TRANSPORTATION, EMOTION, AND CLIMATE CHANGE ATTITUDE:

UNDERSTANDING MAP READER RESPONSE TO STORYTELLING MAPS

by

MICHALA A. GARRISON

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Student: Michala A. Garrison

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This thesis has been accepted and approved in partial fulfillment of the requirements for the Master of Science degree in the Department of Geography by:

Dr. Carolyn Fish	Chairperson
Dr. Amy Lobben	Member

and

Andy Karduna	Interim Vice Provost for Graduate Studies

Original approval signatures are on file with the University of Oregon Division of Graduate Studies.

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THESIS ABSTRACT

Michala A. Garrison

Master of Science

Department of Geography

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Title: Transportation, Emotion, and Climate Change Attitude: Understanding Map Reader Response to Storytelling Maps

Maps are a key way climate change research is displayed because they are an efficient way to convey spatial aspects of climate change information. However, scientific and so-called objective maps often present climate change as abstract and have the potential of failing to engage readers. Despite the increase in popularity of storytelling maps, few studies have focused on how storytelling maps about climate change effects, such as hypoxia, differ from the more scientific maps created by researchers. By focusing on two variables: 1) narrative structure (how story-like something is) and 2) the inclusion of a map, I conducted a between-subjects user study with four stimuli to measure how these variables influenced 1) narrative transportation, 2) emotion, and 3) climate change and hypoxia attitudes. I found that storytelling maps changed climate change attitudes, but that no single combination of narrative structure and maps led to higher transportation or emotional response.

CURRICULUM VITAE

NAME OF AUTHOR: Michala A. Garrison

GRADUATE AND UNDERGRADUATE SCHOOLS ATTENDED:

University of Oregon, Eugene, OR, 2019-2021
Frostburg State University, Frostburg, MD, 2015-2019

DEGREES AWARDED:

Master of Science, Geography, 2021, University of Oregon
Bachelor of Science, Geography, 2019, Frostburg State University

AREAS OF SPECIAL INTEREST:

Cartography
Climate Change Communication

PROFESSIONAL EXPERIENCE:

Graduate Employee, University of Oregon, 2019-2021

Graduate Fellow, NSF/NCAR Innovator Program, 2019-2021

GIS Analyst, Western Maryland Center for GIS, 2018-2019

AWARDS AND HONORS:

Best Cartographic Research, Hypoxia Season: Low Oxygen Events off the Pacific Northwest Coast, North American Cartographic Information Society (NACIS), 2020

William Loy Award for Excellence in Cartography, Hypoxia Season: Low Oxygen Events off the Pacific Northwest Coast, University of Oregon, 2020

Department of Geography Honor Award, Frostburg State University, 2019

Summa cum Laude, Frostburg State University, Maryland, 2019

CONFERENCE PRESENTATIONS:

Garrison, M. (2021, April). *Understanding Map Reader Response to Climate Change Storytelling Maps* [Paper presentation]. American Association of Geographers (AAG) 2021 Conference, Virtual.

Garrison, M. (2019, April). *The effect of climatic trends on the growing season and their correlation to greenness in the Mid-Appalachian region* [Poster presentation]. American Association of Geographers (AAG) 2019 Conference, Washington, D.C.

Garrison, M. (2018, April). *Site suitability analysis for a solar panel farm in Allegany County, MD, using GIS* [Poster presentation]. American Association of Geographers (AAG) 2018 Conference, New Orleans, L.A.

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CHAPTER I

INTRODUCTION

Climate change is a significant problem facing society and the environment. Despite a survey conducted by Leiserowitz et al. (2020) which reported 73% of Americans believe global warming is happening, most Americans view climate change as a temporally and spatially distant problem, and rank it low in their list of urgent priorities facing society (Leiserowitz, 2005; Pew Research Center, 2014; Trope & Liberman, 2010). Cognitive psychologists studying human behavior and decision-making suggest this low engagement is connected with how climate change is communicated to the public (van der Liden et al., 2015). Maps are commonly part of the visualization toolkit for communicating climate change to the public because of their ability to display the spatial aspects of climate change information. However, scientific, and so-called objective, maps constructed by researchers often present climate change as abstract and have the potential to fail to engage and persuade readers. It is suggested that alternative methods which highlight human experience, emotions, and narratives may be one of the more powerful ways in which to engage audiences (Marx et al., 2007). One method that may involve these engaging characteristics is stories. Recent research has shown stories are an effective means of communicating climate change to non-scientific audiences (Gustafson et al., 2020; Morris et al., 2019; Rickard et al., 2021). In addition, the combination of the two, storytelling and maps, have increased in popularity in recent years as a format to engage map readers. With new geoweb technologies, storytelling maps are now a commercial platform (e.g. ArcGIS StoryMaps) and cartographers have joined newsrooms across the world, transforming the ways journalism is shared with the

public by advancing techniques and using new tools to create immersive, multimedia experiences for readers (Cairo, 2017).

Despite the increasing popularity of storytelling maps and the calls for climate change research to focus on better understanding the emotional component of communication, little research has assessed map readers' responses to storytelling maps of climate change information. More so, there have been calls in the field of cartography for alternative methods of assessing maps that break from the historical focus on map effectiveness or efficiency, and to instead focus on how a map makes readers feel, especially when that map's goal is to tell a story (Roth, 2020).

One way in which stories are theorized to be an effective means of persuading readers is through the potential "transportation" readers experience while they read stories (Green & Brock, 2000). *Narrative transportation* is the process of being "lost in a story" (Nell, 1988) and is "defined by the degree to which a plot activates the story receiver's imagination through an empathic connection with the characters" (Morris et al., 2019, p. 21). The process of being transported by a story has been found to heighten emotional arousal, reduce counter-arguing, and facilitate strong feelings toward story characters and places (Green & Brock, 2000). Therefore, stories have the ability to potentially persuade readers depending on the degree of transportation the reader experiences. The level of transportation can be measured by a series of Likert-scale questions called the Transportation Scale (TS) (Appel et al., 2015; Green & Brock, 2000).

Storytelling maps may increase narrative transportation which will activate the readers' emotions and attention while the basemap and thematic data communicate where

the story is taking place and display spatial information related to the story. Despite this potential, little research has focused on how map readers perceive, understand, and respond to storytelling maps and little research, if any, has attempted measuring the narrative transportation readers may experience while viewing and reading storytelling maps. **Therefore, this research seeks to understand how maps and stories influence readers and focuses on narrative transportation, emotional arousal, and climate change attitudes.**

This research concentrates on ocean hypoxia, an aspect of climate change caused by the mixture of warmer ocean temperatures from fossil fuel burning, local nutrient runoff from cities and agriculture into waterways, and the process of coastal upwelling that brings nutrient-rich and oxygen-poor water to the coast (Adams et al., 2016; Grantham et al., 2004). This mixture of natural and anthropogenic factors leads to worsening events of dissolved-oxygen deficits, or commonly referred to as ocean hypoxia. Hypoxia arises in oceans and waterways across the globe, but this research focuses on communicating its effects in the coastal town of Newport, Oregon.

I administered a between-subjects user study with four stimuli to investigate two variables 1) narrative structure (how story-like text is) and 2) inclusion of a map. The goal was to understand the influence of these two variables on potential narrative transportation, emotional arousal, and climate change and hypoxia attitudes. This research expands our understanding of storytelling maps and ways to study them.

1.1 Research Questions and Aims

The overarching goal of this research was to investigate how storytelling maps, the combination of narratives and place, are experienced by readers regarding narrative

transportation, emotion, and climate change and hypoxia attitudes. This research applies the Transportation Scale (TS) to maps which, to my knowledge, has not been done before. Results of this research will provide guidance for improving cartographic climate change communication by furthering our understanding of storytelling maps and assessing the applicability of the TS to maps. To do this, I answer the following research questions:

Narrative Transportation

1. How does narrative structure and inclusion of a map influence the extent to which readers are transported?

Emotion

2. How does narrative structure and inclusion of a map influence emotional response, intensity, and valence?

Climate Change and Hypoxia Attitudes

3. How does narrative structure and inclusion of a map influence climate change and hypoxia attitude change?

CHAPTER II

LITERATURE REVIEW

The proposed research seeks to better understand storytelling maps. Specifically, I focus on narrative structure and the inclusion of maps in the stimuli for this study and the influence of these two variables on narrative transportation, emotions, and climate change and hypoxia attitudes. In this section, I review the importance of stories to humanity and their incorporation with maps, the process in which stories engage readers, and how these topics tie to climate change communication.

2.1 Climate Change Communication

Climate change communication encompasses numerous research fields, theories, and methods focused on in improving communication of research and information regarding climate change. In the following sections, I discuss relevant research regarding climate change engagement, public apathy, perceived psychological distance, and information processing.

2.1.1 Engagement

Despite that a growing number of people in the United States believe climate change is happening and believe it is human caused, far less are engaged. Here engagement is defined as involvement with climate change issues, either cognitively, affectively, or behaviorally (Lorenzoni et al., 2007). Engagement with the issue remains low as many Americans view climate change as a spatially and temporally distance problem and rank it low in their list of urgent priorities facing society (Leiserowitz, 2020;

Pew Research Center, 2014; Trope & Liberman, 2010). In a nationally representative survey on global warming beliefs, Leiserowitz et al. (2020) found that although 75% of U.S. registered voters think global warming is happening, global warming was only ranked as the 13th most important voting issue. Reasons why engagement remains low are complex.

The complexity of low engagement has sparked numerous explanations as to why. In an attempt to understand this complexity, Norgaard (2011) conducted interviews and collected ethnographic data from residents in a Norwegian town. Towards the beginning of her book, *Living in Denial: Climate Change Emotions, and Everyday Life*, Norgaard dispelled common explanations about why people are failing to act against climate change. Norgaard identified these common explanations for public apathy as 1) *if only people knew* (e.g., the idea that the lack of information and knowledge is a barrier to social action); 2) *if only people cared* (e.g., the assumption that not enough people care about climate change); 3) *hierarchy of needs* (e.g., the idea that people commonly focus on immediate needs first and long term needs later); 4) *all is well* (e.g., the belief that everything will eventually be okay either in the form of faith in the government or technological optimism); and 5) *political alienation* (e.g., the hypothesis that people feel incredibly disempowered leading to a lack of optimism in relation to climate change action). However, Norgaard found that none of these reasons adequately explained the lack of action as residents were educated on the issue, were concerned, had adequate resources and wealth, and had a deep care about future generations. Instead, Norgaard suggested that residents were shielding themselves from emotions of fear, guilt, and helplessness by avoiding the issue of climate change altogether. She argued that

considerations of how emotions, political economy, and social norms play a role in climate change nonresponse are needed in academic research.

Public inaction is not solely an issue in the Norwegian town in Norgaard's book, but is present around the world. Arguably one of the most important places for climate change to matter is in the United States due to its high carbon emissions and political and economic power. However, as mentioned above, engagement is low. Out of 26 surveyed countries, the United States comes in 20th when ranking climate change as a major threat, listing issues of cyberattacks and ISIS higher than climate change (Pew Research Center, 2019). Similar to the Norwegian town, Americans also experience feelings of fear, guilt, and hopelessness; however, these similar emotions are further complicated by facets of the United States such as American individualism, corporate-funded campaigns of skepticism, globalization of capitalism, and American exceptionalism (Norgaard, 2011). The culture of individualism present in American often leads us to bear the responsibility to reduce our individual carbon footprints rather than being critical of our political economic system and industry.

2.1.2 Psychological Distance

Another popular explanation for low climate change engagement is perceived remoteness. Leiserowitz (2006) found that Americans believe climate change impacts will happen somewhere else distant to the United States. This psychological distance can be explained by the *construal level theory* (CLT) by Trope & Liberman (2010) which states the farther removed an object or event is from direct experience, the more abstract the mental images are of that object or event. Some researchers in geography and

cartography have explored the role of the CLT. Johannsen et al. (2018) described how climate change relates to the four dimensions of the CLT: temporal distance ("big impacts will occur in the distance future"), spatial distance ("changes are most apparent in geographically distant places"), social distance ("different people in other places will struggle"), and uncertainty of events ("predictions of the future are always prone to uncertainty"). Researchers in the fields of geography and cartography have studied ways to decrease this psychological distance to climate change. Retchless (2020) explored using location-based augmented reality (AR) to help students visualize what storm surge would look like on their campus. The AR representations of storm surge flooding brought the experience to the participants and their familiar environments which in turn increased feelings of risk and willingness to evacuate. Not only did the Retchless (2020) study allow participants to experience what storm surge flooding looked like in person, it also may have decreased the psychological distance of the hazard.

Although outside the scope of this thesis, it is important that research on climate change communication notes the links between psychological distance and political economy. As Norgaard mentioned in her book, the widening wealth gap and increases in international trade from the globalization of capitalism lead to the displacement of environmental and social problems such as climate change. Economically and politically powerful countries like the United States have been able to push these issues relating to climate change onto other people, species, and places outside of United States borders resulting in many Americans viewing the issues as remote. Despite this displacement, global climate change has begun to affect people and communities within the United States (USGCRP, 2018). The year 2020 brought wildfires, hurricanes, and winter storms

to communities across the United States, but the framing of these events was dramatically different across news sources with differing political and economic goals. Perhaps we will observe a shift in how many Americans remain feeling spatially and temporally distant to climate change as more experience it firsthand. This leaves the question of how engagement might vary between real-life experiences of climate change and indirect experiences that highlight human experience such as those in documentaries or news articles.

2.1.3 Information Processing

In relation to psychological distance resulting in abstract mental images, a majority of climate change information and research is communicated in abstract and statistical formats. Many cognitive psychologists argue that our brains are less likely to process that type of information (Myers et al., 2012). Research in psychology proposes that humans have two ways of processing information in their environment (Chaiken & Trope 1999; Evans, 2008; Kahneman & Tversky, 1979; Sloman, 1996). One of the systems is sometimes referred to as analytical processing and is described as slow, rational, effortful, and analytical. The other system is sometimes referred to as experiential processing and involves automatic and intuitive processing heavily influenced by affect and emotion. While both processes are linked to decision-making, Marx (2007) argues that people rely heavily on experiential processing. However, much climate change research is communicated through statistical and graphical evidence which requires analytical processing—a cognitive effort that people usually expend sparingly (Fiske & Taylor 1991). In fact, research suggests people make up their minds

about a graphic in seconds, rather than the minutes a data rich map or graph requires to interpret (Gigerenzer, 2007; Gladwell, 2005; Olson, 2009; Ware, 2008).

On the other hand, experiential processing, learning through experience, occurs quickly and effortlessly. Especially for people that are not already highly engaged in the issue. In the case of climate change, Myers et al. (2012) argued that people are more likely to process climate change information that is experiential such as through powerful narratives and personal stories. van der Liden et al. (2015) called for translating climate change information into relatable and personal experiences as well. There has been little, if any, cartographic research evaluating the impact maps that embed human experience and stories have on readers.

2.2 Stories

As the previous section alluded to, alternative methods are needed to communicate climate change in order to increase audience engagement. The content of these messages should be relatable, highlight human experience, and contain and evoke emotions. Some researchers suggested stories should be used to communicate climate change science (Dahlstrom, 2014) and many have since evaluated the effect stories had on communication in terms of persuasion, behavioral change, attitude change, risk perceptions, and support for climate change action (Gustafson et al., 2020; Morris et al., 2019; Rickard et al., 2021). However, the importance of stories in human existence is certainly not a new realization as stories are a vital part of humanity. From persuading our decision making (Fisher, 1987) to resembling the neural map of our brains (Donald, 1991; Nelson, 2003; Pinker, 2003; Plotkin, 1982), humans process information and

communicate with others via the story structure (i.e. a beginning, middle, and end, although not necessarily presented in that order) (Gopnik et al., 1999). Perhaps the quantitative revolution and the focus on numerical data has had an impact on how we communicate, especially in terms of research findings. Outside of scientific communication departments of research labs, incorporating stories in research communication feels taboo. Oftentimes graphs and maps created by scientists for other experts are picked up by the media and are failing to engage readers and viewers (Fish, 2020).

The terms narrative and story often make an appearance together and sometimes are used interchangeably. However, this research will differentiate the two. *Story* describes unique elements such as events, places, characters overcoming struggles and reaching goals. *Narrative* is the structure and presentation of these elements and can shape the meaning of the story. For example, the arrangement of the structure of the narrative can have differing effects on readers. Surprise may be evoked when crucial information is held back at the beginning and then presented at the end (Bilandzic et al., 2020; Brewer & Lichtenstein, 1982). In terms of story content, Morris et al. (2019) uses the term *narrative structure* as "the degree to which a narrative tells a story and contains essential features including an identifiable character, plot (temporal dimension, goal), and setting" (p. 21). A *high narrative structure* is more "story-like" with a higher degree of characters, emotion, and events. A *low narrative structure* is less story-like and more informational, statistical, and abstract.

2.2.1 Narrative Transportation

The reason there are calls to incorporate storytelling in climate change communication is because stories are engaging. Immersion into a story that readers experience is known as "narrative transportation" (Green & Brock, 2000). Narrative transportation is the process of being "lost in a story" (Nell, 1988) and is "defined by the degree to which a plot activates the story receiver's imagination through an empathic connection with the characters" (Morris et al., 2019, p. 21). Many have probably experienced this immersion while reading a book or watching a movie. Transportation occurs when all mental systems and capacities become focused on events occurring in a story through an empathic connection with the story's characters (Green & Brock, 2000). Narrative transportation is a convergent process meaning readers are less likely to access their preexisting beliefs which can lessen the probability of the 'boomerang' effect where prior beliefs are actually strengthened (Hart et al., 2011). Therefore, stories have the ability to potentially persuade readers depending on the degree of transportation the reader experiences. When the degree of transportation is high, readers are less likely to resist or argue with the information the story communicates (Green & Brock, 2000). This component of transportation theory can lead to attitude change in readers.

Research in climate change communication has evaluated the potential for transportation to lead to increased engagement. In a study on increasing pro-environmental behavior amongst participants, Morris et al. (2019) found those who read a more story-like narrative were more likely to engage in the pro-environmental behavior and experience increased levels of transportation compared to those that read an informational (less story-like) narrative. In a study on influencing support for sustainable

aquaculture, Rickard et al. (2021) found that a story in a text format was more transporting than a video format and led to higher aquaculture support. Gustafson et al. (2020) found that a radio story from a fisherman about how climate change has affected the places he loves had positive effects on global warming beliefs and risk perceptions.

Green & Brock (2000) hypothesized that higher degrees of transportation have the potential to reduce psychological distance as readers or listeners build an empathic connection to the characters and places in the story. Through experiential information processing, their mental imagery may become less abstract as transportation and the story ignite imagination. However, as I review in the next section, there is an increase in interest in cartography and stories, yet the concept of "narrative transportation theory" has not, to my knowledge, been used to better understand how map readers experience storytelling maps.

2.3 Storytelling and Cartography

From traditional cartographers relying on stories from others in order to complete their maps (Caquard, 2011) to writers and filmmakers using maps to place and imagine their narratives (Conley, 2007; Joliveau, 2009), stories and maps have been intertwined for hundreds of years. With the technological developments of the internet, multimedia cartography has increased in popularity as map makers combine web maps with text, video, image, and audio. Journalistic mapping often employs aspects of multimedia cartography while advancing a story or narration of events (Mocnik & Fairbairn, 2018). This combination of map and story allows for the mixture of spatial data with human

experience which can be engaging for readers and possibility elicit narrative transportation.

Although data visualization is useful for communicating numerical data so readers can recognize themes and patterns, the addition of stories to scientific data display has psychological benefits for engaging and persuading audiences (Morris et al., 2019; van der Liden et al., 2015). Cognitive science suggests that framing data into a sequence of events, or a narrative, elicits episodic memory which allows the reader to better remember information (Ma et al., 2012). Furthermore, the addition of unique story elements like characters, setting, and a plot highlights human experience and emotions which have been found to further engage readers (Marx et al., 2007). These findings suggest that stories, especially those highlighting human experience, have potential to persuade audiences to act on climate change.

Spatial narratives and stories have historically been included in geographic and cartographic work as seen in traditional maps which embedded accounts from explorers (Caquard, 2011), however, digital map storytelling has surged in popularity as technology improves. Cartographers have been combining stories with the richness of interactive maps, images, audio, and video to allow readers to experience the story by activating many senses. Roth (2020) proposed a taxonomy of visual storytelling designs specific to digital mapping that include static news maps, longform infographics, dynamic slideshows, narrated animations, personalized story maps, and multimedia experiences (Table 2.1).

Table 2.1. Taxonomy of map-based visual storytelling designs (Adapted from Roth, 2020).

Design	Definition
Static visual stories	Enforce linearity through partitioning of the layout into frames and clarifying reading with annotation
Longform infographic	Enforce linearity through vertical reading and browser scrolling
Dynamic slideshow	Enforce linearity by advancement through a series of slides
Narrated animations	Enforce linearity by the progression of digital display time
Personalized story maps	Enforce linearity by the order that an individual contributes content to the map
Multimedia experiences	Enforce linearity by anchor tags and hyperlinking
Compilations	Enforce linearity by unfolding events in near real-time or major updates to the design

Software and web-based platforms such as 'ArcGIS StoryMaps' launched by Esri in 2012 offer users templates to fill in their own data and stories which prioritize accessibility and ease of use. However, cartographers have created a variety of unique storytelling maps without these platforms. For instance, Pearce (2008) embedded a story into a static map that broke western cartographic standards, such as changing scale, to provide the map reader with a first-person account to connect them with the story character along their journey across space. Cartographers at major publications like the *Washington Post* and the *New York Times* have increasingly used the longform infographic in which the scroll function takes the reader through the story while maps, images, videos, and other multimedia elements appear and disappear as the user scrolls (Fish, 2020). Fish (2020) found through an analysis of how vivid maps from the media were, that amongst the most vivid were from these major news outlets. Across the cartographic literature, there is no singular definition of a storytelling map other than including story elements like characters, a plot, and setting, and using a narrative structure such as the commonly used three-act narrative (Figure 2.1). Mocnik & Fairbairn

(2018) proposed another method called ‘story focus’ in which they suggest embedding structural features of text into maps for the combination of experience and place.

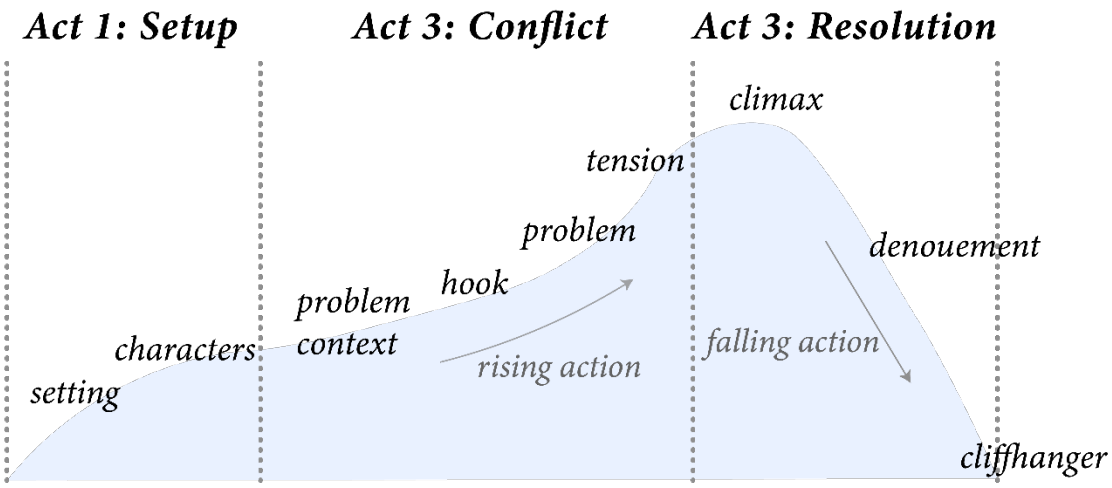


Figure 2.1. Three act narrative. Figure recreated from Roth (2020).

2.4 Emotion

Emotions are also an important component to narrative transportation because emotion and cognition are highly linked. Research has increasingly illuminated the importance of emotion in communication, attitude change, and social action. To name a few, Norgaard (2011) argues emotion is crucial to understanding why there are such low levels of engagement with climate change amongst the public, Van Boven et al. (2010) found that emotion played an important role in reducing psychological distance, and Swim and Bloodhart (2015) found empathic perspective-taking increased environmental support from both environmentalist and non-environmentalists.

There is conflicting research surrounding if positive or negative emotion leads to increased climate change engagement. *Affect* is “the general sense of feeling that you experience throughout each day” while *valence* is how positive or negative the feeling is

(Feldman Barrett 2017). Morris et al. (2019) found that highly transporting climate change videos with negatively valanced endings were better at promoting pro-environmental behavior. Although Morris et al. (2019) found that videos with negative affect increased climate change engagement, they didn't assess what type of negative discrete emotions the participants experienced or what emotional tone the videos had. Similarly, Gustafson et al. (2020) found that the somewhat negative emotions of worry and compassion were associated with higher climate change beliefs and perceptions of risk. In contrast, Swim & Bloodhart (2015) found empathy and hope to be effective appeals when presenting negative narratives. An empathic perspective "increases cooperation, respect, and decreases prejudice, among a host of other pro-social outcomes" (Swim & Bloodhart, 2015, p. 448).

In her research on emotion, Feldman Barrett (2017) proposed the theory of constructed emotion. The theory of constructed emotion argues that emotion categories (sad, happy, angry, and so on) are learned and not discrete, instead evidence suggests that emotions are constructed from our surroundings, our past experiences, and what we've learned to label certain biological responses. The implications this has for research is that is it challenging to measure emotions since they are subjective. Therefore, common and typical measures of emotions such as facial expressions, heart rates, and perspiration are not always correct. Cartographic research has explored mapping emotions, using maps to evoke emotion, and emotions impacting the mapping process (Caquard & Griffin, 2019; Griffin & McQuoid, 2012). Nold (2019) used a combination of GPS, biometric data such as sweat level, and the participant's subjective interpretation of their emotions while

walking through a city in order to map emotions. Perhaps using multiple measures of a person's emotions increases our ability to assess emotion.

2.5 Representing Human Experience Cartographically

There is debate in the fields of geography and cartography surrounding the idea of representing human experience in maps. In the humanities, Knowles et al. (2015) argued that GIS as a method of representing human experience constrains research and shapes empirical results. Alternatively, Knowles urged researchers to use nondigital methods in order to better represent human experience since human experience often lacks the spatial precision that GIS requires. Exploring Lefebvre's (1991) three types of space sheds light on this issue. The three types of space are as follows: 1) "representations of space" (e.g. the actual concrete space as seen), 2) "spatial practice" (e.g. people's everyday movement), and 3) "representational space" (e.g. the meanings we attach to space) (Knowles et al., 2015). While Lefebvre's first and second types of space are mostly suitable for GIS, the third type, "representational space," may be unfit for representing with GIS and western cartographic standards. "Representational space" relates to Tuan's (1977) idea of place as the meanings we attach to the spaces we live. Cartography often uses symbols placed at particular coordinates to communicate the location or process of something which makes visualizing emotion, experiences, place, and perspectives that often lack specific coordinates a difficult task using GIS.

Some cartographers have pushed the boundaries of western cartography in attempts to represent human experience and place in the map. Pearce (2008) used elements like framing, differing scales, and first-person narratives on a map illustrating

the journey of an eighteenth-century fur trader. Kwan (2002) similarly argued that GIS can be re-envisioned in light of feminist visualization practices. Differentiating between the map and the text often placed next to the map to tell the story, Mocnik & Fairbairn (2018) proposed 'story focus' which involved mending the map layers and graphics in order to encompass the abilities of text.

2.6 Summary

Engagement with the issue of climate change is low in America. I reviewed some of the literature as to why this was. Global capitalism increases the spatial and temporal distance between the privileged and social and environmental issues like climate change (Norgaard, 2011). In addition, many cognitive psychologists argued the abstract way climate change information is displayed may further contribute to this psychological distance (Marx et al., 2007; Trope & Liberman, 2010). However, this distance, psychologically and literally, may be decreasing as climate change related events like hurricanes, wildfires, and winter storms occur more frequently in the United States. Increases in geoweb technologies that bring experiences of those effected by climate change to mobile devices could be powerful at mental imagery formation, bringing more closer to the issue and connecting us with distant people and places.

There have been calls to incorporate stories into climate change communication because of their ability to elicit narrative transportation, or the immersion into the narrative world, which can be a persuasive experience (Green & Brock, 2000). Some researchers have found stories to be successful at promoting pro-environmental and climate change attitudes (Morris et al., 2019; Gustafson et al., 2020; Rickard et al., 2021).

Stories and maps have long been intertwined (Harley, 1989); however, the modern combination of the two, storytelling maps, have increased in popularity and have the potential to highlight human experience, contain and evoke emotions, increase narrative transportation, and elicit experiential information processing. Despite the increasingly popularity of storytelling maps, little research has assessed map reader response and experience to understand the potential effectiveness of storytelling maps.

CHAPTER III

METHODOLOGY

The overarching goal of this research is to better understand how two variables: 1) narrative structure (how story-like something is) and 2) the inclusion or exclusion of a map with a narrative may influence a map reader. Specifically, I aimed to measure how narrative structure and the inclusion of a map influence narrative transportation, emotion, and climate change and hypoxia attitudes to answer three specific research questions:

Narrative Transportation

1. How does narrative structure and inclusion of a map influence the extent to which readers are transported?

Emotion

2. How does narrative structure and inclusion of a map influence emotional response, intensity, and valence?

Climate Change and Hypoxia Attitudes

3. How does narrative structure and inclusion of a map influence climate change and hypoxia attitude change?

3.1 Stimuli Design

Narrative structure is defined as "the degree to which a narrative tells a story and contains essential features including an identifiable character, plot (temporal dimension, goal), and setting" (Morris et al., 2019, p. 21). Narratives with a higher narrative structure are more story-like while narratives with a lower narrative structure are less story-like, more informational, fact-based, and scientific. The four stimuli for the user study are as

follows: 1) low narrative text-only, 2) low narrative map, 3) high narrative text-only, and 4) high narrative map. Importantly, all of the stimuli had negatively valanced endings, meaning they are associated with negative emotions, because research suggests negative emotions are associated with promoting pro-environmental attitudes and behaviors (Gustafson et al., 2020; Morris et al., 2019; Peters and Slovic, 2000). The rest of Section 3.1 is organized in the following way: Section 3.1.1 describes the creation of the narratives and the differences between the stimuli with high and low narrative structures and Section 3.1.2 describes the creation of the maps and stimuli using ArcGIS StoryMaps. See Appendix B for links to the four stimuli.

3.1.1 Narrative Structure Text Design

To emulate a high narrative structure, I wrote a fictional story about Alex the fisherman inspired by notes from a 2017 Ocean Acidification and Hypoxia (OAH) Fisherman-Scientists round table discussion (Walker et al., 2017). This story takes the reader on a journey through Alex's and his family's history crab fishing in the coastal town of Newport, OR, and the challenges Alex begins to face regarding ocean hypoxia, a process worsened by climate change where the oxygen levels in water are too low to support living aquatic organisms. The story builds up tension by describing how Alex started noticing changes in Dungeness crab populations and expressing Alex's worries and fears related to supporting his family and losing part of who he is as climate change changes the ocean. Below is a section of the opening paragraph:

> To the sound of his alarm, Alex wakes before the sun has risen. He shuffles to the kitchen to pour coffee into his favorite ceramic mug that consists of the browns, greens, and blues of the Oregon coast. He checks the weather forecast from the coast guard on his phone. The skies look clear, but the waves are larger than he

wants them to be. His phone rings and it's one his crewmembers. It's the first day of crabbing season.

In order for this story to be comparable to other visual stories, the high narrative structure followed the conventional three-act narrative (Figure 3.1) (Song, 2017; Roth, 2020).

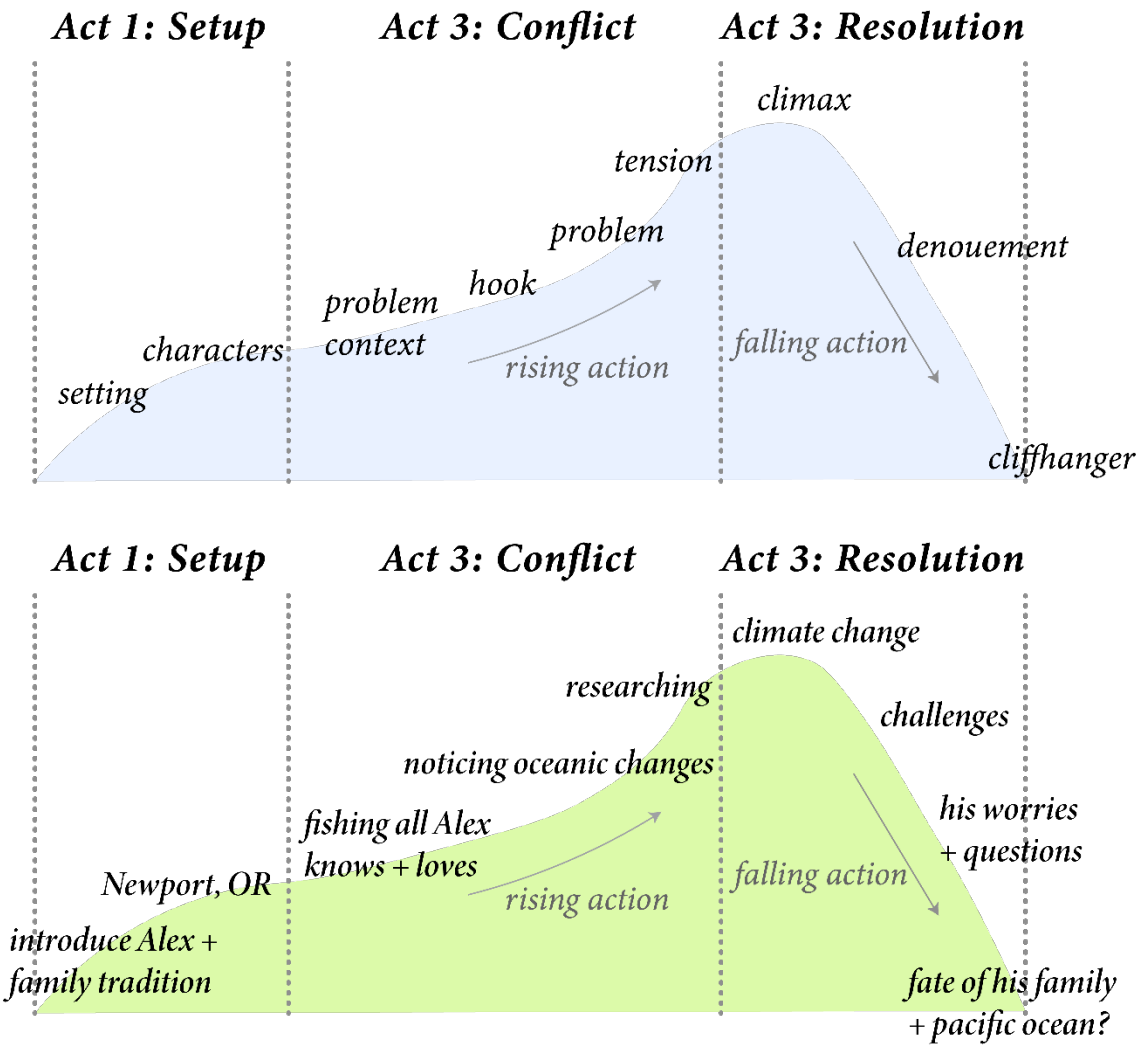


Figure 3.1. The top image (blue) shows the three-act narrative structure and the bottom image (green) shows how I filled in the narrative structure with characters, a setting, a problem, and resolution for the story about Alex the fisherman.

I constructed the low narrative structure text by researching hypoxia and writing about its science and how it affects crab fishers. It was written to mimic scientific and

informational writing. Below is a section of the opening paragraph for the low narrative structure text:

> Carbon dioxide emissions from the burning of fossil fuels are the primary cause of a 40 percent increase in atmospheric carbon dioxide concentrations. These higher levels of greenhouse gases, like carbon dioxide, have increased global temperatures both in the air and the ocean. These warmer ocean temperatures have dire consequences on marine ecosystems and the livelihoods of people that rely on them for jobs and cultural identity.

3.1.2 Map Design

Two of the four stimuli contained maps and photos to mimic journalistic-style map storytelling. I created the maps using Adobe Illustrator and Photoshop. Figure 3.2 shows the maps in the first half of the map stimuli which are used to show locations that the text mentions. These maps introduced the reader/viewer to the setting of the narratives. Maps in the second half of the text contained spatial data to show the reader/viewer the problems of climate change and hypoxia (Figure 3.3). To illustrate some of the causes of hypoxic events, I used a dataset that displayed algal blooms off the Pacific Northwest coast from the Suomi National Polar-orbiting Partnership (Suomi NPP) (NOAA View). Another dataset used to display percent of the water column below the hypoxic threshold is from the JISAO Seasonal Coastal Ocean Prediction of the Ecosystem (J-SCOPE) forecasts (*J-SCOPE*, n.d.). I was able to access this dataset through a collaboration with biogeochemists interested in forecasting ocean acidification and hypoxia (OAH) in the Pacific Northwest at the University of Washington and the University of Connecticut (Siedlecki et al., 2016).

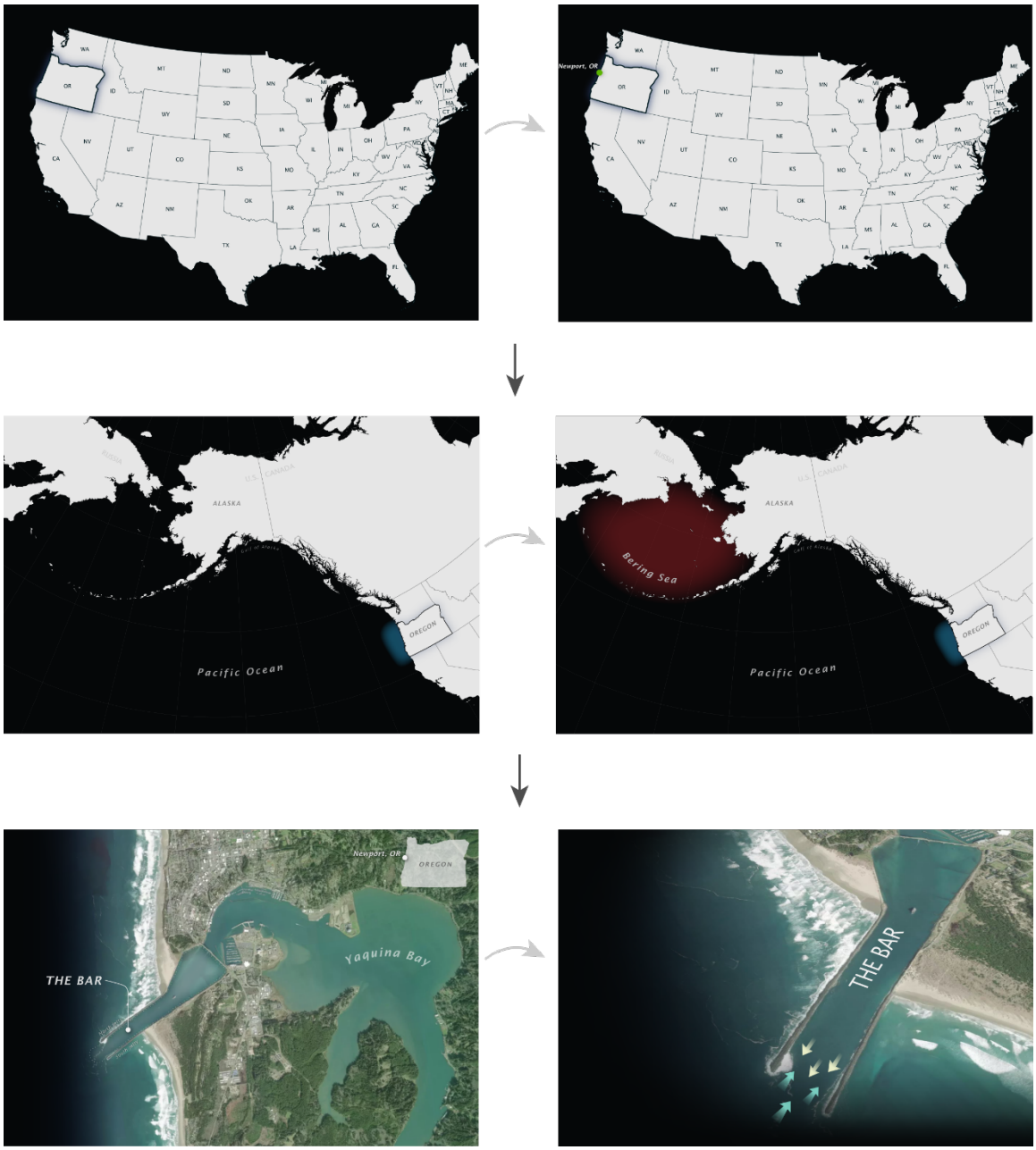


Figure 3.2. The maps used in the first half of the map stimuli that introduce the reader/viewer of the setting location. The vector map data are from Natural Earth and the imagery is from Mapbox. Effects and text were added in Abode Illustrator.

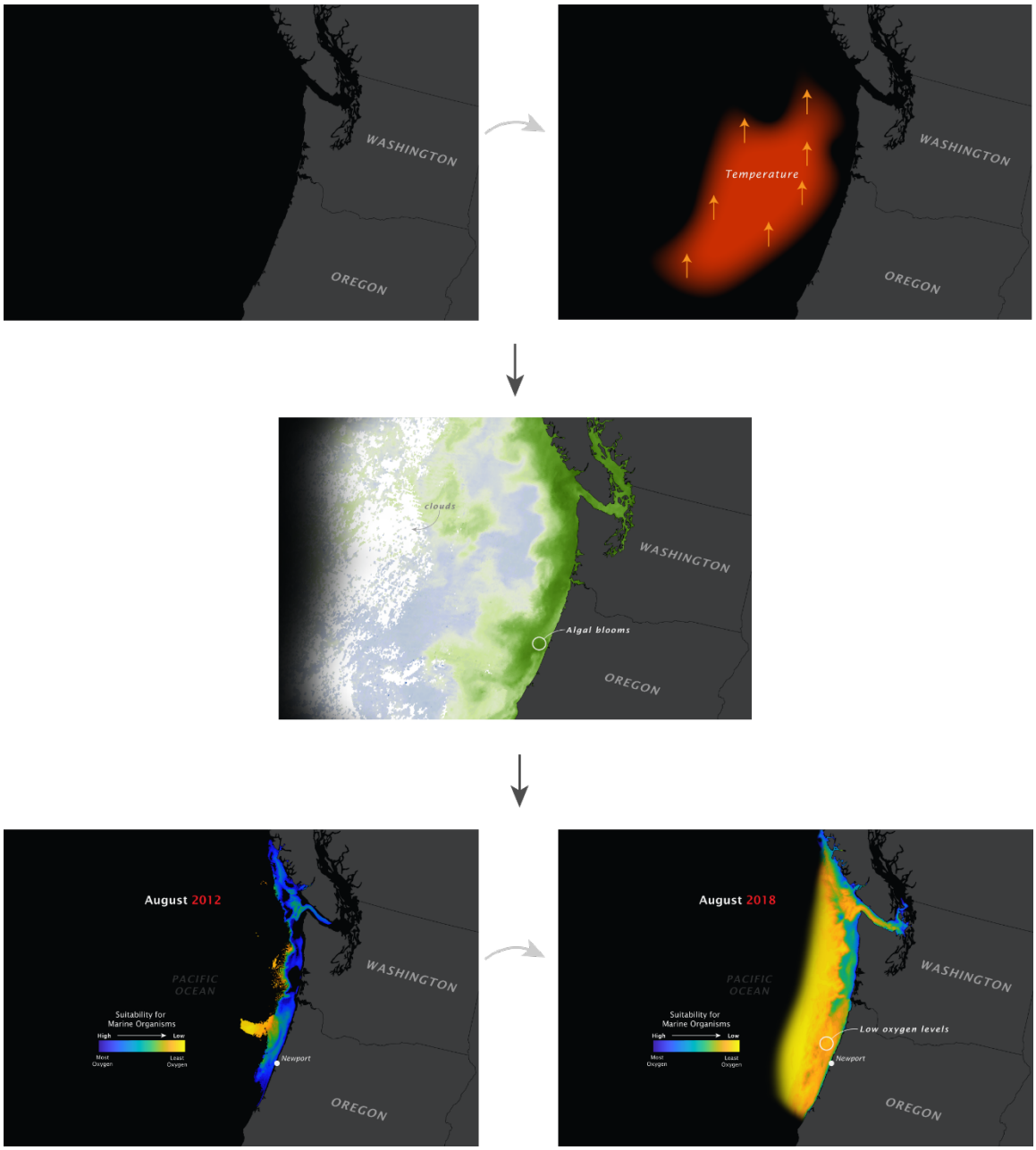


Figure 3.3. Maps in the second half of the map stimuli showing the interactions between climate change, algal blooms, and hypoxia.

3.1.3 Final Stimuli Design

Each stimulus was created with ArcGIS StoryMaps. The online platform was chosen because it is user-friendly for scientists who might want to create something like this for their own data. In addition, it mimics a webpage someone could come across while online. Figure 3.4 displays the organization of the four stimuli regarding narrative structure and inclusion of a map.

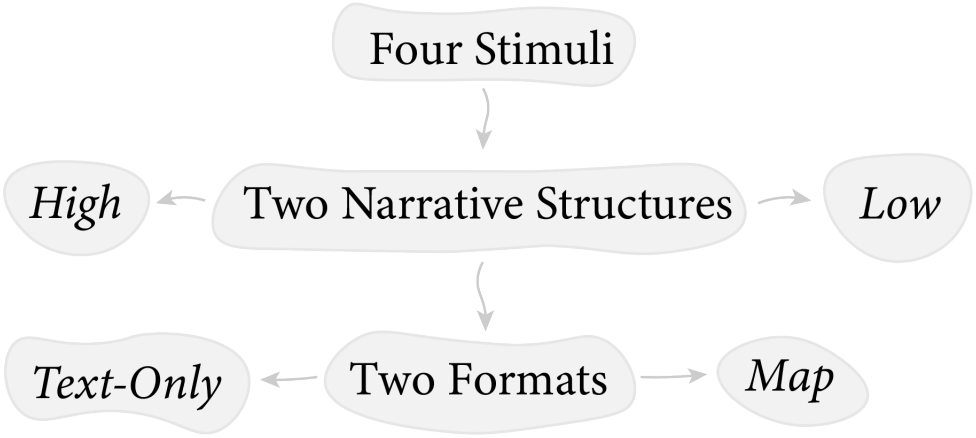


Figure 3.4. The stimuli organization. Two of the stimuli contain the high narrative structure while the other two contain the low. These narrative structures are presented within two formats: either text-only or woven into a map.

Two of the four stimuli used the high narrative structure and the difference between these two high narrative stimuli were that one was text-only (no photos, no maps) and the other was a map (included photos, maps). The other two stimuli contained the low narrative structure and, similarly, one was text-only and the other was a map. Each stimulus contained 851 words, and the map stimuli both contained eight maps and six photos. Table 3.1 describes the characteristics of each stimulus.

Table 3.1. Features of each stimulus.

Stimuli	Title	Narrative Structure	Format	# of Words	# of Maps	# of Photos
Low Narrative Text-Only	*Changing Oceans: Low Oxygen Conditions off the Pacific Northwest Coast*	low	text-only	851	0	0
Low Narrative Map	*Changing Oceans: Low Oxygen Conditions off the Pacific Northwest Coast*	low	map	851	8	6
High Narrative Text-Only	*Changing Ocean, Changing Lives: A Story of an Oregon Fisherman*	high	text-only	851	0	0
High Narrative Map	*Changing Ocean, Changing Lives: A Story of an Oregon Fisherman*	high	map	851	8	6

In order to make the stimuli as congruent as possible while also varying the key variables, all four used the same color schemes and fonts (known as 'themes' in ArcGIS StoryMaps). Each of the four stimuli began with a cover photo of Yaquina Bay in Newport, OR, a title, and a subtitle. The map stimuli were created using the ArcGIS StoryMaps' sidecar template which "pairs a stationary media panel with a scrolling narrative panel into a single slide" (Wilber, n.d.). I placed the maps I created from Adobe Illustrator and Photoshop into the media panel and inserted the low narrative text for the low narrative map or the high narrative text for the high narrative map into the scrollable narrative panel. Figure 3.5 visually illustrates what each stimulus contained.

3.2 Experiment Design

This human subjects user study was reviewed and approved by the University of Oregon's Institutional Review Board (IRB) (#06302020.031). The following sections describe the user study and its measures which were implemented using Qualtrics (Qualtrics, 2005) online survey software and participants navigated to the site and were paid through the online platform Prolific (Prolific, 2014).

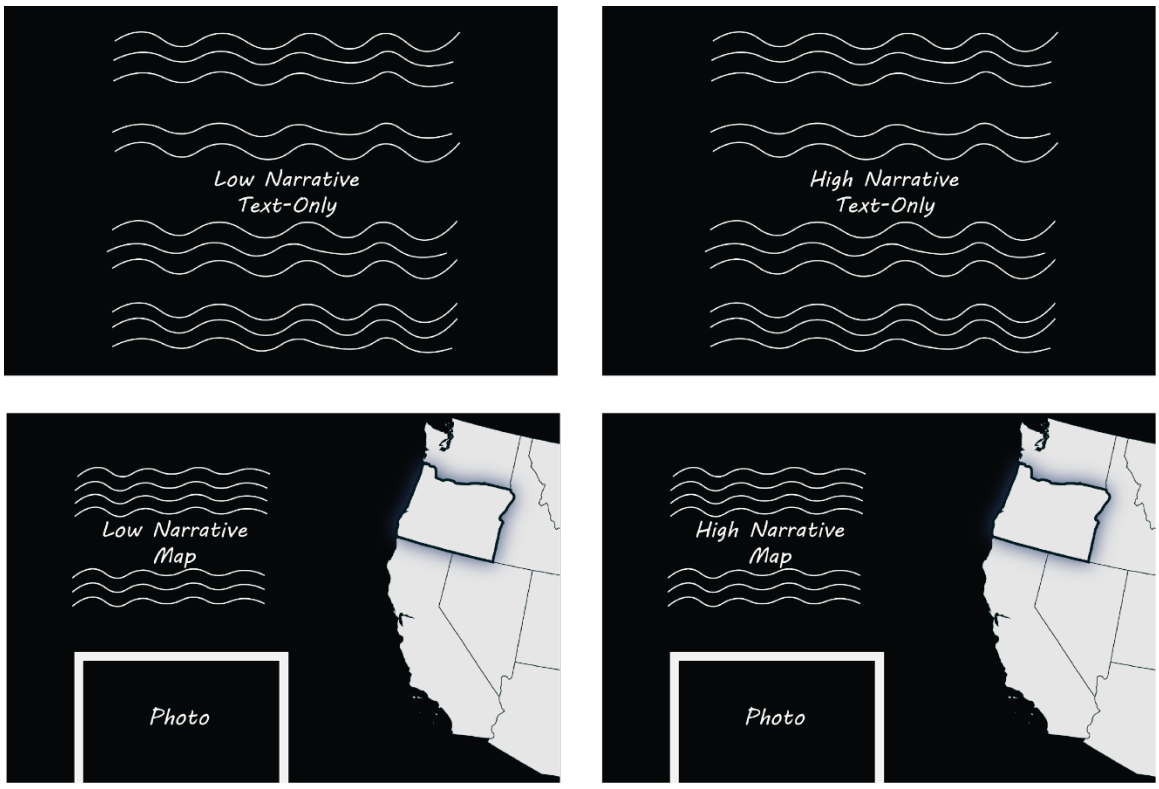


Figure 3.5. Simplified versions of each stimulus.

3.2.1 Participants

A total of 205 participants were solicited through the online participant recruitment platform Prolific (Prolific, 2014). Participants were limited through Prolific to those on a desktop device and only recruited participants who had listed their current geographic residence as the state of Oregon. I was specifically interested in the residents of the Willamette Valley region of Oregon because this is where most of the Oregon population resides and this population visits the coast but does not directly experience the effects of climate change and hypoxia. Because Prolific only allowed me to limit participants to the State of Oregon, to further limit my participant pool, participants were

asked for their zip code so I could focus my analysis on those Oregon residents in the Willamette Valley (Figure 3.6).

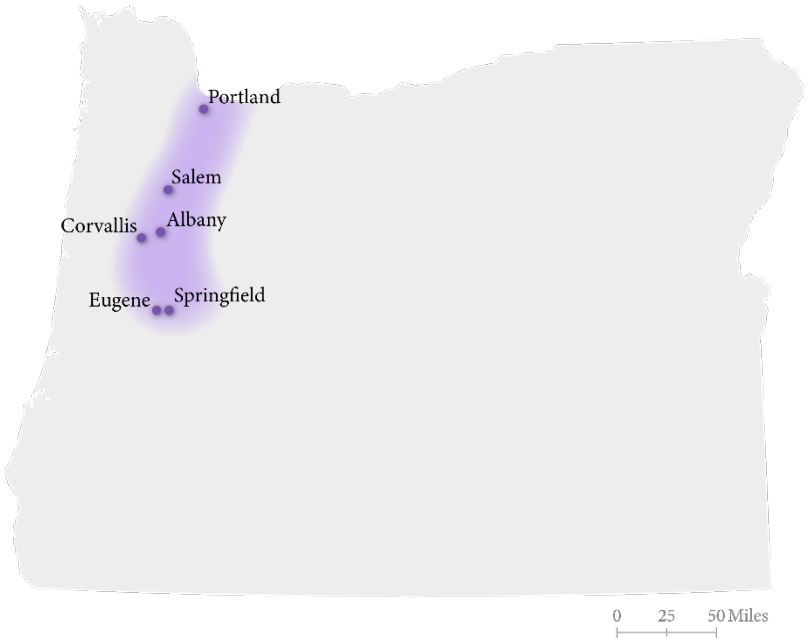


Figure 3.6. Participant pool focused in the Willamette Valley region in Oregon.

A total of 34 responses were removed from the analysis because the zip codes were not located within the Willamette Valley. The total number of participants analyzed in the user study was 171. All 205 solicited participants were paid $4.17 for completing the study regardless of whether they had a Willamette Valley zip code.

3.2.2 Materials

The user study consisted of seven parts: 1) introductory questions, 2) & 3) a pre and post-treatment climate change and hypoxia attitudes, 4) the stimuli, 5) narrative transportation assessment, 6) emotion assessment, and 7) measurement of general climate

change and hypoxia support. The sections below describe these in detail. See Appendix A for the user study organization and all of the questions used.

3.2.2.1 Introductory Questions

Participants were asked screener validation questions regarding if they are on a desktop/laptop computer and if they are a resident of Oregon to confirm participants' prescreening responses are accurate and up-to-date in the Prolific system. Once directed to the user study in Qualtrics, participants were then were asked to type their Oregon zip code to screen for residents that live in the Willamette Valley in Oregon.

3.2.2.2 Pre- and Post-Treatment: Climate Change and Hypoxia Attitudes

Participants completed pre-treatment and post-treatment questions to assess their opinions regarding climate change and hypoxia. Participants' familiarity (1 = *"not at all familiar"* to 5 = *"extremely familiar"*), attitude on the seriousness (1 = *"strongly disagree"* to 5 = *"strongly agree"*), care (1 = *"strongly disagree"* to 5 = *"strongly agree"*), and willingness to take action on hypoxia (1 = *"strongly disagree"* to 2 = *"strongly agree"*). The option of *"I don't know what hypoxia is"* was provided as a potential response for attitude, care, and willingness to take action and was coded as a missing value to not assume unfamiliarity equals *"neutral"* on the topic of hypoxia. At the end of the study, I added descriptive text to acknowledge the stimuli they had just viewed and asked them to answer the hypoxia attitude questions again. This repetition of these questions was designed to assess any changes to the participants' hypoxia attitudes.

For the pre-treatment Likert questions on hypoxia attitude, the Cronbach's alpha testing the internal consistency of the four Likert questions, minus the familiarity question, was 0.81 so the responses were averaged into an index for pretest attitude on hypoxia (M = 3.83; SD = 0.63). The Cronbach's alpha for the three post-treatment questions on hypoxia was also 0.81 so the post-treatment Likert questions on hypoxia were also averaged into an index to measure posttest hypoxia attitude (M = 4.31; SD = 0.58).

For climate change attitudes, participants were provided a definition of climate change and then asked to indicate the degree to which they thought climate change was happening (1 = *"I strongly believe climate change is NOT happening"* to 7 = *"I strongly believe climate change IS happening"*), is human caused (1 = *"I believe climate change is caused entirely by natural changes in the environment"* to 7 = *"I believe climate change is caused entirely by human activities"*), and their willingness to join a movement to reduce climate change (1 = *"I definitely would NOT do it"* to 7 = *"I definitely would do it"*). I adapted the questions from Gustafson et al. (2020). Participants were presented with these same questions at the end of the study to assess any changes to the participants' climate change attitude. I added descriptive text to acknowledge the stimuli they just viewed and asked them to answer the climate change attitude questions again. On a reliability check, these items were averaged into an index for pretest climate change attitude (M = 6.0, SD = 0.96, $\alpha = 0.72$) and posttest climate change attitude (M = 6.03, SD = 0.86, $\alpha = 0.66$). A Cronbach's alpha of 0.65 is a recommend minimum for some (Goforth, 2015); however, I also assessed each of the pretest and posttest climate change attitude Likert items individually.

3.2.2.3 Stimuli

As this was a between-subjects user study, participants were randomly assigned to read/view one of the four stimuli: 1) low narrative text-only, 2) low narrative map, 3) high narrative text-only, and 4) high narrative map (Table 3.2).

Table 3.2. The stimuli used in the between-subjects user study and the corresponding number of participants that read/viewed each stimulus.

Stimuli	*Sample size (n = 171)*
Low Narrative Text-Only	44
Low Narrative Map	35
High Narrative Text-Only	48
High Narrative Map	44

3.2.2.4 Narrative Transportation

To assess whether participants were transported by the different stimuli, they answered questions from the Transportation Scale (TS) measure. The TS is a common and supported method of measuring narrative transportation (Green & Brock, 2000). This research used 5 items of a 6-item shortened version of the TS created by Appel et al. (2015) on a scale from 1 = *not at all* to 7 = *very much*. I modified the wording slightly so the items were applicable to either the high narrative structure, where I used the term 'story' or the low narrative structure, where I used the term 'narrative.' Figure 3.7 shows an example question from the TS. Following other researchers that use the TS (Appel et al. 2015; Rickard et al. 2021), these items were averaged into an index for transportation on reliability check ($M = 5.33$; $SD = 1.14$; $\alpha = 0.84$).

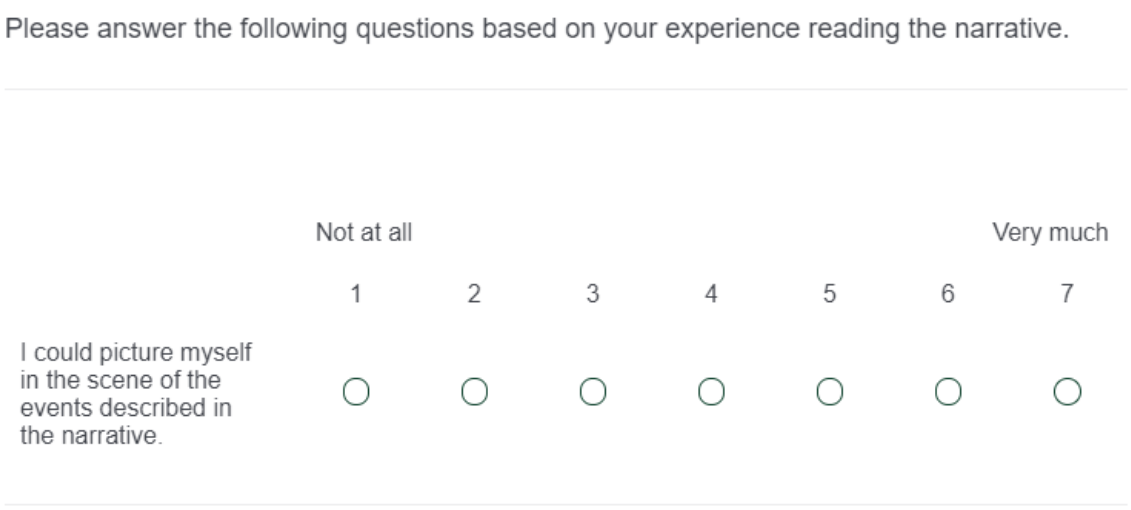


Figure 3.7. One Likert-item from the five items of the TS.

3.2.2.5 Emotions

To measure emotions, I used the Geneva Emotion Wheel (GEW; Scherer, 2013) using the Qualtrics heatmap function (Figure 3.8) to collect self-reported emotions experienced while looking at the stimuli. The GEW consists of 40 discrete emotion words corresponding to emotion families along the circumference of a circle. The circle of emotion concepts lies on a grid with four quadrants, with the x-axis for valence (unpleasant to pleasant) and the y-axis for control (power). In the center of the wheel, respondents can choose "no emotion" and "other emotion." To input "other emotion" participants answered a follow-up question where they typed their "other" emotion and indicated the level of intensity using a 6-point Likert scale (1 = "*Low*" to 6 = "*High*").

The measures I analyzed from the GEW included emotion concept, emotional intensity, and emotion valence. Emotion intensity varied from 1 (weak) to 6 (strong), unless the participant chose 'none' for no emotion experienced which was coded as a missing value (Jonauskaite et al., 2020). Some participants clicked on the emotion word

text box instead of the corresponding 'spoke' for intensity and these were also coded as missing values in order to not make assumptions regarding intended intensity level. If the chosen emotion word was located on the left side of the y-axis, the emotion valence was coded as "*negative*" and if located on the right side, coded as "*positive*." If participants typed in their own emotion word, I used my best judgement for choosing the correct emotion valence.

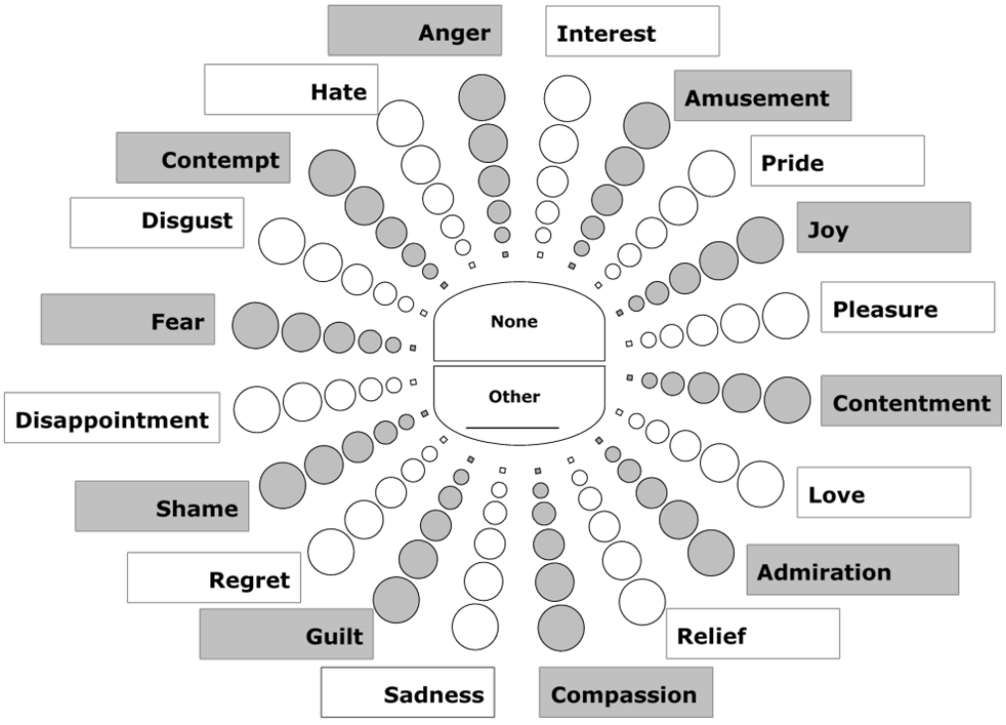


Figure 3.8. The Geneva Emotion Wheel (GEW) (Scherer et al. 2013).

3.2.2.6 Stimuli Understanding

To assess whether participants understood the stimuli and how they interpreted the information from the stimuli, participants were asked to write what the narrative they just read was about: *"In your own words, what was the narrative you just read about?*"

3.2.2.7 Support for Climate Change and Hypoxia

Finally, participants answered questions regarding how likely they were to engage in the following activities: if they would support policies that fund climate change research (1 = *"extremely unlikely"* to 7 = *"extremely likely"*), join a movement to raise awareness about how hypoxia is affecting the marine environment in Oregon (1 = *"extremely unlikely"* to 7 = *"extremely likely"*), and join a movement to raise awareness about how hypoxia affects crab fishers in Oregon (1 = *"extremely unlikely"* to 7 = *"extremely likely"*). These questions were included in the user study to assess general support for combating climate change and hypoxia in Oregon. On a reliability check, the three Likert items returned a Cronbach's alpha of 0.81 so the items were averaged together to create an index of support (M = 5.42; SD = 1.14).

3.3 Procedure

Participants were solicited through Prolific after I published my study to Prolific's website. Prolific then notified eligible participants (Oregon residents) via email. Once they agreed to participate in the study on Prolific they were redirected to Qualtrics through my study's URL. At the outset of the Qualtrics questionnaire participants entered their Prolific ID so that responses could be matched with their demographic data provided by Prolific. Next, participants answered introductory questions followed by the pre-treatment climate change and hypoxia attitude questions. Participants were then provided with a link to one of the four stimuli. Clicking on the link opened a new tab in their web browser to view the stimuli in the ArcGIS StoryMap interface containing the stimuli they were randomly assigned. Once they read through the narrative on the

StoryMap, they could then click back to the Qualtrics tab to continue answering questions in the user study. Participants then answered the TS, rated their emotional response on the GEW, and then answered the open-ended "understanding" question. Finally, the participants answered the post-treatment climate change and hypoxia attitude questions and answered three questions on general climate change and hypoxia support. Once the participants finished the last question they were redirected to Prolific and their answers were automatically recorded.

CHAPTER IV

RESULTS

This chapter examines the statistical results of the analyses conducted on the data collected from the user study. The user study data were exported from Qualtrics to IBM SPSS Statistics 27 for analysis. Nonparametric analyses were used because the user study Likert-scale data were largely non-normally distributed and samples sizes could be considered too small to permit parametric tests (Siebert & Siebert, 2018).

4.1 Participant Characteristics

Data of 171 participants located in the Willamette valley were analyzed (Figure 4.1). The average time the user study took to complete was around 10 minutes. There were more participants that identified as 'female' (52.6%) than those that identified as 'male' (46.8%), while just 0.6% that 'preferred not to say' (categories chosen by Prolific). Table 4.1 provides a breakdown of the participant sample in total and for each stimulus.

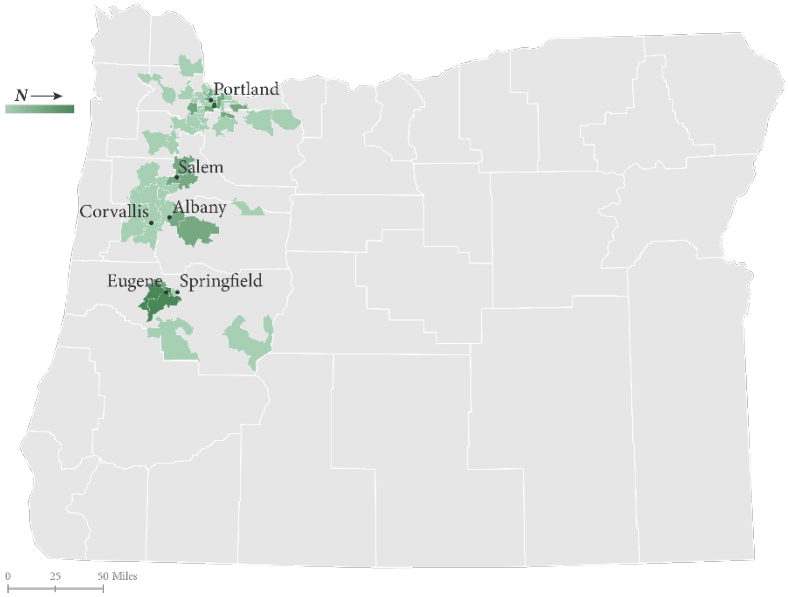


Figure 4.1. Frequency of participants' zip codes within Willamette Valley region.

Table 4.1. Demographic data of between-subjects user study.

	Low Narrative Text-Only	Low Narrative Map	High Narrative Text-Only	High Narrative Map	Total
Age (years)					
18-20	9.1%	11.4%	4.2%	11.4%	8.8%
21-25	13.6%	17.1%	22.9%	13.6%	17%
26-30	22.7%	28.6%	8.3%	18.2%	18.7%
31-36	15.9%	22.9%	14.6%	18.2%	17.5%
36-40	11.4%	8.6%	12.5%	18.2%	12.9%
41-45	2.3%	5.7%	18.8%	6.8%	8.8%
46-50	11.4%	2.9%	8.3%	4.5%	7%
51-55	6.8%		2.1%	2.3%	2.9%
56-60	2.3%		4.2%	4.5%	2.9%
61-65	2.3%		2.1%	2.3%	1.8%
> 65	2.3%	2.9%	2.1%		1.8%
Gender					
Female	63.6%	48.6%	47.9%	50%	52.6%
Male	36.4%	51.4%	50%	50%	46.8%
Prefer not to say			2.1%		0.6%

Overall, participants were not very familiar with the topic of hypoxia (Figure 4.2).

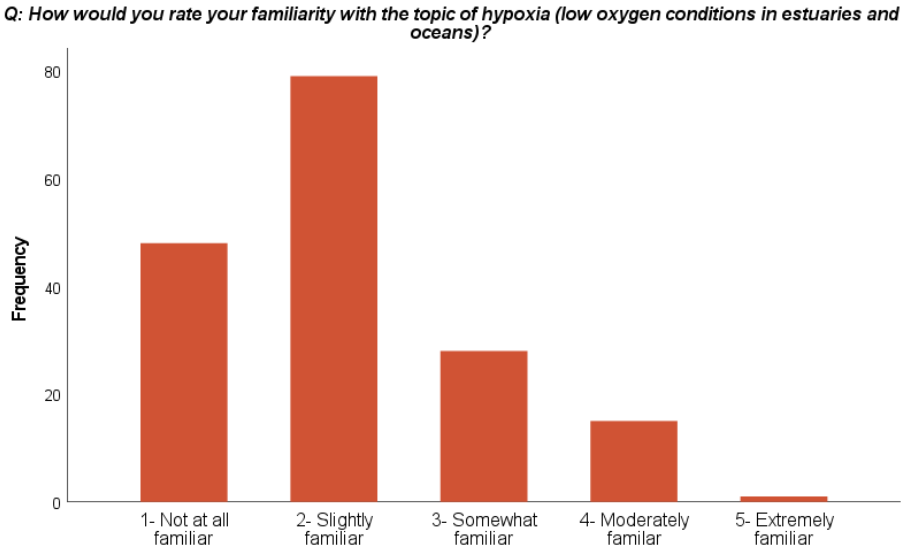


Figure 4.2. Participant familiarity to the topic of hypoxia.

4.2 Transportation

In my user study, the Transportation Scale (TS) measure assessed levels of narrative transportation each participant experienced while reading and viewing the stimuli. As mentioned in the methodology chapter, TS was assessed through 7-point Likert-scale questions ranging from 1 = *not at all* to 7 = *very much* across five questions. To assess differences in levels of transportation between the stimuli, I used the Kruskal-Wallis one-way ANOVA because much of the transportation data for the groups were not normally distributed and this test does not assume normality. Also, I conducted a series of Mann-Whitney U tests for pairwise comparisons of the differences in levels of transportation between the low and high narrative map stimuli, the low and high narrative text-only stimuli, the high narrative map and text-only stimuli, and the low narrative map and text-only stimuli.

4.2.1 Transportation Differences Across All Stimuli

To assess differences in levels of transportation between all four stimuli, I ran the Kruskal-Wallis test. The Kruskal-Wallis test did not find significant distribution differences among the four groups, $H(3) = 4.484$, $p = 0.21$. Figure 4.3 displays each of the four stimuli statistics.

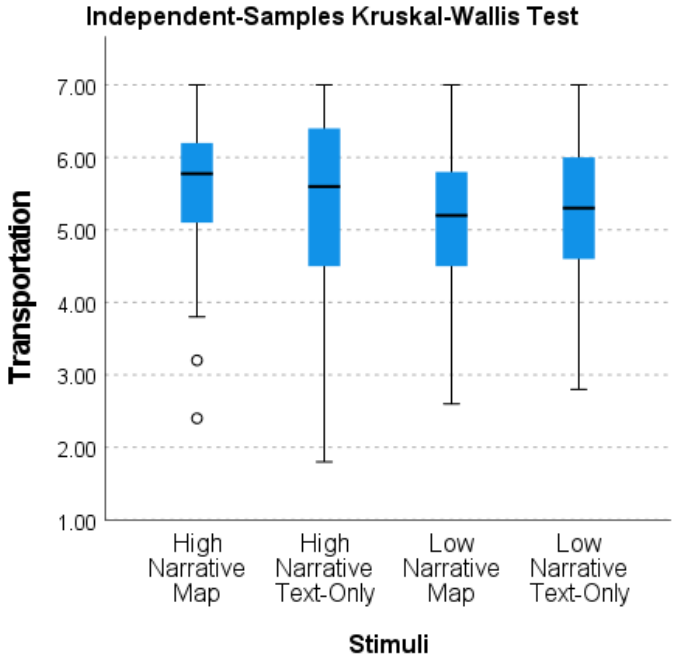


Figure 4.3. Boxplots showing the minimum, first quartile, median, third quartile, and maximum levels of transportation for each stimulus.

Table 4.2 describes the statistics for levels of transportation readers experienced while viewing and reading the four stimuli. The high narrative map returned the greatest average level of transportation (M = 5.58; SD = 0.95).

Table 4.2. Descriptive statistics of narrative transportation for the four stimuli including the mean ranks produced from the Kruskal-Wallis test.

	Statistics						
Stimuli	N	Mean	SD	Median	Rank	Minimum	Maximum
Low Narrative Text-Only	44	5.19	1.14	5.3	79.66	2.8	7.0
Low Narrative Map	35	5.19	1.0	5.2	75.93	2.6	7.0
High Narrative Text-Only	48	5.33	1.38	5.6	89.28	1.8	7.0
High Narrative Map	44	5.58	0.95	5.78	96.77	2.4	7.0

In order to get a closer look at the differences in transportation between each stimulus, I conducted a series of Mann-Whitney U tests. There was no significant difference in level of transportation between the low narrative text-only and the low narrative map ($U = 741.50$; $p = 0.778$), the high narrative text-only and the low narrative text-only ($U = 951$; $p = 0.410$), or the high narrative text-only and the high narrative map ($U = 992.50$; $p = 0.619$). The only pairing that returned a p-value lower than 0.05 was the difference in level of transportation between the low narrative map and the high narrative map, with the high narrative map generating higher levels of transportation ($U = 562$; $p = 0.040$) (Figure 4.4). However, when conducting multiple analyses on the same dependent variable, the chance of committing a Type I error increases; therefore, I calculated the Bonferroni adjusted p-value by dividing the original alpha value (0.05) by the number of analyses (4) to get an adjusted p-value (0.0125). Therefore, I cautiously consider that there is a difference in levels of transportation between the low and high narrative map stimuli.

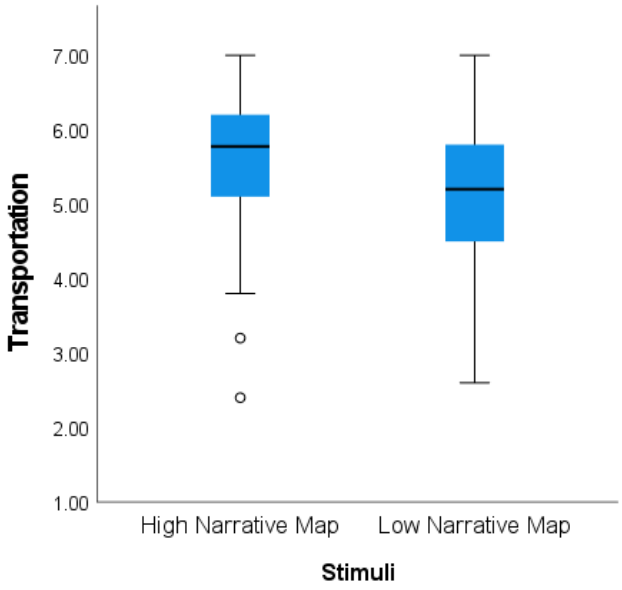


Figure 4.4. Boxplots comparing median levels of transportation for the high and low narrative map stimuli.

4.3 Emotion

The results below represent the analysis of the Geneva Emotion Wheel (GEW). The GEW returned data on emotion words, emotional intensity, and emotion valence. For emotion words, I calculated simple proportions of each reported word per stimulus. For emotional intensity, I used the Kruskal-Wallis one-way ANOVA test and a series of Mann-Whitney U tests to assess differences in levels of emotional intensity between the stimuli because the data were largely non-normally distributed and sample sizes could be considered too small to permit parametric texts (Siebert & Siebert, 2018). For emotion valence, I separated the emotional intensity data into positive and negative valance groups and used the Kruskal-Wallis one-way ANOVA test to determine if certain stimuli evoked more positive or negative emotional responses. The following subsections provide these results while highlighting the differences of emotion between the four stimuli.

4.3.1 Influence of Stimuli on Emotion Words

For the low narrative text-only stimulus (n = 44), the top emotion concepts chosen were *sadness* (47.7%), *fear* (11.4%), *compassion* (11.4%) and *disappointment* (9.1%). For the low narrative map stimulus (n = 34), the top emotion concepts chosen were *sadness* (35.3%), *disappointment* (17.6%), *fear* (14.7%), *compassion* (8.8%), and *anger* (8.8%). For the high narrative text-only stimulus (n = 46), the top emotion concepts chosen were *sadness* (47.8%), *fear* (17.4%), and *compassion* (17.4%). For the high narrative map stimulus (n = 43), the top emotion concepts chosen were *sadness* (44.2%),

fear (16.3%), *disappointment* (14%), and *compassion* (9.3%). Figure 4.5 displays heatmaps of the location participants per stimuli clicked when choosing an emotion word.

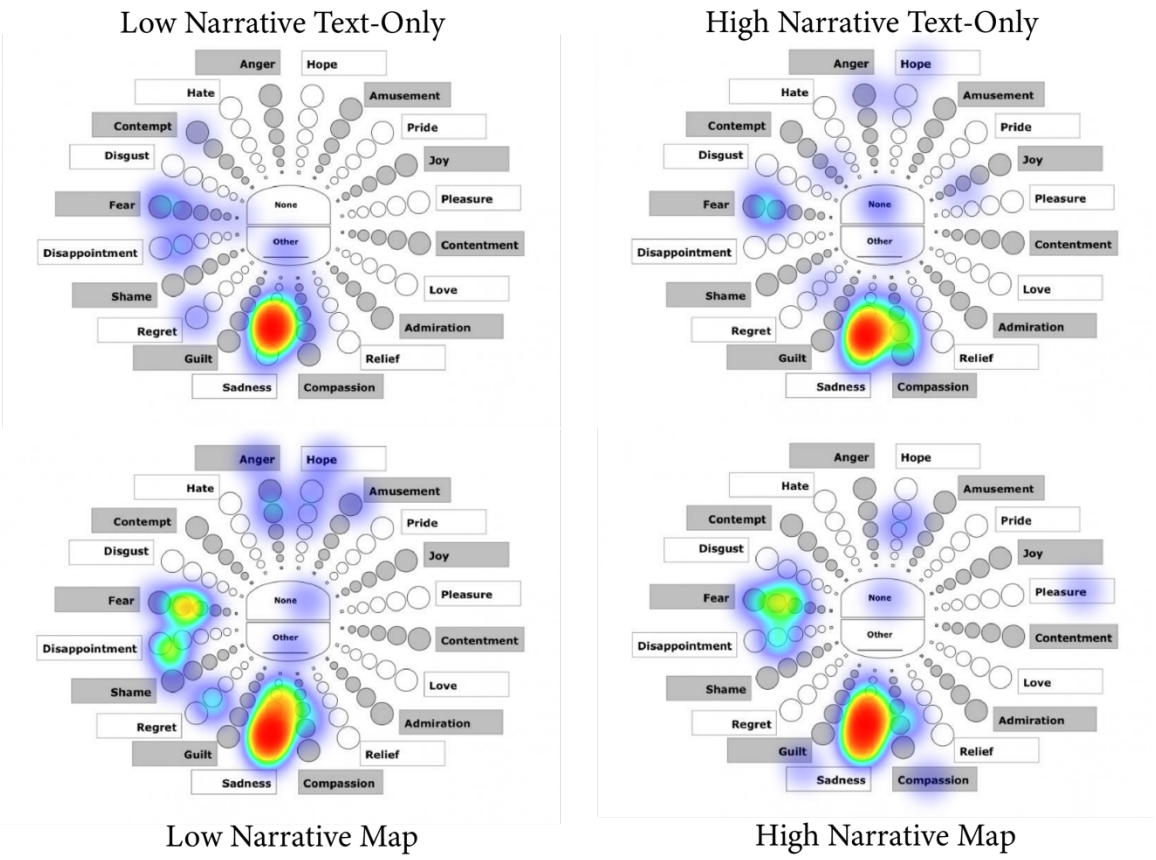


Figure 4.5. Qualtrics generated heatmaps illustrating where participants clicked on the GEW when asked what emotion they experienced while reading/viewing the stimuli.

4.3.2 Stimulus Influence on Emotional Intensity

I ran the Kruskal-Wallis test to assess differences in levels of emotional intensity between all four stimuli, which were 1) low narrative text-only, 2) low narrative map, 3) high narrative text-alone, and 4) high narrative map. The Kruskal-Wallis test showed no significant differences for intensity across the stimuli, $H(3) = 5.100$, $p = 0.165$. Figure 4.6 shows boxplots of emotional intensity for each stimulus.

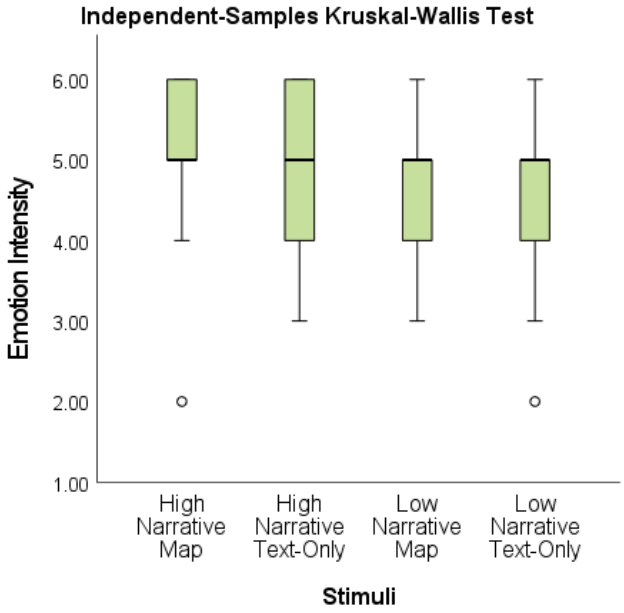


Figure 4.6. Boxplots comparing median emotional intensity measured by the GEW for each stimulus.

The high narrative map had the highest mean level of emotional intensity as well the highest mean rank generated by the Kruskal-Wallis test. Table 4.3 provides descriptive statistics as well as the mean ranks for all stimuli.

Table 4.3. Descriptive statistics for emotional intensity as well as mean ranks from the Kruskal-Wallis test.

Stimuli	*Statistics*						
	N	Mean	SD	Median	Rank	Minimum	Maximum
Low Narrative Text-Only	44	4.73	1.0	5.0	75.45	2.0	6.0
Low Narrative Map	32	4.66	0.90	5.0	70.75	3.0	6.0
High Narrative Text-Only	45	4.93	0.86	5.0	84.10	3.0	6.0
High Narrative Map	40	5.08	0.89	5.0	91.81	2.0	6.0

To get a closer look of the differences between the stimuli, I conducted a series of Mann-Whitney U tests. The only grouping that returned a significant result was the high narrative map compared to the low narrative map ($U = 471.50$; $p = 0.042$) (Figure 4.7). Conducting multiple analyses on one variable increases the likelihood of Type I errors. A Bonferroni adjusted alpha of 0.0125 makes the comparison between the high narrative map and low narrative map no longer significant ($p < 0.0125$). As was done for level of transportation for these two stimuli, I cautiously consider that there is a difference in levels of emotional intensity between the low and high narrative map stimuli.

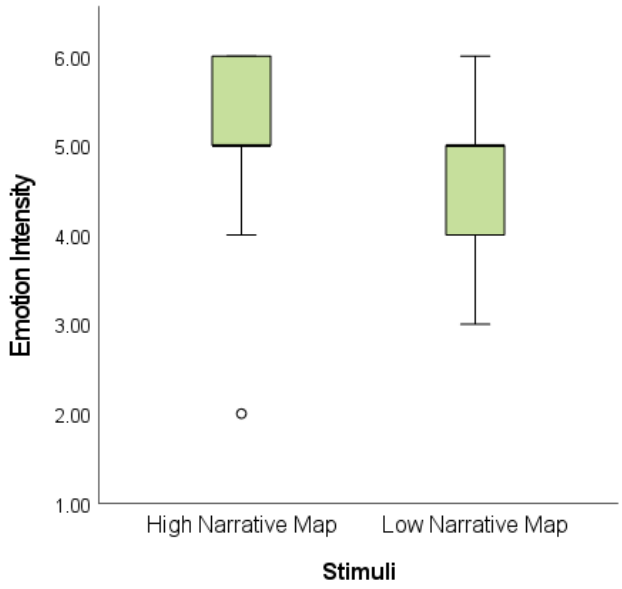


Figure 4.7. Boxplots of emotional intensity for the high and low narrative map stimuli.

4.3.3 Stimulus Influence on Emotional Valence

Valence is how pleasant or unpleasant a feeling is (Feldman Barrett, 2017). Participants experienced negative emotions the most overall (79.5% negative vs 17% positive). By using the emotional intensity data, each stimulus was analyzed to see

differences in positive and negative emotional responses. When isolating for positive emotions, there was no significant difference between emotional intensity levels for the stimuli, $H(3) = 4.097$, $p = 0.251$. When isolating for negative emotions, there was also no significant difference between emotional intensity levels across the four stimuli, $H(3) = 3.174$, $p = 0.366$.

4.4 Pre- and Post-Treatment: Climate Change and Hypoxia Attitudes

This section presents the results of changes in climate change and hypoxia attitudes in order to see which stimuli lead to changes in attitudes. To evaluate differences between pretest and posttest climate change and hypoxia attitudes, I used the Wilcoxon matched pair signed rank test which uses the ordering of positive and negative matched pairs value differences to determine if median values are equal (Siebert & Siebert, 2018). The section 4.4.1 provides the results for changes in climate change attitudes and section 4.4.2 provides the results for changes in hypoxia attitudes.

4.4.1 Climate Change Attitudes

Pretest climate change attitudes were all negatively skewed meaning a majority of participants strongly knew climate change was occurring, human-caused, and were willing to join a movement to combat climate change prior to reading the stimuli narrative. Regarding the existence of climate change, 78.4% of participants chose the

maximum Likert point (7 = "*I strongly believe climate change IS happening*"). Only five participants choose Likert points four and below (Figure 4.8).

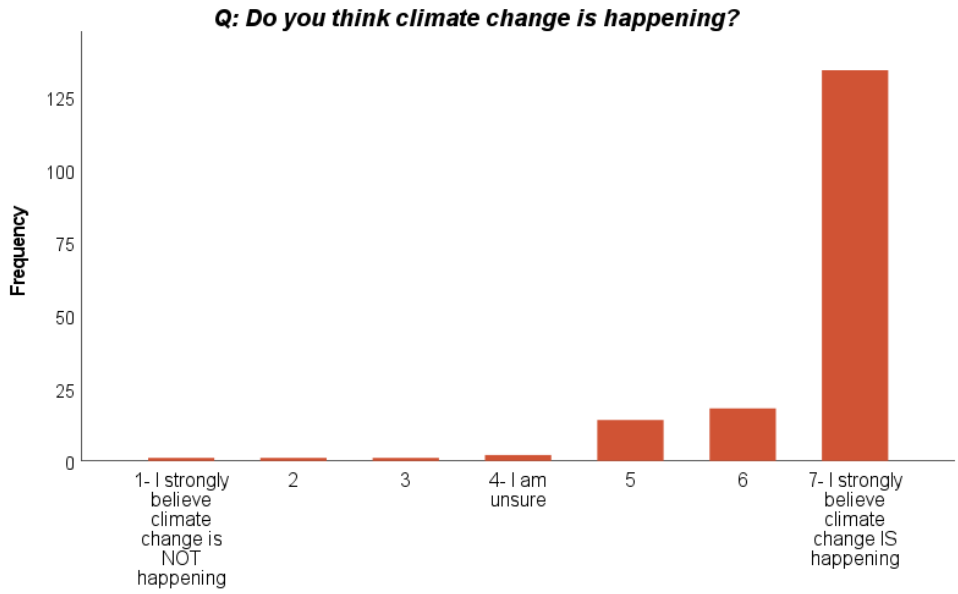


Figure 4.8. Bar graph of participant pretest responses to if they think climate change is happening.

For participant thoughts in the causes of climate change, a majority (60.2%) chose the sixth Likert point out of seven (7 = "*I believe climate change is caused entirely by human activities*"). Only 18 (10.6%) chose Likert points four and below (Figure 4.9). Lastly, for willingness to join a movement to take action to reduce climate change, results were negatively skewed as most participants (92.4%) chose Likert points between "*I am unsure*" and "*I would definitely would do it*" (Figure 4.10).

Overall, the average pretest and posttest climate change attitudes were statistically different, indicating that there is a difference between climate change attitude levels for the pretest and posttest measures ($z = 3.486$; $p = 0.006$). An evaluation of the mean ranks showed that the posttest climate change attitudes were greater than the pretest attitudes.

Each stimulus was analyzed individually in order to understand how differences in narrative structure and inclusion of a map influenced changes in climate change attitudes.

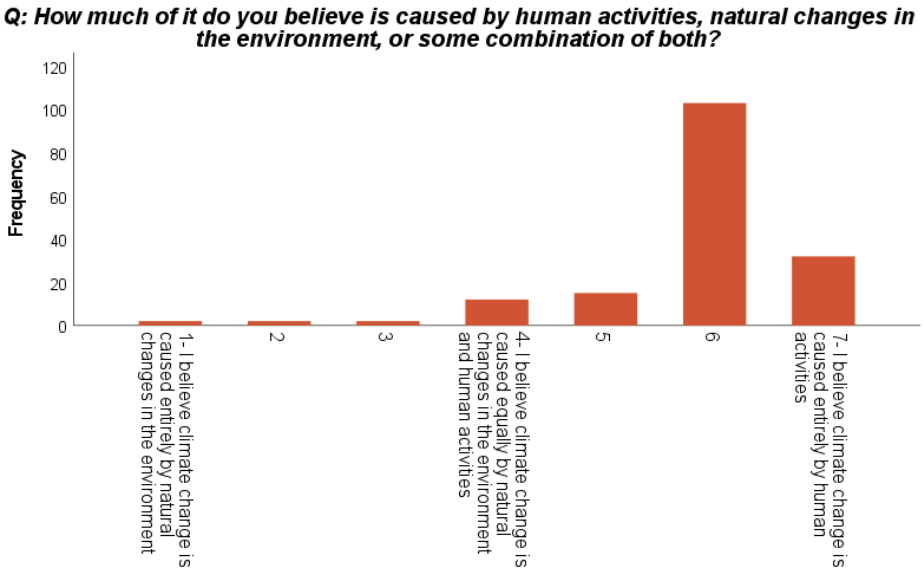


Figure 4.9. Pretest Likert responses to the causes of climate change.

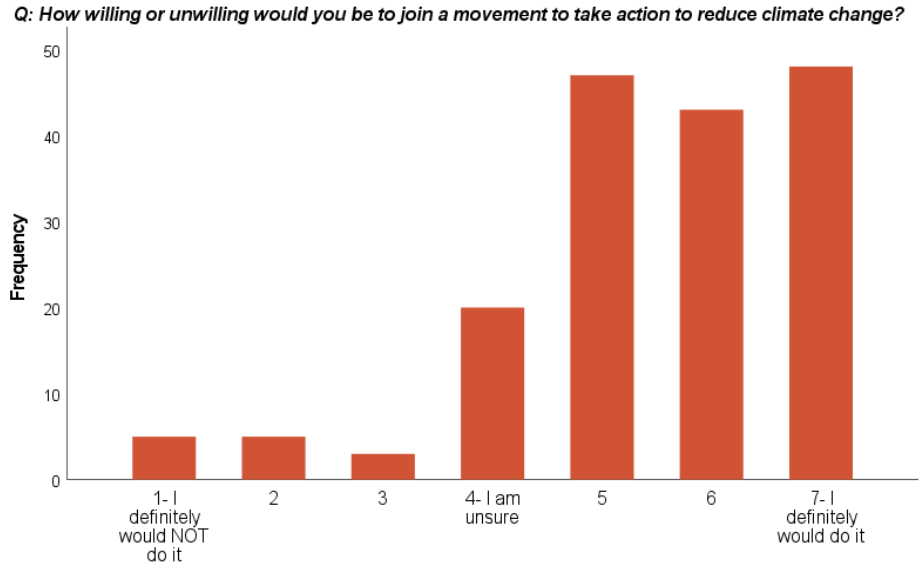


Figure 4.10. Pretest Likert responses to willingness to join a movement for climate change.

4.4.1.1 Stimuli Influences on Changes in Pre and Post Climate Change Attitudes

A series of Wilcoxon matched-pair signed rank tests determined that the only stimulus that experienced statistically significant changes in pre and posttest climate change attitudes was the high narrative structure map (z = -3.207; p = 0.001). There was a significant median increase in climate change attitudes between the pretest and posttest measures. Table 4.4 provides the attitude results for all of the stimuli. Interestingly, all of the stimuli had greater positive differences in attitudes, meaning the posttest measures were greater than the pretest measures.

Table 4.4. Pretest and posttest climate change attitude index descriptive statistics and Wilcoxon matched-pair signed rank results.

		Descriptive				*Ranks*				
Stimuli		n	M	SD	Median	Post - Pre	n	M Rank	*-Z*	*p*
Low Narrative Text-Only	*Pretest*	44	6.10	0.79	6.3	*Negative*	5	7.5	1.713	0.087
	Posttest	44	6.17	0.67	6.33	*Positive*	11	8.95		
						Ties	28			
Low Narrative Map	*Pretest*	35	5.90	0.98	6.0	*Negative*	3	8.5	0.686	0.493
	Posttest	35	5.93	0.91	6.0	*Positive*	8	5.06		
						Ties	24			
High Narrative Text-Only	*Pretest*	48	5.79	1.23	6.30	*Negative*	7	10.86	0.785	0.432
	Posttest	48	5.86	1.07	6.17	*Positive*	12	9.5		
						Ties	29			
High Narrative Map	*Pretest*	44	6.09	0.72	6.33	*Negative*	1	7.5	3.207	0.001
	Posttest	44	6.18	0.69	6.33	*Positive*	13	7.5		
						Ties	30			

4.4.1.2 Exploring the Individual Likert Items per each Stimulus

Despite the climate change attitude index returning a Cronbach's alpha of 0.81, I wanted to explore the three Likert items individually: 1) if climate change is happening 2) thoughts that climate change is natural or human-caused and 3) willingness to join a

movement to take action to reduce climate change. My reasoning to explore each question individually is that the three-item index lacked questions about a person's care and concern on the topic of climate change (Gustafson et al., 2020). Also, a majority of participants (78.4%) indicated that they strongly know climate change is happening and a majority indicated (80.7%) that climate change was human-caused in the pretest Likert questions. Therefore, the measure might not be fit for a population that already strongly thinks climate change is happening and my goal was to learn if the stimuli influenced participants' willingness to join a movement to combat climate change.

For participants that viewed the low narrative text-only stimuli, the only Likert item that returned a statistically significant change was the willingness to join a movement (z = -2.516; p = 0.012). For the low narrative map, none of the Likert items returned a statistically significant result. The high narrative map text-only returned a statistically significant change was the willingness to join a movement (z = -2.516; p = 0.012). Lastly, the high narrative map also returned a statistically significant change between the pretest and posttest willingness to join a movement (z = -2.469; p = 0.013).

In summary, none of the pretest and posttest attitudes in the existence or causes of climate change were significantly different, but the differences in willingness to join a movement to take action to reduce climate change were significantly different for all stimuli except for the low narrative map. Many participants did not change their opinion on whether climate change existed or whether climate change is natural or human-caused, perhaps, in part, due to the skew of the pretest data indicating that most of the participants already knew climate change was happening and was human-caused, but their willingness to take action differed after viewing certain stimuli.

4.4.2 Hypoxia Attitudes

Overall, there was a statistically significant median increase in hypoxia attitudes between the pretest and posttest measures (z = -9.027; p = 0.000). This suggests some of the stimuli evoked some participants to have higher scores in the posttest measure than the pretest measure. As for the individual stimuli, each stimulus reported statistically significant changes between the pretest and posttest measures. Table 4.5 summarizes the findings. To account for Type I errors that occur when conducting multiple analyses on the same dependent variable, the Bonferroni corrected alpha was calculated yet all of the stimuli were still statistically significant ($p < 0.0125$).

Table 4.5. Results from Wilcoxon matched-pair signed rank tests per stimulus for hypoxia attitude.

		Descriptive				*Ranks*				
Stimuli		n	M	SD	Median	Post - Pre	n	M Rank	*-Z*	*p*
Low Narrative Text-Only	*Pretest*	36	3.85	0.54	4.00	*Negative*	2	6.50	4.577	0.000*
	Posttest	44	4.34	0.53	4.33	*Positive*	28	16.14		
						Ties	6			
Low Narrative Map	*Pretest*	31	3.82	0.62	4.00	*Negative*	0	0.00	4.248	0.000*
	Posttest	35	4.33	0.53	4.33	*Positive*	23	12.00		
						Ties	8			
High Narrative Text-Only	*Pretest*	43	3.85	0.71	3.67	*Negative*	2	7.00	4.479	0.000*
	Posttest	48	4.21	0.69	4.33	*Positive*	28	17.86		
						Ties	11			
High Narrative Map	*Pretest*	40	3.81	0.65	4.00	*Negative*	0	0.00	4.828	0.000*
	Posttest	44	4.38	0.55	4.33	*Positive*	30	15.50		
						Ties	10			

* $p < 0.0125$

4.5 Support

I compared the differences in levels of support across the stimuli. A Kruskal-Wallis test revealed no significant differences across stimuli regarding average support, $H(3) = 0.368$, $p = 0.947$ (Figure 4.11). Table 4.6 summarizes the descriptive and Kruskal-Wallis statistics.

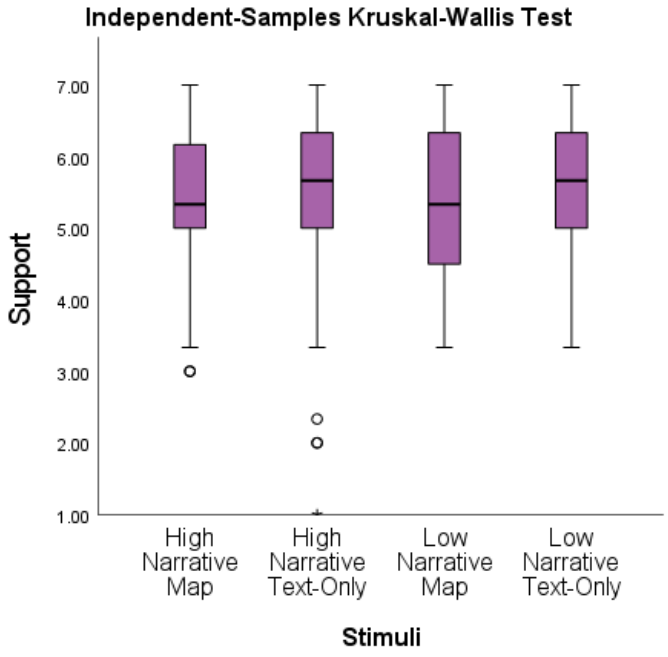


Figure 4.11. Boxplots for each stimuli of average levels of support for hypoxia and climate change.

Table 4.6. Descriptive statistics for average support for climate change and hypoxia as well as mean ranks from the Kruskal-Wallis text.

	Statistics						
Stimuli	N	Mean	SD	Median	Rank	Minimum	Maximum
Low Narrative Text-Only	44	5.50	1.02	5.67	87.74	3.0	7.0
Low Narrative Map	35	5.41	1.04	5.33	82.71	3.33	7.0
High Narrative Text-Only	48	5.33	1.44	5.67	88.32	1.0	7.0
High Narrative Map	44	5.43	1.0	5.33	84.34	3.0	7.0

4.6 Variable Interactions

I conducted a series of bivariate correlations to observe how variables like transportation, emotional intensity, and difference in support and attitudes for and on climate change and hypoxia relate (Table 4.7). I used Spearman's rho because this test is not restricted by the assumption of a linear relationship between two variables. In addition, tests like the Pearson correlation assume the absence of outliers, equal variance, and bivariate normality whereas Spearman's rho does not (Siebert & Siebert, 2018).

Table 4.7. Transportation correlations with other variables using Spearman's rho.

Variables	Low Narrative Text-Only	Low Narrative Map	High Narrative Text-Only	High Narrative Map
Posttest Climate Change	0.380*	0.428*	0.440**	0.393**
Posttest Hypoxia	0.504**	0.641**	0.566**	0.356*
Support	0.472**	0.522**	0.631**	0.490**
Posttest Climate Change "Join a movement"	0.355**	0.443**	0.458**	0.306*
Emotional Intensity	0.277	0.283	0.543**	0.362*

*$p < 0.05$. **$p < 0.01$.

CHAPTER V

DISCUSSION

Research over recent years has demonstrated that stories have been a persuasive way to communicate climate change (Morris et al., 2019; Gustafson et al., 2020; Rickard et al., 2021). Some research has narrowed their scope on this topic of persuasive stories to look at how the medium matters (text, video, etc.) and Rickard et al. (2021) found narrative text to be more transporting than narrative video. However, no one has evaluated storytelling maps as the medium with the Transportation Scale (TS) until this research. In the following sections, I reflect on the results and answer my three research questions.

RQ #1: How does narrative structure and inclusion of a map influence level of transportation?

All of the stimuli generated high levels of transportation (M = 5.20; SD = 1.14). For comparison, in a study assessing level of transportation to narrative text and video about aquaculture, Rickard et al. (2021) used the long-form of the TS and reported average levels of transportation between 4.10 and 4.24 while the range of transportation in this study was between 5.19 and 5.58 out of the maximum seven. However, levels of transportation did not differ much between stimuli, $H(3) = 4.484$, $p = 0.21$. Unfortunately, this study did not have a control stimulus to compare to. One reason that all of the stimuli were somewhat equally transporting may be that an overwhelming majority (78.4%) of the participants chose that they '*strongly believe climate change is happening*' in the pretest climate change attitude section of the user study. Therefore, a

majority of the participants in the user study already thought climate change was happening and that it was human-caused (81.2%) which may have made them more likely to be transported while reading/viewing stimuli related to a climate change issue that is occurring not far from them geographically. This idea is supported by the finding that climate change attitudes were positively related to levels of transportation for each stimulus ($p < 0.05$). Furthermore, the most common response for the hypoxia attitude questions assessing if participants care about hypoxia, their belief that hypoxia is a serious issue, and if they would be willing to take action to combat hypoxia in Oregon was '*agree*.' Like climate change attitudes, average hypoxia attitudes were positivity related to level of transportation for each stimulus ($p < 0.05$).

Even though there was no significant difference in levels of transportation between the four stimuli, I discuss the results further here. The two stimuli that returned the highest average levels of transportation, although not significantly, were the high narrative map (M = 5.80; Mdn = 5.78) and the high narrative text (M = 5.33; Mdn = 5.60). This finding follows other research that has consistently found stories to be more transporting for readers than non-stories (Morris et al., 2019; Rickard et al., 2021). However, more research with larger sample sizes and measures that detect subtle differences between stimuli are needed to support the literature that high narrative structures are more transporting.

The two stimuli that returned the most difference between levels of transportation when compared to one another was the high narrative map (M = 5.80; Mdn = 5.78) and the low narrative map (M = 5.19; Mdn = 5.20), $p = 0.040$. In other words, when the high narrative text about Alex the fisherman was woven into a storytelling map, it was more

transporting for the participants than when the low narrative text was woven into a storytelling map. This difference between levels of transportation from the high narrative map and low narrative map stimuli might demonstrate that the combination of the high narrative text, which communicates human experience, with imagery and maps were most transporting. This possible finding fits with Green and Brock's (2000) statement that the ideal transportation experience includes descriptive text and imagery. However, as noted in Chapter III, I cautiously considered there to be a difference between the high and low narrative map stimuli because the Bonferroni adjusted p-value for the four Mann-Whitney U tests conducted was 0.0125 making the difference in transportation levels between the high and low narrative map no longer significant ($p = 0.040$). More research with larger samples sizes and methods to better measure the subtle differences between the stimuli is encouraged for future research.

While others have applied the TS to visual stimuli like videos and documentaries (Green et al., 2008; Williams et al., 2010; Morris et al., 2019; Rickard et al., 2021), no research has applied the TS to storytelling maps. More so, much of the research on the TS rarely, if at all, mentions maps when discussing types of mediums the TS could be applied to. This brings me to a question that inspired part of this research: is the TS fit for storytelling maps? What about just maps? While the answer to these questions is beyond the scope of this research, I'd like to discuss a few thoughts. Transportation involves entering the narrative world and two components of transportation are cognitive engagement and the formation of mental imagery. When comparing the transportability of films vs texts, Green et al. (2008) describe that texts may require the reader to use more effort to form mental imagery of the characters and events taking place whereas

films provide much of this imagery for the reader. While the imagery films provide may "increase the ease or fluency with which individuals can enter the narrative world," the effort required by readers of text to imagine the characters and setting could also increase transportation (Green et al., 2008, p. 517). While some cognitive psychologists have found text to be more transporting than video (Rickard et al., 2021), other researchers suggest the two may be equally transporting (Green et al., 2008).

In terms of mental imagery formation, maps may sit somewhere between the two extremes of texts and films because maps provide a visual version of our spatial environment. Maps can show the setting of the story without providing all of the visual stimuli of the narrative that a film would. Of course, there are different types of maps, storytelling maps, and visualizations that could result in different imagination levels. For example, the maps in this research were created using conventional GIS and western cartographic standards. They consisted of vector GIS layers of the U.S. and Oregon coast. Some of the maps also included raster data of algal blooms and spatial hypoxia data. The maps may be considered plain which may or may not contribute more or less to mental imagery formation. Other types of maps like dynamic, interactive, or even Augmented Reality (AR) maps could provide greater mental imagery formation for viewers. However, the other components of emotion and human experience are also important to include when the goal is increasing transportation and engagement. The map stimuli in this study were designed to represent the multimedia journalistic style storytelling maps which often include descriptive text, photos, and maps.

While the photos and maps provided and encouraged mental imagery formation, the descriptive text contained human experience and emotions. Of course, there are other

types of storytelling maps outside of the type used in this study. Mocnik and Fairbairn (2018) explored ways to embed stories into the map itself without using text while Knowles et al. (2015) left the limits of conventional cartography and GIS behind for nondigital methods to visualize spatial human experience. Even just maps themselves could be explored with TS or a version of TS as critical cartographers have unveiled the long history between maps, narratives, and persuasion (Caquard, 2011; Harley, 1989). The distinction between maps and storytelling maps is fuzzy; however, many cartographers have advocated that maps should describe human experience, promote a deeper understanding of place, contain and evoke emotions, and inspire action and change (Kwan, 2002; MacFarlane, 2007). We need innovative and creative ways to better understand how maps elicit emotion, contain human experience, and persuade readers.

RQ #2: How does narrative structure and inclusion of a map influence emotional response, intensity, and valence?

Results indicated that the stimuli elicited emotions, but with little difference across stimuli. The top three emotions reported by participants were *sadness* (43.3%), *fear* (14.9%), and *compassion* (11.7%). Differing combinations of narrative structure and inclusion of a map did not exert much influence as these emotion concepts were similar across stimuli. This was a surprising finding as I expected the high narrative stimuli to elicit *compassion* more than the low narrative stimuli. Although compassion and empathy differ, stories about characters facing struggles often promote feelings of empathy (Green & Brock, 2000; Swim & Bloodhart, 2015); therefore, perhaps having a measure for *empathy* in this study would have returned differing results. Another explanation as to

why compassion was not as frequent of a response may be that participants did not relate to Alex the fisherman and his struggles. To bridge this gap of the study, participants' connections to the Oregon coast or how they felt about main characters could have been assessed. Gustafson et al. (2020), which also focused on the influence of stories on climate change attitudes, used questions in their survey measuring how frequently participants fished to understand how the potential connection affected participant responses to a radio story about climate change impacts on a fisherman's favorite places to fish.

There was no significant difference between stimuli regarding emotional intensity. However, like with levels of transportation, average levels of emotional intensity per stimuli could be considered quite high, with means ranging from 4.73 to 5.01 out of the maximum six. Reasons as to why there were no significant emotional intensity differences across stimuli are that both the low and high narratives were negative and about changes occurring to the Oregon coast. Even though the low narrative structure stimuli did not have a human main character, hypoxia could be considered a character (Roth, 2020) that is negatively affecting the Newport, OR, community. To support this thought, a Kruskal-Wallis test revealed no significant difference across stimuli for the fifth TS Likert item which asked if participants could vividly picture the main character of the narrative ('Alex' for the high and 'hypoxia' for the low narrative structures), $H(3) = 0.990$, $p = 0.804$. The low narrative still communicated the negative effects of hypoxia and climate change to the ecosystem and crab fishers which might have resonated with the participants as a majority indicated their care for climate change and hypoxia in the pretest attitude questions.

As for valance, all four stimuli returned largely negative emotional responses. This finding was expected as all of the stimuli were negatively valanced. In other words, the text in the stimuli had a negative ending in order to promote negative emotional responses because research suggests negative emotion is associated with greater attitude change and promoting pro-environmental behavior (Peters & Slovic, 2000; Morris et al., 2019). My findings also support this body of research because the experience of negative emotions was correlated with support ($r_s = 0.336$; $p = 0.000$), posttest climate change attitudes ($r_s = 0.262$; $p = 0.002$), and posttest hypoxia attitudes ($r_s = 0.398$; $p = 0.000$) while positive emotions were not ($p > 0.05$). However, there was no control in this experiment, so future research might consider a control to better understand these interactions.

RQ #3: How does narrative structure and inclusion of a map influence climate change and hypoxia attitude change?

The high narrative map stimuli lead to the greatest change between pretest and posttest average climate change attitudes ($z = -3.207$; $p = 0.001$). This illustrates that the high narrative structure woven into a storytelling map led participants to increase their average climate change attitudes more than the other stimuli. Part of this finding is consistent with studies that have shown stories lead to increased climate change attitudes (Gustafson et al., 2020). Taking a closer look at the individual Likert items that make up the climate change attitude index revealed the "willingness to join a movement" item returned significant changes between pretest and posttest for all stimuli except for the low narrative map. These findings suggest that a high narrative structure map led to increased

overall climate change attitudes, and that all combinations except the low narrative map persuaded participants to take action against climate change. The high narrative structure may be most useful for altering attitudes towards the existence and causes of climate change as well as persuading readers/viewers to take action.

The low narrative map was the only stimuli to not persuade readers to take action and was also the stimuli that returned the lowest levels of transportation (M = 5.19; Mdn = 5.2) and lowest levels of emotional intensity (M = 4.66; Mdn = 5.0). The low narrative map stimuli may have been poorly received because of its low narrative structure as well as its length. While the length of the text in the low narrative structure stimulus was technically the same length as the other stimuli, it is possible readers were not being immersed into the narrative and became bored of scrolling through the images and maps. Assessing variables like boredom and readers' interest in the stimuli could shed light on these findings.

Pretest and posttest measures for hypoxia attitudes returned significant changes after viewing the stimuli. In other words, the combinations of narrative structure and inclusion of a map lead participants to care more about hypoxia, view hypoxia as a serious issue, and increased their willingness to take action. This finding is not quite surprising because all the stimuli generated similar levels of transportation and emotional intensity. Furthermore, participants had varying levels of familiarity with hypoxia (Figure 5.1) as it is a lesser known issue compared to climate change. It is possible this participant pool, where a majority appeared interested in climate change, would be swayed to care about the related issue of hypoxia as the setting of the narratives was geographically near participants. It is also possible that taking action on a smaller aspect

of climate change (hypoxia), occurring a few miles from them, was more appealing than taking action on the larger issue of climate change. However, a limitation relating to this aspect of the study is that the climate change attitude questions differed from the hypoxia attitude questions. Improving ways to assess attitudes on two different yet relational environmental processes in order to increase comparability of results would benefit this aspect of the study.

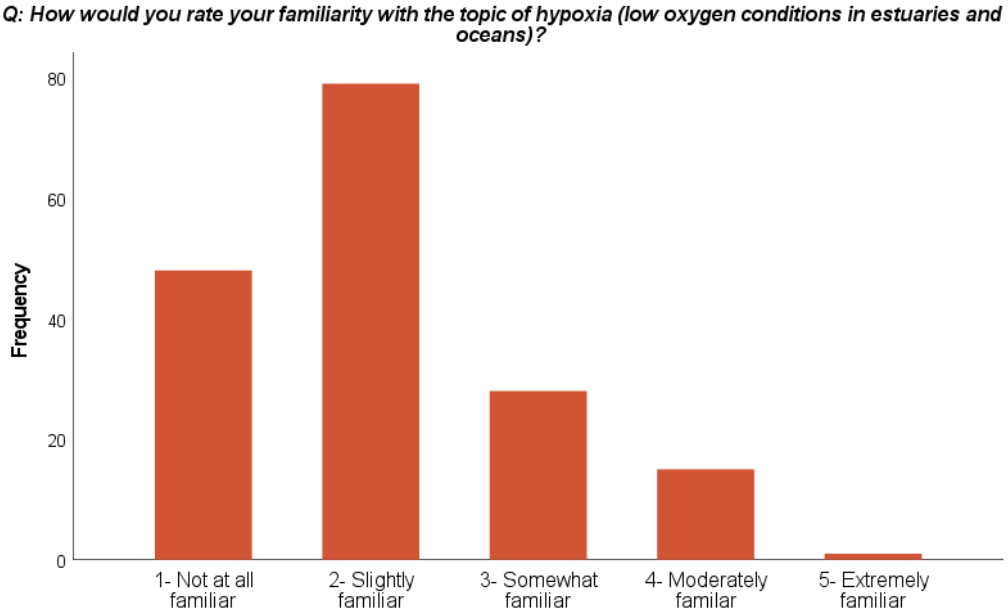


Figure 5.1. Participants' familiarity to hypoxia.

CHAPTER VI

CONCLUSION

This thesis focused on understanding how two variables: 1) narrative structure (how story-like something is) and 2) the inclusion or exclusion of a map with a narrative may influence a map reader. I administered a between-subjects user study with four stimuli to measure how narrative structure and the inclusion of a map influence narrative transportation, emotion, and climate change and hypoxia attitudes to answer three specific research questions:

Narrative Transportation

1. How does narrative structure and inclusion of a map influence the extent to which readers are transported?

Emotion

2. How does narrative structure and inclusion of a map influence emotional response, intensity, and valence?

Climate Change and Hypoxia Attitudes

3. How does narrative structure and inclusion of a map influence climate change and hypoxia attitude change?

My findings revealed that the combinations of narrative structure and inclusion of a map were transporting and evoked emotional responses; however, no singular combination outperformed the others. As for altering climate change and hypoxia attitudes, the high narrative structure map, the most story-like, significantly increased overall climate change attitudes while all other stimuli effectively increased hypoxia

attitudes, except for the low narrative structure map, the most scientific writing. In order words, weaving a low narrative structure which is more informational and less story-like into a multimedia 'StoryMap' was ineffective at persuading attitude change on climate change and hypoxia based on this study. The high narrative map structure's story-like and descriptive text woven into a multimedia 'StoryMap' was most effective at persuading participants' attitude on the existence of climate change, its causes, and willingness to take action. This finding was unsurprising because not only did the high narrative map stimuli return the highest levels of transportation and emotional intensity, although not significantly, this stimulus contained human experience in the text and its photos and maps may have contributed to mental imagery formation. This combination of human experience and mental imagery formation may reduce feelings of psychological distance, promote experiential processing, and help transport the reader into the narrative world (Green et al., 2008; Trope & Liberman, 2010; Myers et al., 2012).

For hypoxia, as mentioned above, all of the stimuli promoted hypoxia attitude change except for the low narrative map meaning that the participants changed their minds about how much they cared about the topic of hypoxia after taking part in the study. Care for hypoxia may have increased more overall than climate change attitudes because the sets of questions assessing each differed. The climate change attitude questions focused on the existence and causes of climate change while the hypoxia questions assessed participants' care for hypoxia and whether it is a serious issue or not. Because the only overlap between the two sets of questions were willingness to take action, the climate change and hypoxia attitudes may not be entirely comparable. Other than lack of comparability, as mentioned in Chapter IV, a majority of participants scored

high on the pretest existence and causes of climate change questions while a majority of participants were relatively unfamiliar with the topic of hypoxia. Also, participants may have felt geographically and politically closer to hypoxia verses the broadness of climate change, which was also a goal of the map stimuli, to give geographic reference to a topic that is unfamiliar to most Oregonians.

This research applied the TS to storytelling maps for the first time. Specifically, this research applied the TS to a type of storytelling map that was created by weaving a story about a crab fisherman's struggles and anxieties about the effects climate change and hypoxia are having on the ocean, marine organisms, and his livelihood. I compared this storytelling map to other stimuli with varying narrative structures and inclusions or exclusions of maps in order to learn more about how these variables affect engagement and persuasion. This study focused on just one type of storytelling map and future research may want to apply the TS to other types of maps and storytelling maps as a way to assess how immersive and persuasive these visualizations can be. Accordingly, considering the ethics of persuasive material is necessary and "Cartographers must search outwardly for insight into these guidelines, drawing from critical theory as well as professional standards to establish tent poles of ethical visual design" (Roth, 2020, p. 27).

6.1 Limitations

There are several limitations to this study. First, the sample size may be considered too small to make broad judgments about which stimuli influenced transportation, emotion, or attitudes. The sample in this study was based on geographical constraints as only Oregon residents were solicited from Prolific and then further

narrowed to those residing in the Willamette Valley region. Also, the sample population of participants did not have an even distribution of climate change attitudes. An overwhelming majority strongly agreed climate change was occurring and that it was human-caused. Because the data was already skewed it would be difficult to measure changes within this population. In addition, I did not collect data on long-term attitude change and persuasion because attitudes were measured within one online user study which means that I do not know whether there may be differences in how the conditions affect attitudes over a longer period of time. Finally, more individual differences could have been considered such as the need for cognition (Cacioppo & Petty, 1982) or political beliefs.

Another limitation is the comparability of the four stimuli as one could argue they are not informationally equivalent (Tversky et al., 2002). I made every effort to control the variables by only changing one at a time (low vs high narrative, map vs text-only). I also attempted to make the stimuli similar by using congruent color schemes, number of words (n = 851), and using the same maps and photos for the map stimuli. Also, related to the stimuli, this study only tested the type of storytelling map that resembled multimedia journalistic styles when there are other, perhaps infinite, types of storytelling maps that could be studied.

In addition, the Likert data in this study were largely non-normally distributed and were treated as scale variables. Some researchers advise against treating non-normal data as scale and suggest transforming the data (Siebert & Siebert, 2018), however, this was done so my methods would match similar research on the TS (Appel et al., 2015; Rickard et al., 2021). This could have influenced my results. I used nonparametric analysis tests to

avoid failing the assumptions for parametric methods as the user study data sample sizes were small and non-normally distributed.

Lastly, some participants may have known the goal of the user study when they were presented with the second round of climate change and hypoxia questions, which may have impacted their ability to be persuaded by the stimuli. A second round of posttest questions could be written differently but measure the same thing as the pretest questions.

6.2 Future Research

Appel et al. (2015) stress that the validity of the short-form TS "is the product of the experiences a number of researchers gather over time" (p. 261). This study applied the TS to storytelling maps for the first time to my knowledge. I encourage more cartographers to use the TS on other types of storytelling maps because of a map's ability to be persuasive, evoke emotion, and communicate human experience. Perhaps a new version of the TS could be developed specifically for maps if researchers find that the TS does not pick up the influence narratives and maps have on our brains.

Other studies could use qualitative methods including open-ended questions, talk-aloud protocols, focus groups, or interviews when assessing reader response. One way to possibly better gauge attitude change would be to give the stimuli to participants and have them use it at home to fully experience and then observe long-term attitude change. Another potential study could assess reader response to stimuli they scroll by on their mobile devices to understand what types of narrative visualizations capture participant's attention, hold it, and persuade them.

Lastly, when researching engagement with climate change or other related social issues, care should be taken when reviewing the literature and designing surveys that aim to measure 'taking action' or activism. This user study asked participants '*how willing or unwilling would you be to join a movement to take action to reduce climate change*?' Phrasing like '*join a movement*' could alter a participant's results depending on their own personal definition of a movement. Many surveys consider 'taking action' as supporting a campaign or voting for policy change, however, having more specific questions about other forms of action, protest, and organizing may help to better understand how people would support different types of issues or communication modes.

APPENDIX A

USER STUDY

Start of Block: Prolific ID- required

Q1.1 Please enter your unique Prolific ID in the text box below:

_____

End of Block: Prolific ID- required

Start of Block: Consent Form- required

Q2.1

Consent for Research Participation

Title: Your Experiences while Viewing Climate Change-Related Stories and Maps

Researcher(s): Michala Garrison, University of Oregon
Dr. Carolyn Fish, University of Oregon
Researcher Contact Info: 541-346-0785
michalag@uoregon.edu

You are being asked to participate in a research study. The bulleted text below highlights key information about this research for you to consider when making a decision whether or not to participate. Carefully consider this information and the more detailed information provided below the bulleted text. Please ask questions about any of the information you do not understand before you decide whether to participate.

Key Information for You to Consider Voluntary Consent.

Voluntary Consent. You are being asked to volunteer for a research study. It is up to you whether you choose to participate or not. There will be no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate or discontinue participation.

Purpose. The purpose of this research is to assess responses to maps about climate change. Approximately 200 people will take part in this research.

Duration. It is expected that your participation will last no longer than 30 minutes.

Procedures and Activities. You will be asked to view maps and read a story related to climate change. You will answer questions about the maps and story. The goal of the study is to understand the emotional responses and engagement individuals have while reading the maps and story. You will also be asked about your demographics and opinions you have about climate change.

Risks. Some of the foreseeable risks or discomforts of your participation include risk of loss of confidentiality if your information or your identity is obtained by someone other than the investigators, but precautions will be taken to prevent this from happening. The confidentiality of

your electronic data created by you or by the researchers will be maintained to the degree permitted by the technology used. Absolute confidentiality cannot be guaranteed. **Benefits.** There is no direct benefit to you beyond financial compensation, but the researchers hope to learn about how maps lead to different emotional responses.
Alternatives. Participation is voluntary and the only alternative is to not participate.
Who is conducting this research?
The researchers Michala Garrison and Dr. Carolyn Fish from the University of Oregon are asking for your consent to this research.

What happens if I agree to participate in this research?
If you agree to be in this research, your participation will include participating in a questionnaire. The questionnaire will be conducted in an online survey tool called Qualtrics. During the questionnaire, you will answer questions regarding your opinions about hypoxia (low oxygen conditions in the ocean) and climate change. After these questions, you will be randomly assigned to view/read either a narrative, story, or storytelling map. After viewing one of the stimuli, you will answer questions about your emotional response and engagement regarding the stimuli. You may skip any questions which make you feel uncomfortable and you can stop the questionnaire at any time. Once you have completed the questionnaire you will follow the link back to Prolific so that we can send you your payment for participating.

What happens to the information collected for this research? Information collected for this research will be used to answer a set of research questions. The goal is to understand how map readers experience storytelling maps and what emotions are elicited by individuals who read and view these types of maps. The results, after statistical analysis, will be written into an academic journal article. Your name will not be used in any published reports, articles, or conference presentations about this study.
How will my privacy and data confidentiality be protected? We will take measures to protect your privacy including storing data from the study on a password protected computer and on a password protected server. Despite taking steps to protect your privacy, we can never fully guarantee your privacy will be protected.
What are the benefits of participating in this research? You may or may not benefit from participating in this research. There is no direct benefit to you beyond financial compensation.
What other choices do I have besides participation in this research? It is your choice to participate or not to participate in this research.
What if I want to stop participating in this research? Taking part in this research study is your decision. Your participation in this study is voluntary. You do not have to take part in this study, but if you do, you can stop at any time. You have the right to choose not to participate in any study activity or completely withdraw from continued participation at any point in this study without penalty or loss of benefits to which you are otherwise entitled. Your decision whether or not to participate will not affect your relationship --with the researchers or the University of Oregon.
What if I am injured because of participating in this research? If you experience harm because of the project, you can ask the State of Oregon to pay you. If you have been harmed, there are two University representatives you need to contact. Here are their addresses and phone

numbers:
General Counsel/Office of the President
1226 University of Oregon
Eugene, OR 97403-1226
(541) 346-3082
Research Compliance Services
5237 University of Oregon
Eugene, OR 97403-5237

A law called the Oregon Tort Claims Act may limit the amount of money you can receive from the State of Oregon if you are harmed.

Will I be paid for participating in this research?
Each participant will be paid $10.00/hr for their participation in the study.

Who can answer my questions about this research?
If you have questions, concerns, or have experienced a research related injury, contact the research team at:
Michala Garrison
541-346-0785
michalag@uoregon.edu

An Institutional Review Board ("IRB") is overseeing this research. An IRB is a group of people who perform independent review of research studies to ensure the rights and welfare of participants are protected. UO Research Compliance Services is the office that supports the IRB. If you have questions about your rights or wish to speak with someone other than the research team, you may contact:
Research Complince Services
5237 University of Oregon
Eugene, OR 97403-5237
(541) 346-2510

STATEMENT OF CONSENT
I have had the opportunity to read and consider the information in this form. I have asked any questions necessary to make a decision about my participation. I understand that I can ask additional questions throughout my participation.
I understand that by signing below, I volunteer to participate in this research. I understand that I am not waiving any legal rights. I have been provided with a copy of this consent form. I understand that if my ability to consent or assent for myself changes, either I or my legal representative may be asked to re-consent prior to my continued participation in this study.

Q2.2 Do you consent to participate in this study?

- ○ Yes
- ○ No

End of Block: Consent Form- required

Start of Block: Screener validation

Q4.1 Do you currently live in the U.S. state of Oregon?

- ○ Yes
- ○ No

Q4.2 Are you currently using a laptop or a desktop computer?

- ○ Yes
- ○ No

End of Block: Screener validation

Start of Block: Introduction, Pretest Climate Change and Hypoxia Attitudes

Q6.1 What is your current Oregon zip code?

_____

Page Break

Q6.2 How would you rate your familiarity with the topic of hypoxia (low oxygen conditions in estuaries and oceans)?

- ○ 1- Not at all familiar
- ○ 2- Slightly familiar
- ○ 3- Somewhat familiar
- ○ 4- Moderately familiar
- ○ 5- Extremely familiar

Q6.3 Please indicate your level of agreement to the following questions regarding hypoxia in Oregon.

Q6.4 Hypoxia in coastal Oregon is a serious issue

- ○ 1- Strongly disagree
- ○ 2- Disagree
- ○ 3- Neutral
- ○ 4- Agree
- ○ 5- Strongly agree
- ○ I don't know what hypoxia is

Q6.5 I care about hypoxia in coastal Oregon

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree
- I don't know what hypoxia is

Q6.6 I would be willing to take action to combat ocean hypoxia in Oregon

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree
- I don't know what hypoxia is

Page Break

Q6.7 Climate change refers to a change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Q6.8 Do you think climate change is happening?

- 1- I strongly believe climate change is NOT happening
- 2
- 3
- 4- I am unsure
- 5
- 6
- 7- I strongly believe climate change IS happening

Q6.9 How much of climate change do you believe is caused by human activities, natural changes in the environment, or some combination of both?

- 1- I believe climate change is caused entirely by natural changes in the environment
- 2
- 3
- 4- I believe climate change is caused equally by natural changes and human activities
- 5
- 6
- 7- I believe climate change is caused entirely by human activities
- I don't believe climate change is happening

Q6.10 How willing or unwilling would you be to join a movement to take action to reduce climate change?

- 1- I definitely would NOT do it
- 2
- 3
- 4- I am unsure
- 5
- 6
- 7- I definitely would do it

End of Block: Introduction, Pretest Climate Change and Hypoxia Attitudes

Start of Block: Low Narrative Text-Only

Q7.1 Please click the link to read a website to answer the following questions. This link will open a new tab. Return to this survey page when you have completed reading.

Click this link.

Page Break

Q7.2 Please answer the following questions based on your experience reading the narrative.

Q7.3

	1	2	3	4	5	6	7
I could picture myself in the scene of the events described in the narrative.	○	○	○	○	○	○	○

Q7.4

	1	2	3	4	5	6	7
I was mentally involved in the narrative while reading it.	○	○	○	○	○	○	○

Q7.5

	1	2	3	4	5	6	7
I wanted to learn how the narrative ended.	○	○	○	○	○	○	○

Q7.6

	1	2	3	4	5	6	7
The narrative affected me emotionally.	○	○	○	○	○	○	○

Q7.7

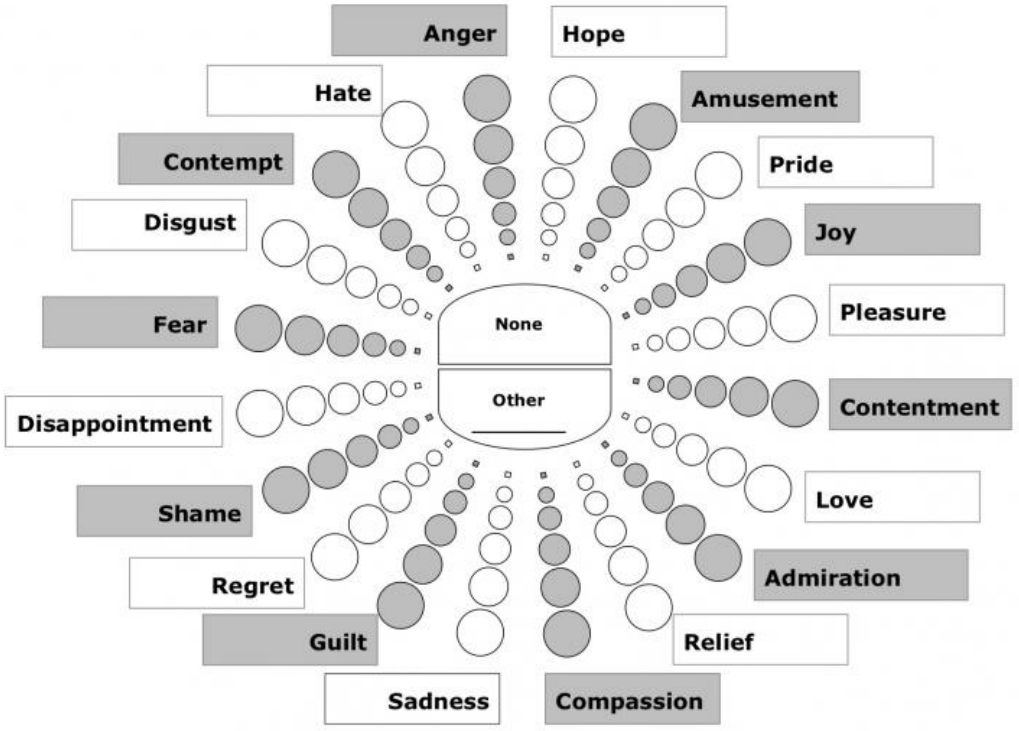
	1	2	3	4	5	6	7
While reading the narrative I had a vivid image of hypoxia.	○	○	○	○	○	○	○

Page Break

Q7.8 Which one of the emotions on the diagram below best describes how you felt while reading the narrative?

Choose an emotion, then click on the corresponding circle in the "spoke" adjacent to this emotion to rate how intensely you felt it. Larger circles indicate more intense emotion; smaller circles indicate less intense emotion.

If you did not feel any emotion at all, please click the upper half-circle in the center of the wheel (Labeled "None"). If you experienced an emotion that is very different from any of the emotions in the wheel please click the lower half-circle (labeled "Other") and type the emotion in the text box below.



Q7.9 If you chose 'other', please type your emotion experienced here:

_____

Q7.10

	1	2	3	4	5	6
If you chose 'other,' select the intensity of the emotion experienced.	○	○	○	○	○	○

Page Break

Q7.11 In your own words, what was the narrative you just read about?

_____

End of Block: Low Narrative Text-Only

Start of Block: Low Narrative Map

Q8.1 Please click the link to read a website to answer the following questions. This link will open a new tab. Return to this survey page when you have completed reading.

Click this link.

Page Break

Q8.2 Please answer the following questions based on your experience reading the narrative.

Q8.3

	1	2	3	4	5	6	7
I could picture myself in the scene of the events described in the narrative.	○	○	○	○	○	○	○

Q8.4

	1	2	3	4	5	6	7
I was mentally involved in the narrative while reading it.	○	○	○	○	○	○	○

Q8.5

	1	2	3	4	5	6	7
I wanted to learn how the narrative ended.	○	○	○	○	○	○	○

Q8.6

	1	2	3	4	5	6	7
The narrative affected me emotionally.	○	○	○	○	○	○	○

Q8.7

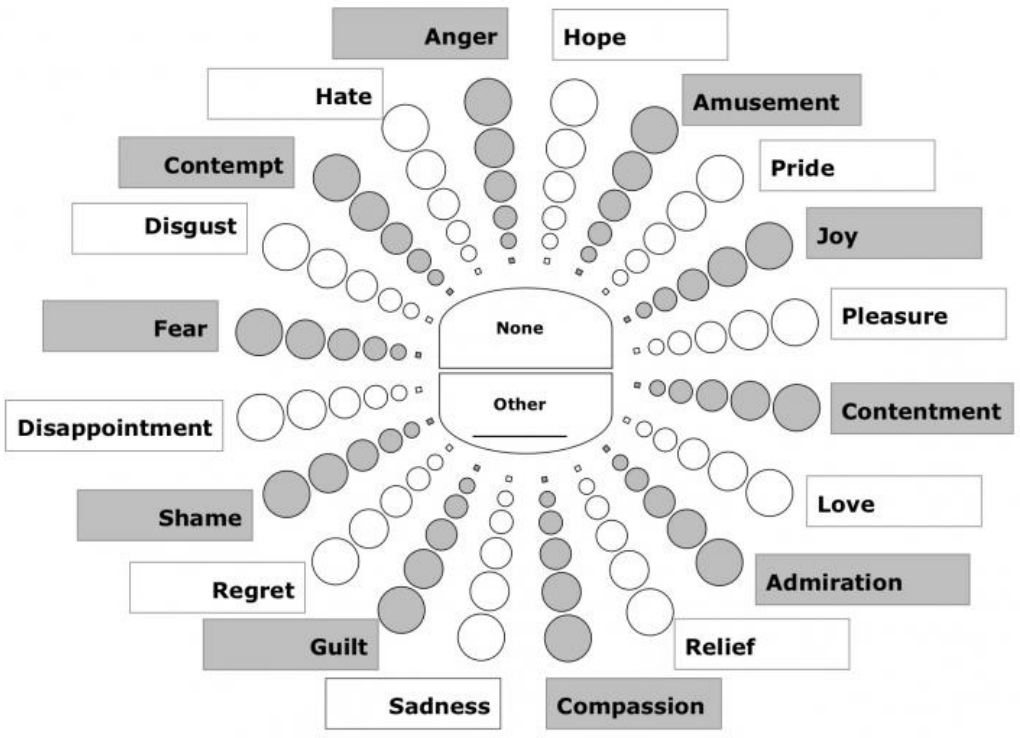
	1	2	3	4	5	6	7
While reading the narrative I had a vivid image of hypoxia.	○	○	○	○	○	○	○

Page Break

Q8.8 Which one of the emotions on the diagram below best describes how you felt while reading the narrative?

Choose an emotion, then click on the corresponding circle in the "spoke" adjacent to this emotion to rate how intensely you felt it. Larger circles indicate more intense emotion; smaller circles indicate less intense emotion.

If you did not feel any emotion at all, please click the upper half-circle in the center of the wheel (Labeled "None"). If you experienced an emotion that is very different from any of the emotions in the wheel please click the lower half-circle (labeled "Other") and type the emotion in the text box below.



Q8.9 If you chose 'other', please type your emotion experienced here:

_____

Q8.10

	1	2	3	4	5	6
If you chose 'other,' select the intensity of the emotion experienced.	○	○	○	○	○	○

Page Break

Q8.11 In your own words, what was the narrative you just read about?

_____

End of Block: Low Narrative Map

Start of Block: High Narrative Text-Only

Q9.1 Please click the link to read a website to answer the following questions. This link will open a new tab. Return to this survey page when you have completed reading.

Click this link.

Page Break

Q9.2 Please answer the following questions based on your experience reading the story.

Q9.3

	1	2	3	4	5	6	7
I could picture myself in the scene of the events described in the story.	○	○	○	○	○	○	○

Q9.4

	1	2	3	4	5	6	7
I was mentally involved in the story while reading it.	○	○	○	○	○	○	○

Q9.5

	1	2	3	4	5	6	7
I wanted to learn how the story ended.	○	○	○	○	○	○	○

Q9.6

	1	2	3	4	5	6	7
The story affected me emotionally.	○	○	○	○	○	○	○

Q9.7

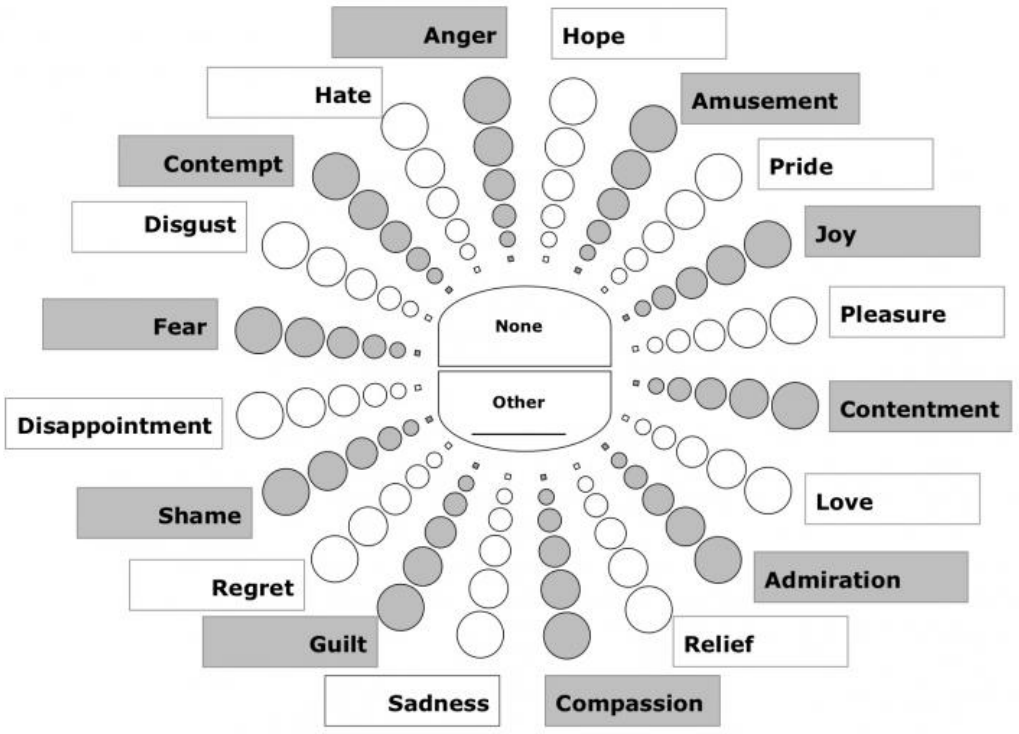
	1	2	3	4	5	6	7
While reading the story I had a vivid image of Alex.	○	○	○	○	○	○	○

Page Break

Q9.8 Which one of the emotions on the diagram below best describes how you felt while reading the story?

Choose an emotion, then click on the corresponding circle in the "spoke" adjacent to this emotion to rate how intensely you felt it. Larger circles indicate more intense emotion; smaller circles indicate less intense emotion.

If you did not feel any emotion at all, please click the upper half-circle in the center of the wheel (Labeled "None"). If you experienced an emotion that is very different from any of the emotions in the wheel please click the lower half-circle (labeled "Other") and type the emotion in the text box below.



Q9.9 If you chose 'other', please type your emotion experienced here:

_____

Q9.10

	1	2	3	4	5	6
If you chose 'other,' select the intensity of the emotion experienced.	○	○	○	○	○	○

Page Break

Q9.11 In your own words, what was the story you just read about?

_____

End of Block: High Narrative Text-Only

Start of Block: High Narrative Map

Q10.1 Please click the link to read a website to answer the following questions. This link will open a new tab. Return to this survey page when you have completed reading.

Click this link.

Page Break

Q10.2 Please answer the following questions based on your experience reading the story.

Q10.3

	1	2	3	4	5	6	7
I could picture myself in the scene of the events described in the story.	○	○	○	○	○	○	○

Q10.4

	1	2	3	4	5	6	7
I was mentally involved in the story while reading it.	○	○	○	○	○	○	○

Q10.5

	1	2	3	4	5	6	7
I wanted to learn how the story ended.	○	○	○	○	○	○	○

Q10.6

	1	2	3	4	5	6	7
The story affected me emotionally.	○	○	○	○	○	○	○

Q10.7

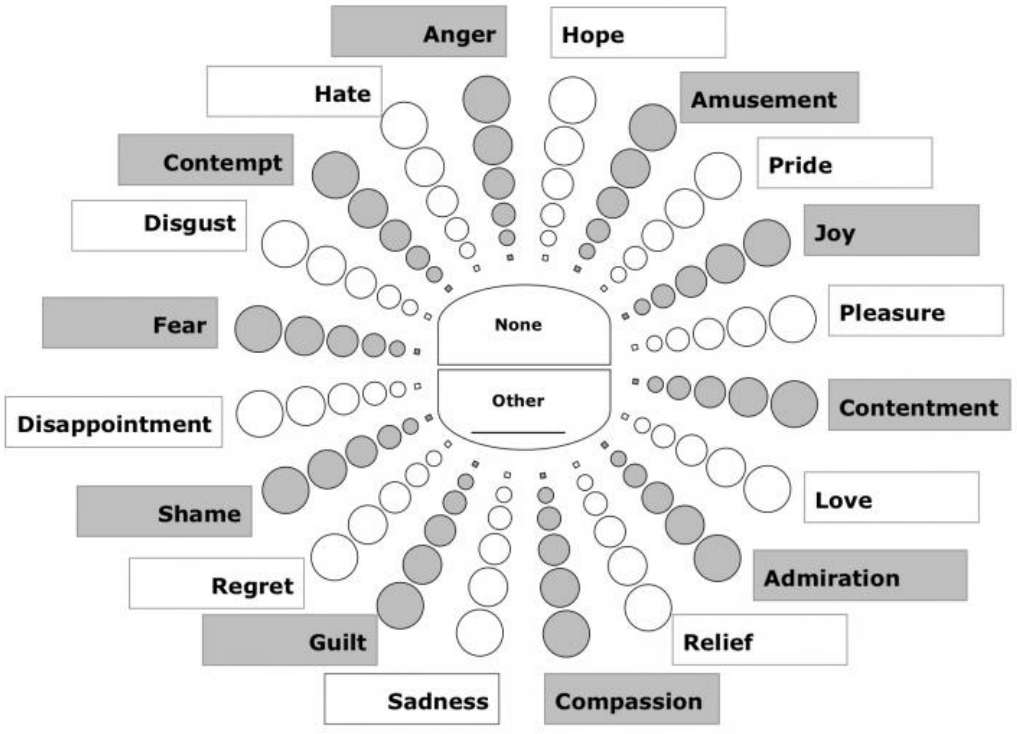
	1	2	3	4	5	6	7
While reading the story I had a vivid image of Alex.	○	○	○	○	○	○	○

Page Break

Q10.8 Which one of the emotions on the diagram below best describes how you felt while reading the story?

Choose an emotion, then click on the corresponding circle in the "spoke" adjacent to this emotion to rate how intensely you felt it. Larger circles indicate more intense emotion; smaller circles indicate less intense emotion.

If you did not feel any emotion at all, please click the upper half-circle in the center of the wheel (Labeled "None"). If you experienced an emotion that is very different from any of the emotions in the wheel please click the lower half-circle (labeled "Other") and type the emotion in the text box below.



Q10.9 If you chose 'other', please type your emotion experienced here:

_____

Q10.10

	1	2	3	4	5	6
If you chose 'other,' select the intensity of the emotion experienced.	○	○	○	○	○	○

Page Break

Q10.11 In your own words, what was the story you just read about?

_____

End of Block: High Narrative Map

Start of Block: Posttest Climate Change and Hypoxia Attitudes

Q11.1 Now that you've read the website, please answer the following questions related to your feelings about hypoxia again.

Q11.2 Hypoxia in coastal Oregon is a serious issue

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

Q11.3 I care about hypoxia in coastal Oregon

- 1- Strongly disagree
- 2- Disagree
- 3- Neutral
- 4- Agree
- 5- Strongly agree

Q11.4 I would be willing to take action to combat ocean hypoxia in Oregon

- ○ 1- Strongly disagree
- ○ 2- Disagree
- ○ 3- Neutral
- ○ 4- Agree
- ○ 5- Strongly agree

Page Break

Q11.5 Now that you've read the website, please answer the following questions related to your climate change beliefs again.

Q11.6 Please indicate your belief in the existence of climate change.

- 1- I strongly believe climate change is NOT happening
- 2
- 3
- 4- I am unsure
- 5
- 6
- 7- I strongly believe climate change IS happening

Q11.7 Assuming climate change IS happening: How much of it do you believe is caused by human activities, natural changes in the environment, or some combination of both?

- 1- I believe climate change is caused entirely by natural changes in the environment
- 2
- 3
- 4- I believe climate change is caused equally by natural changes in the environment and human activities
- 5
- 6
- 7- I believe climate change is caused entirely by human activities
- I don't believe climate change is happening

Q11.8 How willing or unwilling would you be to join a movement to take action to reduce climate change?

- 1- I definitely would NOT do it
- 2
- 3
- 4- I am unsure
- 5
- 6
- 7- I definitely would do it

End of Block: Posttest Climate Change and Hypoxia Attitudes

Start of Block: General Support

Q12.1 For each statement below, please indicate how likely you are to engage in the following actions.

Q12.2

	Extremely unlikely	Very unlikely	Somewhat unlikely	Not sure	Somewhat likely	Very likely	Extremely likely
I would support policies that fund research on climate change.	○	○	○	○	○	○	○

Q12.3

	Extremely unlikely	Very unlikely	Somewhat unlikely	Not sure	Somewhat likely	Very likely	Extremely likely
I would join a movement to raise awareness of how low oxygen conditions (hypoxia) are affecting the marine environment in Oregon.	○	○	○	○	○	○	○

Q12.4

	Extremely unlikely	Very unlikely	Somewhat unlikely	Not sure	Somewhat likely	Very likely	Extremely likely
I would join a movement to raise awareness of how low oxygen conditions (hypoxia) are affecting crab fishers in Oregon.	○	○	○	○	○	○	○

End of Block: General Support

APPENDIX B

STIMULI

Low Narrative Text-Only:

https://arcg.is/1XL5Si0

Low Narrative Map:

https://arcg.is/1jzSaC

High Narrative Text-Only:

https://arcg.is/TLezy

High Narrative Map:

https://arcg.is/10zvbm0

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