dusseljee-Peute, L.W. (2019). Mobile health for older adult patients: Using an aging barriers framework to classify usability problems. *International Journal of Medical Informatics, 124,* 68-77.

APPENDICES

Table A-1: Studies Using 360º Video

Authors	Topic	Sample Size	Participant Average Age	Equipment	Findings
Anderson, A.P., Mayer, M.D., Fellows, A.M., Cowan, D.R., Hegel, M.T., & Buckey, J.C. (2017)	Restor-ation, Mood	18	32	Oculus Rift DK2	Participants found VR nature scenery relaxing; Preference for scenery had a significant effect on mood
Appel et al. (2020)	Restor-ation, Mood	66	80.5	Samsung S7 + Gear VR	Most participants felt more relaxed and adventurous after nature VR, with 76% interested in further VR experiences.
Browning, M.H.E.M., Mimnaugh, K.J., van Riper, C.J., Laurent, H.K., & LaVelle, S.M. (2020)	Restor-ation, Mood	98	Unknown. Article only specifies that they are university students.	Galaxy Note 5 + Gear VR	VR and outdoor nature both improved levels of positive affect; both showed associated physiological arousal. Participants rated VR nature to be as restorative as outdoor nature.

Table A-1 Continued

Authors	Topic	Sample Size	Participant Average Age	Equipment	Findings
Calogiuri, G., Litleskare, S., Fagerheim, K.A., Rydgre, T.L., Brambilla, E., & Thurston, M. (2018)	Comp-arison	26	26	Samsung S7 + Gear VR	Participants reported higher exertion in VR walk than outdoor walk, although heart rate and walking speed were equivalent between conditions. Cybersickness was an issue in VR condition, therefore mood data skewed.
Chirico, A., & Gaggiloi, A. (2019)	Comp-arison	50	24	Galaxy Note 4 + Gear VR	No statistically significant difference in the emotional experiences of participants in the *in vivo* and *in virtuo* groups.
Chung, K., Lee, D., & Park, J.Y. (2018)	Restor-ation	40	24	LG G5 + LG VR glasses	Five minutes of VR nature exposure restored involuntary attention as evidenced by P3a amplitudes.
Kucher, N., Larson, J.M., Fischer, G., Mertaugh, M., Peterson, L., & Gershan, L.A. (2020)	Mood	4	Not provided	Oculus Rift	Reduced pain, nausea, and anxiety in pediatric patients (aged 8-18).

Table A-1 Continued

Authors	Topic	Sample Size	Participant Average Age	Equipment	Findings
Litleskare, S., & Calogiuri, G. (2019)	Restor-ation, Mood, Cyber sick-ness	50	30	Samsung S7 + Gear VR	Reduction in cybersickness resulted in improved psychophysiological response in the high-stability condition; physiological measures were similar between the two conditions.
Schebella, M.F., Weber, D., Schultz, L., & Weinstein, P. (2019)	Restor-ation, Mood	52	38	Oculus Rift	When compared to urban environments, recovery was statistically different in low biodiversity environments in the following domains: Perceived stress, anxiety, and happiness. Anxiety recovery scores were significantly greater in low biodiversity than moderate biodiversity environments.
Tarrant, J., Viczko, J., & Cope, H. (2018)	Mood	26	47	Samsung S7 + Gear VR	Significant electrophysiological markers relating to reduced anxiety only appeared after VR condition; Also, VR resulted in both global and regional decreases in beta wave activity in the brain.

Table A-2: *Demographic Characteristics*

	M(*SD*)	Median
Age	64.42 (6.05)	64
	N	%
Gender		
Male	12	27.9
Female	31	72.1
Race/Ethnicity		
Black or African American	1	2.3
Hispanic or Latinx	2	4.7
Multiracial	1	2.3
White or Caucasian	37	86%
Relationship Status		
Married	31	72.1
Divorced	4	9.3
Single	4	9.3
Widowed	2	4.7
Separated or Committed Relationship, Not Married	2	4.7
Education		
High School / GED	4	9.3
Some College	9	20.9
Associate	6	14
Bachelor's	9	20.9
Master's	11	25.6
PhD / Professional	4	9.3
Income		
$20,001 – 40,000	1	2.3
$40,001 – 60,000	6	14
$60,001 – 80,000	8	18.6
$80,001 – 100,000	10	23.3
$100,001+	17	39.5
Health		
Very Poor	1	2.3
Fair	3	7.0
Good	6	14.0

Table A-2 Continued

Very Good	20	46.5
Excellent	13	30.2

Table A-3: *Mean & Standard Deviation for each VAS score*

	Baseline M(SD)	Post-video 1 M(SD)	Post-video 2 M(SD)
Troubled-Tranquil	71.00 (19.198)	78.95 (15.291)	80.02 (13.730)
Tense-Relaxed	67.35 (22.333)	77.79 (18.631)	78.07 (17.370)
Sad-Happy	73.81 (20.066)	74.51 (19.467)	78.53 (15.039)
Hostile-Peaceful	77.26 (20.571)	82.84 (14.259)	83.86 (14.079)
Bored-Interested	66.23 (23.504)	73.00 (15.030)	73.40 (20.299)

Table A-4: *Technology Questionnaire*

	I agree	I disagree
Technology can make life better for everyone.		
I enjoy using new technology.		
We are too dependent on technology in our daily lives.		
Technology does more harm than good.		
Having the latest technology has always been important to me.		
New technology is confusing to me.		

Table A-5: *Nature Questionnaire*

	I agree	I disagree
Being in nature makes me feel good.		
I have spent a lot of my free time outdoors.		
Being in nature worries me (fear of insects, animals, etc.)		
I would rather be indoors than outdoors.		
Being in nature is relaxing.		
I don't find nature agreeable.		
I don't get out in nature as much as I used to because of the COVID-19 pandemic.		
I have *increased* my time spent in nature since the start of the COVID-19 pandemic.		

VITA

Joseph M. Strong was born in Okinawa, Japan. His father was in the United States Air Force, taking the family from Japan, to Oklahoma, California, Florida, and Texas before retirement. He attended the University of Central Florida, earning a BS in Molecular Biology & Microbiology in 2012. He earned his MS in Social Work at the University of Tennessee in 2014. Dr. Terri Combs-Orme, University of Tennessee College of Social Work Professor Emeritus, mentored him and encouraged pursuit of a Doctor of Philosophy, a journey he began in 2015. A gerontological social worker, Strong focuses his research attention on healthy aging, with a particular emphasis on people living with neurodegenerative conditions. After graduation, he will be a post-doctoral fellow at the University of North Carolina – Greensboro in the African American Families and Kinship Care Lab, led by Dr. Tyreasa Washington. He is incredibly grateful for the unending support of his mentors and family throughout this process.