ABSTRACT

Title of Dissertation: FRAMING CLIMATE CHANGE: THE IMPACT OF REPEATED EXPOSURE TO SELF- AND SOCIAL-FRAMING MESSAGES ON CLIMATE CHANGE OUTCOMES AND PUBLIC SEGMENTATION IN CHINA

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Background and Purpose. Climate change is an urgent global issue, and China, as the world's largest emitter of greenhouse gases, plays a crucial role in the global response to this challenge (Reuters, 2024; Wang et al., 2016; Xu et al., 2022). Despite increased media coverage and public discussion (Huan, 2024; Pan et al., 2021; Xu et al., 2022; Zeng, 2022), skepticism and negative attitudes toward climate change persist among certain Chinese individuals (Chan et al., 2023; Jia & Luo, 2023; Pan et al., 2022, 2023). This dissertation aims to contribute to developing effective climate change communication strategies in China by examining the effects of repeated self- and social-framing messages and using the Situational Theory of Problem Solving (STOPS) model for public segmentation (Florence et al., 2022; Kim & Grunig, 2011; Tao et al., 2020).

Theoretical Frameworks. This dissertation draws from the construal level theory of psychological distance to understand self- and social-framing (Liberman & Trope, 2003; Loy & Spence, 2020; Ma et al., 2023), the inverted U-shaped model to examine the impact of repeated

exposures (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022), and the STOPS model to investigate how the effects of self- and social-framing may vary across different public segments and the potential for proportional changes in public segments after longitudinal repeated exposure (Grunig, 1997; Kim, 2006; Kim & Grunig, 2011).

Methods. This dissertation employs a two-part study design. The first part is a pilot study designed to validate the manipulation of climate change messages framed as either self- or social-focused, adapted from leading Chinese news outlets. The main study, formatted as a longitudinal between-subjects experiment, consists of six separate exposures spaced three days apart. In the first session, seven hundred and fifty Chinese residents over 18 years old were randomly assigned to one of three conditions, either containing self- or social-framing messages or a mix of both framing messages six times at three-day intervals. Three hundred and thirty-three participants completed all six sessions and are included in the final sample.

Results. The results reveal that repeated exposure to climate change messages enhances their persuasive effects on climate change outcomes, including attitudes, beliefs, and private and public pro-environmental intentions. The overall trends are increasing and do not follow the inverted U-shaped model's predicted pattern of initial growth followed by a decline. After six exposures, the mixed-framing condition slightly outperforms self- and social-framing conditions, indicating the potential benefits of diversified communication strategies for repeated messaging. The results also reveal that situational activity levels in climate change significantly predict positive and negative communicative behaviors and outcomes, with more engaged publics showing stronger climate change outcomes and positive communicative actions (Grunig, 1997; Kim & Grunig, 2011). Results further suggest that six exposures can shift public segmentation,

making more individuals more active in climate change issues (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018).

Theoretical and Practical Implications. Theoretically, the findings do not support the inverted U-shaped model with theoretical explanations (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022). Also, this dissertation extends the message convergence theory (Anthon & Sellnow, 2016; Liu et al., 2020) by demonstrating the effectiveness of mixed-framing strategies in repeated exposures. It also addresses research gaps in framing combination (Chen et al., 2020; Florence et al., 2022) and provides new insights into the effectiveness of repeated communication strategies in public segmentation using the STOPS model (Grunig, 1997; Kim & Grunig, 2011).

Practically, the findings of this dissertation offer guidance for developing repeated communication strategies, suggesting that journalists can leverage the power of repeated exposure and mixed-framing approaches to enhance the impact of climate change communication coverage. The study also highlights the potential for repeated message exposures to actively change public segment types, enabling journalists to design targeted strategies for shifting individuals from less engaged to more active publics in addressing climate change (Hine et al., 2014; Metag & Schäfer, 2018).

FRAMING CLIMATE CHANGE: THE IMPACT OF REPEATED EXPOSURE TO SELF- AND SOCIAL-FRAMING MESSAGES ON CLIMATE CHANGE OUTCOMES AND PUBLIC SEGMENTATION IN CHINA

by

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As I sit here, reflecting on the past four years, I am overwhelmed by emotions. Time has flown by, and all the challenging, disappointing, sad, despairing, joyful, and triumphant moments have seamlessly woven into my journey's fabric. As I step into the future, I pledge to cherish every moment, to persevere in my career, and to make a lasting impact in academia. I aspire to make meaningful contributions to enrich my life and inspire others.

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Chapter 1 Introduction

Section 1.1 Background

Climate change refers to the long-term changes in climate that occur directly or indirectly due to human activities over decades (Arbuckle et al., 2013; Bostrom et al., 2019; Chan et al., 2023; Jørgensen & Termansen, 2016; Metag & Schäfer, 2018; Neumann et al., 2022; Reuters, 2024; Yu et al., 2013). The recognition of this unprecedented environmental challenge is no longer confined to the scientific community but has pervaded the public sphere as a pressing global issue (Copsey et al., 2013; Egan & Mullin, 2017; Jørgensen & Termansen, 2016; Metag & Schäfer, 2018; Neumann et al., 2022; Pan et al., 2023; Wang & Huan, 2024). Evidence of a warming planet is unequivocal – sea levels are rising, ice sheets are shrinking, and extreme weather events are becoming more frequent and severe. The Intergovernmental Panel on Climate Change (IPCC) warns that the planet's average surface temperature could rise by 1.5 degrees Celsius above pre-industrial levels by 2040, resulting in devastating impacts (IPCC, 2018).

China, as the world's largest emitter of greenhouse gasses, is both a significant contributor to climate change and a critical player in the global response to this challenge (Copsey et al., 2013; Gong et al., 2020; Intergovernmental Panel on Climate Change, 2018; Ortega-Ruiz et al., 2022; Shan et al., 2020; Wang et al., 2016; Xu et al., 2022; Yu et al., 2013). However, despite China's crucial role in global emissions, a significant knowledge gap exists in understanding how to effectively engage the Chinese public—the largest population on Earth—in the fight against climate change, as it is widely recognized that

behavioral change at the individual level is an essential component of the broader societal and structural changes required to mitigate climate change (Hine et al., 2014; Huan, 2024; Ma et al., 2023; Metag & Schäfer, 2018; Pan et al., 2021, 2022; Steg et al., 2023; Xu et al., 2022; Yu et al., 2013).

The Chinese government's commitment to carbon neutrality by 2060 and peak emissions by 2030 has catalyzed increased media coverage and public discussion on climate change (Pan et al., 2021; Xu et al., 2022; Zeng, 2022). However, despite this increased media and public attention, research reveals a continued prevalence of skepticism and negative attitudes towards climate change among certain Chinese individuals, attributed to factors such as the negative impact of climate change mitigation efforts on economic development and conspiracy beliefs (e.g., Chan et al., 2023; Jia & Luo, 2023; Pan et al., 2022, 2023; Wang & Huan, 2024; Xue et al., 2016). Hence, examining the dynamics of climate change communication in China can provide vital insights into the possibilities for perceptual and behavioral changes necessary to mitigate climate change's impacts in China and around the globe (Ma et al., 2023; Steg et al., 2023; Xu et al., 2022; Xue et al., 2016). This dissertation aims to fill these research gaps and contribute to understanding climate change communication in China with theories from risk communication and public relations.

Climate change communication is a field that addresses climate change by focusing on the "persuasion of individuals to change their own energy use and adaptations, mobilization to foster collective action to change individuals' and institutions' behaviors, and deliberation, collective efforts to identify problems and solutions" (Johnson, 2012, p. 973).

The purpose of climate change communication can be summarized into three goals (Metag & Schäfer, 2018; Moser, 2010, 2016; Nerlich et al., 2010; Neumann et al., 2022; Steg et al., 2023). The first is to inform and educate the public about climate change, including its causes, effects, and solutions. The second goal is to engage the public at the behavioral level, and the third goal is to bring about changes in social norms and cultural values that can fundamentally lead to lasting solutions to the climate change problem.

As an interdisciplinary field, climate change communication research can be generally categorized into four main topics: public knowledge, beliefs, adaptation, and mitigation (Eise et al., 2020; Moser, 2016; Nerlich et al., 2010). The first main topic, defined as research identifying factors influencing knowledge acquisition and engagement of climate change information, is the most popular topic in climate change communication research (Ehret et al., 2017; Eise et al., 2020; Gustafson & Rice, 2016; Milfont, 2012; Moser, 2010, 2016). Climate change beliefs research examines factors influencing public beliefs in the existence, causes, and severity of climate change (Hornsey et al., 2016; Ma et al., 2023; Steg, 2023; Yu et al., 2017). Adaptation and mitigation are two distinct public actions in responding to climate change. Mitigation refers to pro-environmental actions at individual, community, and societal levels that could reduce greenhouse gasses and their future impact on the environment and people, which includes using renewable energy, saving energy, and supporting climate-related policies (Jørgensen & Termansen, 2016; Lu, 2022; Schill & Shaw, 2016; Steg, 2023; van Valkengoed & Steg, 2019; Yu et al., 2017). On the other hand, adaptation refers to actions that adjust our lives and reduce the harm caused by climate

change (Jørgensen & Termansen, 2016; Koteyko et al., 2015; Moser, 2010, 2016; Nabi et al., 2018; Outcault et al., 2018).

Another rising topic in the field of climate change communication is segmentation. Segmentation, originally a fundamental element in marketing, has been defined as an approach that accurately adjusts products and marketing efforts to align with consumers' needs (Beane & Ennis, 1987; Bian et al., 2019; Hine et al., 2014; Jaiswal et al., 2022; Smith, 1956). Recently, segmentation in the climate change context has served as a theoretically grounded and empirically driven framework, with prominent examples such as the Six Americas project, which demonstrates how segmentation aids strategic communicators in identifying and understanding their target audiences, subsequently enhancing public engagement with climate science, driving solutions, and fostering public will for climate action (Hine et al., 2014; Jaiswal et al., 2022; Leiserowitz et al., 2008, 2021, 2023; Metag & Schäfer, 2018; Neumann et al., 2022; Steg, 2023). The situational theory of problem solving (STOPS), a dominant public relations segmentation theory, is applied in climate change communication segmentation, offering unique insights into the field with situational variables and detailed divisions of communication action (Grunig, 1997; Kim, 2006; Kim & Grunig, 2011).

Section 1.2 Purpose of Study

Effective climate change communication is crucial for China. As discussed in the previous section, despite increased media coverage and public discussion (Pan et al., 2021; Huan, 2024; Xu et al., 2022; Zeng, 2022), skepticism, conspiracy beliefs, and concerns about

the economic impacts of mitigation efforts persist among certain Chinese individuals (Chan et al., 2023; Jia & Luo, 2023; Pan et al., 2022, 2023; Wang & Huan, 2024; Xue et al., 2016). To address these challenges and drive public understanding, engagement, and action on climate change, it is essential to understand how individuals respond to daily climate change messages and how persuasive communication strategies can influence their perceptions, attitudes, and behaviors. This dissertation aims to contribute to developing effective climate change communication strategies in China by examining the effects of repeated self- and social-framing messages and using the STOPS model for audience segmentation (Florence et al., 2022; Kim & Grunig, 2011; Tao et al., 2020). The main contribution of this dissertation lies in offering guidance for developing repeated communication strategies and suggesting the potential for repeated message exposures to change public segment types actively, ultimately fostering understanding, engagement, and action in response to this urgent global challenge.

Following calls by public relations scholars to investigate messaging (Cacciatore et al., 2016; Ji et al., 2019; Liu et al., 2016, 2020; Ma & Bentley, 2022), this research examines the effects of self- and social-framing climate change messages on individual attitudes and pro-environmental behaviors following longitudinal repeated exposure in China. Specifically, the distinction between self- and social-framing signifies varying social distances based on the construal level theory of psychological distance (Liberman & Trope, 2003; Loy & Spence, 2020; Ma et al., 2023; Spence et al., 2012; van Valkengoed et al., 2023). Self-framing is defined as a strong emphasis on individual impacts, responsibilities, and actions,

while social-framing denotes a strong emphasis on impacts, responsibilities, and actions relevant to groups, the environment, and society (Chen, 2019, 2020; De Dominicis et al., 2017; Florence et al., 2022). In general, self-focused benefits (or costs) are perceived as proximal and internalized or experienced by the individual. In contrast, social-focused framing is more distant and externally motivated (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Ma et al., 2023).

In addition, repeated exposure is the process by which individuals encounter identical or similar information, such as messages or images, multiple times (Diamond & Urbanski, 2022; Hassan & Barber, 2021; Lee, 2001; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017; Schmidt, 2015). This phenomenon is particularly relevant in the age of social media, where climate change information is easily and repeatedly accessible, and individuals interact with climate change-related messages daily (Agin & Karlsson, 2021; Koteyko et al., 2015; Moser, 2016).

The literature review in the first two sections of Chapter Two reveals two critical knowledge gaps, grouped as the first objective of this dissertation. The first pertains to the scarcity of research addressing repeated message exposure in real-world scenarios, which is important as understanding the tangible effects of message exposure on individual attitudes and behavioral intentions remains paramount in climate change communication (Diamond & Urbanski, 2022; Funder et al., 2019; Lu et al., 2015; Lu, 2022; Stern, 2020; van der Linden et al., 2020). This dissertation applies the inverted U-shaped model, a psychology theory in understanding the effects of repeated exposures, to examine how repeated exposures to

climate change messages impact climate change outcomes (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017). The results reveal that repeated exposure to climate change messages enhances their persuasive effects on climate change outcomes. However, the overall trends do not follow the inverted U-model's predicted pattern of initial growth followed by a decline. Instead, there are consistent overall upward trends for most climate change outcomes, suggesting the need to reassess the model's application in climate contexts in China.

The second gap lies in the lack of studies examining the combined use of opposing message framing strategies, such as self- and social-framing in climate change communication, to determine whether a mixed use of these frames yields increased persuasive powers than either self-framing or social-framing alone (Chen et al., 2020; Grazzini et al., 2018; Outcault et al., 2018; van den Broek et al., 2017; Yang et al., 2015). By addressing these knowledge gaps, the first objective of this dissertation is to understand the impacts of repeated exposure to self- and social-framing messages on individual attitudes and behavioral intentions in China. Results reveal that after six exposures, the mixed-framing condition slightly outperforms self- and social-framing conditions, indicating the potential benefits of diversified communication strategies.

Addressing these two research gaps for the first objective of this dissertation offers both theoretical and practical implications. Theoretically, the findings of the first objective of this dissertation challenge the inverted U-shaped model (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022), extend message convergence theory (Anthon & Sellnow,

2016; Liu et al., 2020) and the STOPS model (Grunig, 1997; Kim & Grunig, 2011), and address research gaps in climate change communication, such as the effectiveness of framing combinations (Chen et al., 2020; Florence et al., 2022). Practically, these findings demonstrate the potential of repeated exposure and mixed-framing strategies to enhance the impact of climate change communication and support current practices in risk communication.

Then, the second objective of this dissertation is to apply STOPS to segment individuals into various publics, providing unique insights compared to the dominant public segmentation approaches in the climate change literature (Grunig, 1997; Grunig & Hunt, 1984; Hine et al., 2014; Kim, 2006; Kim & Grunig, 2011; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Individuals are grouped into different publics based on STOPS, defined as groups of individuals who confront a shared problem, acknowledge the problem's existence, and collectively mobilize to address it (Grunig, 1997; Kim, 2006; Kim & Grunig, 2011).

Applying STOPS for segmenting publics in climate change communication reveals insights about varying levels of climate change outcomes and communicative action (defined and reviewed in detail in sections 2.1.2 and 2.3.3, respectively) among different publics, including climate change beliefs, attitudes, and private and public pro-environmental intentions, and information acquisition, information selection, and information transmission. The results supported hypotheses, demonstrating that the level of situational activity significantly influenced individuals' climate change outcomes and communicative action. Specifically, being part of an active public correlated with higher engagement in positive

communicative behaviors, lower engagement in information avoidance and omission, and stronger climate change outcomes.

This dissertation also uncovers how the impact of repeated exposure to self- and social-framing messages on climate change outcomes may vary among different STOPS publics (Bain et al., 2012; Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2010, 2016). However, the analysis did not reveal significant interaction effects between framing conditions and types of publics across all climate change outcomes after six exposures. Further, the longitudinal effects of tailored messages on the attitudes, beliefs, behavioral intentions, and segment membership of publics in response to prolonged, repeated exposure to climate change messages are examined (Hine et al., 2014; Leiserowitz et al., 2021; Martel-Morin & Lachapelle, 2022; Metag & Schäfer, 2018; Moser, 2016). The findings revealed significant shifts in public segments after the six exposures in all conditions, with a substantial increase in the active publics.

The above-mentioned examinations of segmentation using STOPS and the corresponding findings underscore two significant contributions. First, this research is pioneering in testing self- and social-framing messages in the context of climate change across diverse publics (Bain et al., 2012; Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2010, 2016). The results can thus significantly enrich the existing theoretical choices in climate change segmentation literature and improve message effectiveness for the targeted publics (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Rickard et al., 2016). The successful segmentation of communicative actions

and climate change outcomes using the STOPS model extends the model's applicability to other outcomes in public relations research. This contribution opens new avenues for future research on climate change and public relations segmentation.

Second, this dissertation contributes to both public relations and climate change communication literature by examining potential proportional shifts in public segments in response to longitudinal repeated exposure to climate change messages (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). This approach makes this dissertation a unique piece of segmentation research focusing on examining how messages might impact individuals' engagement with issues over time (i.e., move from latent to aware publics, according to the STOPS). The finding that repeated exposures significantly shift the overall proportion of different publics highlights the importance of considering the impact of repeated exposure on audience segmentation and engagement in future research and practice, offering new directions for researching and designing news coverage for sustained engagement and perceptional changes.

This dissertation employs a two-part study design. The first part is a pilot study designed to validate the manipulation of climate change messages framed as either self- or social-focused, adapted from leading Chinese news outlets. Participants, all Chinese residents, are exposed to 12 climate change messages that share the same base information but have distinct self- and social-framing parts. The framing effectiveness of these messages is evaluated through a set of specific measures, and the insights and validated messages gathered from this pilot study are used to inform and shape the subsequent main experiment.

The main study, formatted as a longitudinal between-subjects experiment, consists of six separate exposures spaced three days apart, consistent with prior longitudinal research. Participants, Chinese residents over 18, were randomly assigned to one of three conditions, either containing self- or social-framing messages or a mix of both framing messages six times at three-day intervals. This dissertation measures participants' cognitive and behavioral responses to climate change messages using variables in the STOPS and moderators, outcome variables, and control variables over repeated exposures.

The results of this dissertation reveal that repeated exposure to climate change messages enhances their persuasive effects, and the impacts do not follow the inverted U-shaped model's predicted pattern of initial growth followed by a decline. Instead, there is a consistent overall upward trend, suggesting the need to reassess the model's application in climate contexts, at least for this study's sample and design. After six exposures, the mixed-framing condition slightly outperforms self- and social-framing conditions, indicating the potential benefits of diversified communication strategies for repeated exposures.

Furthermore, the study applies the STOPS to segment publics and examine how the level of situational activity on climate change influences individuals' communicative behaviors and climate change outcomes. The results demonstrate that situational activity levels in climate change are significant predictors of positive and negative communicative behaviors and outcomes, with more engaged individuals showing stronger beliefs, attitudes, communicative actions, and private and public pro-environmental intentions. The study also

reveals that six exposures are sufficient to shift public segmentation, making more individuals more active in climate change issues.

Section 1.3 Dissertation Overview

The structure of this dissertation is as follows. Chapter 1 introduces the research background, identifies research gaps, and discusses the overall purposes and implications of the dissertation. Chapter 2 thoroughly reviews the relevant literature on key research and theoretical frameworks that directly influence the formation of this dissertation's research questions and hypotheses. Chapter 2 is divided into three distinct sections: The first section lays the groundwork for understanding the self- and social-framing, drawing from the construal level theory of psychological distance. Following this, the second section scrutinizes the inverted U-shaped model, examines the impact of message fatigue, and explores the moderating role of pro-environmental identity in repeated exposure literature. In the third section, the focus shifts to investigating how the effects of self- and social-framing may vary across different public segments and the potential for proportional changes in public segments after longitudinal repeated exposure.

Chapter 3 is dedicated to the method of this dissertation, which consists of a pilot study and a main experiment. The pilot study assesses the manipulation of self-social framed climate change messages adjusted from major Chinese news sources. The sample size planning, participant recruitment, stimuli development, measures, and data analysis associated with the pilot study are specified. The main experiment, structured as a longitudinal between-subject experiment, involves six individual exposures, each separated

by three days to align with previous longitudinal studies. Three conditions of Chinese participants aged over 18 randomly assigned were repeatedly exposed to the self or/and social framed climate change messages. Chapter 3 then presents the details concerning a list of all the proposed research questions and hypotheses, sample size planning, participant recruitment, experimental procedures, measurement, and data analysis for the main study.

Chapter 4 details the research findings. It opens with a concise overview of the hypotheses, research questions, and their corresponding findings in the form of a summary figure. The chapter then describes the data preparation process for subsequent analyses in section 4.1. In section 4.2, the outcomes of the pilot study are presented, along with an explanation of how these results informed the selection of experimental stimuli for the main study. Moving on to section 4.3, the characteristics of both the initial and final samples are outlined, followed by a detailed account of the approach employed to address participant attrition in the main study. The chapter then reports the results of reliability tests. Finally, the findings for each research hypothesis and question are presented in detail, accompanied by relevant figures and tables to provide a clear and thorough understanding of the data.

Chapter 5 summarizes and discusses each of the main findings of the dissertation, contextualizing them within the existing body of research on climate change communication and the STOPS. Subsequently, these findings' theoretical and practical implications for climate change communication and public relations are explored in detail. This chapter concludes by addressing the limitations of the dissertation and proposing potential avenues

for future research to investigate further the effectiveness of repeated message strategies in tackling climate change in China.

Section 1.4 Conclusion Preview

Through a pilot experiment and a longitudinal experiment with six repeated exposures, this dissertation offers valuable insights into the effects of repeated exposure to self- and social-framing messages on climate change communicative actions, outcomes, and public segmentation in China. The findings challenge the inverted U-shaped model, demonstrate the effectiveness of mixed-framing strategies, and confirm the applicability of the STOPS model in segmenting climate change publics based on their situational activeness in China. The dissertation also highlights the potential for targeted messages to change public segment membership through repeated exposure over time.

The dissertation contributes to the literature by extending the inverted U-shaped model and the message convergence theory, addressing research gaps on framing combination, and providing new insights into the effectiveness of repeated communication strategies in public segmentation. The findings offer practical guidance for developing repeated communication strategies and suggest the potential for repeated message exposures to change public segment types actively. Despite limitations on issues such as sampling, study design, context, social desirability, and measurement issues, this dissertation provides valuable avenues for future research to investigate further the complex interplay between message framing, repeated exposure, and public segmentation in climate change communication.

Chapter 2 Literature Review

Chapter 2 presents a comprehensive literature review covering the key research and theories that led to the development of research questions and hypotheses for this dissertation (e.g., Chang et al., 2015; Diamond & Urbanski, 2022; Florence et al., 2022; Grunig, 1997; Kim, 2006; Kim & Grunig, 2011; Lu et al., 2015; Lu, 2022; Montoya et al., 2017; Schmidt, 2015; Trope & Liberman, 2010). The literature review is structured into four sections. The first section establishes the foundation for understanding the self and social-framing derived from construal level theory. The second section examines the inverted U-shaped model, message fatigue, and pro-environmental identity as potential moderators in repeated exposure literature. Two significant knowledge gaps are identified in the second section: limited investigations of repeated message exposure and lack of examination of the effects of the combined use of opposing framing strategies, thus leading to the main research questions and hypotheses this dissertation aims to address.

The third section explores applying STOPS in segmenting climate change publics, outlining the theory's potential to provide unique insights compared to social public segmentation approaches in the climate change communication literature (Grunig, 1997; Grunig & Hunt, 1984; Hine et al., 2014; Kim, 2006; Kim & Grunig, 2011; Leiserowitz et al., 2021; Metag & Schäfer, 2018). This section also investigates how the effects of self- and social-framing messages may vary across different public segments and the possibility of proportional changes in public segments after longitudinal repeated exposure (Hine et al., 2014; Leiserowitz et al., 2021; Martel-Morin & Lachapelle, 2022; Metag & Schäfer, 2018;

Moser, 2016). Unpacking these changes contributes to a more comprehensive understanding of the effects of repeated exposure to self-social frames on publics' attitudes and behaviors in response to climate change communication. In the final section of this chapter, all proposed research questions and hypotheses are summarized.

Section 2.1 Climate Change Messaging

This section first delves into an overview of climate change messaging and key climate change outcomes this research aims to examine. Then the definitions and applications of self- and social-framing derived from construal level theory both in and out of the climate change context are illustrated (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Hornsey et al., 2016; Liberman & Trope, 2008; McBride et al., 2021; Steg, 2023; Stern, 2000, 2020; Trope & Liberman, 2010). This section also establishes the foundation for the subsequent sections of the literature review, all leading to the articulation of research hypotheses and questions that fill important knowledge gaps.

Section 2.1.1 Overview

Message strategies have been an essential part of research in climate change communication. Researchers mostly conduct experiments to test whether the manipulation of message characteristics affects participants' perceptions, attitudes, beliefs, and pro-environmental actions (e.g., Bayes et al., 2023; Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; O'Neill & Nicholson-Cole, 2009; Moser, 2010, 2016; Nabi et al., 2018). These key climate change outcomes are defined and reviewed in detail in the following subsection, providing the foundation for the rest of the literature review.

Information framing shapes how individuals perceive, interpret, and respond to various issues, including climate change. Framing theory posits how information is presented can significantly influence individuals' understanding and interpretation of a subject (Borah, 2011; Guenther et al., 2021; Ma & Bentley, 2022; Tewksbury & Scheufele, 2019). This theory has been extensively applied and researched in various disciplines, including communication, psychology, and political science (e.g., Borah, 2011; Badullovich et al., 2010; Chang et al., 2015; D'angelo, 2012; Ma et al., 2023; Shulman & Sweitzer, 2018; Spence & Pidgeon, 2010; Tewksbury & Scheufele, 2019).

Section 2.1.2 Climate Change Outcomes

This subsection focuses on key climate change outcomes, including climate change beliefs, attitudes, and private and public pro-environmental behavioral intentions. Each of these outcomes plays a crucial role in determining the overall impact of climate change communication on individuals' perspectives and engagement toward climate change (Funder et al., 2019; Hornsey et al., 2016; McBride et al., 2021; Steg, 2023; Stern, 2000, 2020; Wong-Parodi & Rubin, 2022; van der Linden et al., 2020; Yu et al., 2017).

Climate Change Beliefs. One key motivator for individuals to engage in various climate actions is their level of belief in the reality and severity of climate change, and three main beliefs are typically considered. The first belief is whether people believe climate change is real (Ma et al., 2023; Metag & Schäfer, 2018; Steg, 2023). The second belief is whether people think climate change is caused by human activity (Hornsey et al., 2016; Leiserowitz et al., 2008, 2021; Yu et al., 2017). The third belief is whether people believe the

consequences of climate change are primarily negative (Hornsey et al., 2016; Leiserowitz et al., 2008, 2021; Ma et al., 2023; Metag & Schäfer, 2018; Steg, 2023; Yu et al., 2017).

These three beliefs about climate change—its reality, its human causes, and its negative consequences—although conceptually distinct, are profoundly interconnected, suggesting that if an individual acknowledges the reality of climate change, they are likely to attribute it to human activities and anticipate its detrimental effects (Metag & Schäfer, 2018; Steg, 2023; van Rensburg, 2015; van Valkengoed et al., 2021). Hence, it is improbable that someone will accept the reality of anthropogenic climate change and simultaneously view its impacts positively. Moreover, climate change beliefs are associated with both mitigation and adaptation actions, likely due to their shared objective: avoiding the adverse consequences of climate change (Hornsey et al., 2016; Steg, 2023; van Rensburg, 2015; van Valkengoed & Steg, 2019; van Valkengoed et al., 2021).

A recent meta-analysis of the determinants and outcomes of climate change beliefs synthesized 25 polls and 171 studies across 56 nations and found that many variables that might seem intuitively significant, such as education, gender, subjective knowledge, and personal experiences of extreme weather events, are overshadowed in predictive power by concepts such as values, ideologies, worldviews, and political orientations (Hornsey et al., 2016). Also, the impact of climate change beliefs on individuals' willingness to engage in pro-environmental actions is modest at best, revealing that belief and action are not always tightly coupled in climate change (Hornsey et al., 2016). However, climate change beliefs still stand out as an essential concept in climate change communication, although it may not

directly impact actions (Hornsey et al., 2016; Leiserowitz et al., 2008, 2021; Ma et al., 2023; Steg, 2023; van Rensburg, 2015; van Valkengoed & Steg, 2019; van Valkengoed et al., 2021).

Climate Change Attitudes. Attitudes towards climate change pertain to the overall evaluative stance that individuals have towards climate change, often including beliefs that climate change is happening and caused by humans, concerns about climate change, and support for climate change mitigation policy, among many others (Akerlof et al., 2013; Diamond & Urbanski, 2022; Gifford & Comeau, 2011; Klöckner, 2013; Lu, 2022; Rode et al., 2021; McBride et al., 2021; Wong-Parodi & Rubin, 2022).

This study applies two dimensions of climate change attitudes based on previous studies, namely climate change concerns and importance, but climate change beliefs and policy preferences are discussed separately (Diamond & Urbanski, 2022; Gifford & Comeau, 2011; Hart & Feldman, 2016; Rode et al., 2021). Climate change concerns refer to the degree of personal worry or anxiety an individual expresses regarding climate change (Akerlof et al., 2013; Diamond & Urbanski, 2022; Gifford & Comeau, 2011; Konisky et al., 2016; McBride et al., 2021; Wong-Parodi & Rubin, 2022). The perception of the importance of climate change is another vital aspect of individuals' attitudes toward climate change, which is informed by how significant individuals consider the threat of climate change to be (Diamond & Urbanski, 2022; Hart & Feldman, 2016; Rode et al., 2021).

A rising topic in climate change research is whether personal experience with extreme weather events—such as severe heat waves, droughts, floods, and hurricanes—can heighten

an individual's level of concern and importance about climate change (Akerlof et al., 2013; Hoffmann et al., 2022; Howe, 2021; Konisky et al., 2016). Scholars have attempted to answer this question by matching micro-level geospatial data on extreme weather events from the National Oceanic and Atmospheric Administration's Storm Events Database with public opinion data from multiple years of the Cooperative Congressional Election Study (Konisky et al., 2016). Konisky et al. discovered a slight but noticeable positive correlation between experiencing extreme weather events and expressing concerns about climate change. However, this study was a single snapshot in time, and a longitudinal study, such as the one this dissertation proposes, could potentially see greater impacts as communities repeatedly experience high-impact weather.

Another important area is the examination of the outcomes of climate change concerns and perceived importance (Bergquist et al., 2022; Hart & Feldman, 2016; Hornsey et al., 2016; McBride et al., 2021; Wong-Parodi & Rubin, 2022). Drawing from 76 datasets encompassing 34 countries, a meta-analysis of 15 climate change mitigation policy acceptance determinants was conducted (Bergquist et al., 2022). Bergquist et al. found that individuals' concern for climate change moderately impacts accepting climate change mitigation policies across 34 countries, although without a sample of mainland China. This effect size (r = 0.48) is higher than those of other crucial antecedents of climate change, such as beliefs (r = 0.23), risk perceptions (r = 0.31), and trust (r = 0.23), revealing the critical role of climate change concerns in predicting policy preference.

In general, attitudes are considered a direct antecedent of intentions (Klöckner, 2013; Lu, 2022; McBride et al., 2021; Rode et al., 2021). For instance, a meta-analytical structural equation modeling study by Klöckner (2013), based on a pool of 56 datasets, confirmed that individuals' attitudes were direct antecedents to pro-environmental intentions, with a large effect size (r = 0.62), indicating a strong correlation between the two. However, the correlation between attitudes and actual pro-environmental behavior was only moderate (r = 0.36), underscoring the potential disparity between attitudes, intentions, and actual behavior.

Regarding interventions for changing attitudes towards climate change, a meta-analysis by Rode et al. (2021) included 396 effect sizes obtained from 76 independent experiments involving 76,033 participants in the US. Rode et al. found that interventions had a small but significant positive effect (g = 0.03) on attitudes. As mentioned by other scholars, it is important to note that effect sizes in psychology tend to be small, and their impacts can accumulate over time with repetition (Funder et al., 2019; Stern, 2020; van der Linden et al., 2020). This cumulative effect with repetition is a statement that the current study also aims to verify.

Private and Public Pro-environmental Intentions. Pro-environmental intentions refer to the stated commitment or plan by individuals or groups to engage in actions aimed at minimizing their environmental impact and contributing to environmental preservation and sustainability in the future (Akerlof et al., 2013; Bergquist et al., 2023; Hoffmann et al., 2022; Hornsey et al., 2016; Steg, 2023; Stern, 2000; van Rensburg, 2015; Wong-Parodi & Rubin, 2022). Pro-environmental behaviors can be categorized into two types: private and public.

Private pro-environmental behaviors pertain to environmentally impactful actions concerning personal and household consumption, such as routine recycling, reducing personal energy usage, or regularly selecting sustainable products. In contrast, public pro-environmental intentions involve collective initiatives to confront environmental issues. These may comprise active environmental citizenship activities, such as petitioning about environmental matters, joining, and contributing to environmental organizations, and endorsing or accepting public policies, such as expressing approval for environmental regulations or demonstrating a willingness to pay increased taxes for environmental preservation (Bergquist et al., 2023; Hornsey et al., 2016; Steg, 2023; Stern, 2000).

Unlike private, public pro-environmental behaviors can have a broad environmental effect as public policies can potentially modify the behavior of large populations and organizations. The environmental impact of an individual's private behavior is typically minor. However, when performed by many people and aggregated, these individual behaviors can result in substantial environmental consequences (Bergquist et al., 2023; Hornsey et al., 2016; Steg, 2023; Stern, 2000).

Also, in their meta-analysis examining the consequences of climate change beliefs, Hornsey et al. (2016) discovered that an individual's belief in climate change positively correlates with their pro-environmental intentions and actions; however, the correlation is stronger for intentions (r = 0.251 for public pro-environmental intentions, r = 0.316 for private pro-environmental intentions) than for behaviors (r = 0.188 for public pro-environmental intentions, r = 0.173 for private pro-environmental intentions). This is likely

because intentions are less compromised by practical reality constraints than behaviors, making the relationship between beliefs and intentions more direct (Bergquist et al., 2023; Hornsey et al., 2016; Steg, 2023). Additionally, they found a stronger correlation between climate change beliefs and private pro-environmental intentions (r = 0.32) compared to public pro-environmental intentions (r = 0.25). However, when it came to behaviors, there was no noticeable difference between the two (Hornsey et al., 2016).

In a recent large-scale meta-analysis, Bergquist et al. (2023) focused on five categories of private pro-environmental behaviors: conservation, consumption, littering, recycling, and transportation. This study synthesized research on interventions promoting private pro-environmental behaviors in field settings, incorporating 430 primary studies across ten meta-analyses. The results showed that interventions to reduce littering had the most substantial effects (d = 0.52). Interventions to encourage recycling (d = 0.27), conservation (d = 0.25), and consumption (d = 0.20) behaviors were less effective but still statistically significant. In contrast, interventions targeting transportation behaviors had the smallest effects (d = 0.08) compared to other private pro-environmental behaviors.

After discussing the key climate change outcomes, one of the central theoretical frameworks of this dissertation, the construal level theory of psychological distance, is reviewed in the following subsection (Florence et al., 2022; Green & Peloza, 2014; Liberman & Trope, 2008; Trope & Liberman, 2010). This theory is frequently employed to guide the design of message frames aimed at promoting pro-environmental behaviors (Brügger, 2020; Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; Trope & Liberman, 2010).

Section 2.1.3 Construal Level Theory of Psychological Distance

Overview. Framing emphasizes specific aspects within a message, guiding the audience to prioritize those considerations over others during decision-making (Borah, 2011; Chong & Druckman, 2007; Guenther et al., 2021). Message frames can be characterized as positive or negative, abstract, or concrete, and self or social-focused (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Liberman & Trope, 2008; Trope & Liberman, 2010).

According to a recent systematic review focusing on message framing effects, the construal level theory of psychological distance was the most often applied theory to guide message frame design in promoting pro-environmental behaviors (Florence et al., 2022). Specifically, construal level theory is employed to emphasize specific aspects of climate change, thus guiding the individual's attention, and potentially influencing their attitudes, beliefs, and behaviors (Brügger, 2020; Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; Trope & Liberman, 2010). For instance, a message framed around the detrimental consequences of climate change can evoke individuals' fear or concern towards the climate change issue, leading to a higher likelihood of individuals adopting pro-environmental behaviors. Conversely, a message emphasizing the benefits of mitigation actions may inspire hope and optimism towards the climate change issue, increasing the motivation to engage in pro-environmental behaviors (e.g., Brügger, 2020; Chang et al., 2015; Diamond & Urbanski, 2022; Florence et al., 2022; Green & Peloza, 2014; Trope & Liberman, 2010).

Construal level theory of psychological distance posits that individuals' responses to stimuli at varying distances are influenced by mental construal, which reflects the degree of abstraction or concreteness in an individual's mental representation of a stimulus (Liberman & Trope, 2008; Trope & Liberman, 2010). Psychological distance pertains to an individual's perceived proximity to an object, event, or issue (Liberman & Trope, 2003; Loy & Spence, 2020; Ma et al., 2023; Spence et al., 2012; van Valkengoed et al., 2023).

Psychologically distant events prompt individuals to concentrate on fundamental, primary, overarching, and decontextualized elements, which can be described as the core, essential, and broad aspects not tied to specific contexts. These elements represent the central, foundational concepts that hold true across various situations and circumstances, allowing for a more generalized understanding of the event. Concentrating on these elements results in high construal levels. Consequently, individuals may process these psychologically distant events using abstract processing, which entails focusing on the general, essential features of a stimulus. Abstract processing involves identifying the commonalities and patterns that exist across different instances of the event rather than dwelling on the specific details unique to each situation (Chong & Druckman, 2007; Chu & Yang, 2020; Liberman & Trope, 2003; Loy & Spence, 2020; Ma et al., 2023).

In contrast, psychologically proximal events promote low construal levels, characterized by a more detailed and concrete representation of the event. These events encourage individuals to process situation-specific, discrete, and contextualized features. Situation-specific features refer to the unique aspects of the event that are relevant only

within the context of that event. Discrete features are the separate, distinct elements that make up the event. Contextualized features focus on the relationships and interactions between various elements of the event, as well as how the event is influenced by and connected to its surrounding context (Loy & Spence, 2020; Ma et al., 2023; Spence et al., 2012; Thomas & Tsai, 2012; van Valkengoed et al., 2023).

Four Dimensions of Psychological Distance. The theory identifies four interconnected dimensions of psychological distance crucial to understanding climate change perceptions: spatial, social, temporal, and hypotheticality (Spence et al., 2012; Trope & Liberman, 2010; van Valkengoed et al., 2023). Spatial distance refers to the physical separation between an object and the observer. In the context of climate change, spatial distance plays a significant role in shaping individuals' perceptions of climate-related events. Climate change-induced disasters in foreign lands are often perceived as more distant than those affecting one's homeland (Brügger et al., 2016; Rickard et al., 2016; van Valkengoed et al., 2023). This can lead to a decreased sense of urgency or responsibility to act, as individuals may prioritize immediate, local concerns over distant issues.

Social distance encompasses the strength and nature of social ties (e.g., in-group vs. out-group) and frequently correlates with spatial distance perception (Brügger et al., 2016; Trope & Liberman, 2010). Within the climate change context, social distance can shape individuals' empathy and concern for those affected by environmental disasters (Loy & Spence, 2020; Ma et al., 2023; McDonald et al., 2015; Spence et al., 2012). For instance, individuals may feel more connected to and concerned about climate change's effects on their

in-group members, such as family and friends, than on out-group members or those with whom they share little social connection.

Temporal distance refers to the perceived time separating the present from a future event. When considering climate change, individuals might perceive its effects as temporally distant if they believe the impacts will unfold in the far-off future rather than the near present (Loy & Spence, 2020; Spence et al., 2012; Trope & Liberman, 2010). This perception can result in a lack of urgency or motivation to tackle climate change, as the seemingly remote consequences may not appear as pressing or pertinent to one's current circumstances (Jones et al., 2017; van Valkengoed et al., 2023).

Hypotheticality pertains to the perceived probability or certainty of an event happening, as uncertain events are perceived as more distant than certain ones (Loy & Spence, 2020; Spence et al., 2012; Trope & Liberman, 2010). In climate change, hypotheticality can sway how seriously individuals take the issue and their willingness to act accordingly (Trope & Liberman, 2010; van Valkengoed et al., 2023). If individuals perceive climate change consequences as highly uncertain or improbable, they may be less inclined to participate in mitigation or adaptation efforts. On the other hand, if they consider the impacts highly likely and well-supported by evidence, they may be more inclined to prioritize climate initiatives and endorse policies addressing the issue (Loy & Spence, 2020; Spence et al., 2012; Trope & Liberman, 2010; Weber, 2006).

In conclusion, information framing is a powerful tool in climate change communication, as it can shape individuals' perceptions and encourage them to adopt pro-

environmental behaviors (Diamond & Urbanski, 2022; Florence et al., 2022; Loy & Spence, 2020; Ma et al., 2023; Thomas & Tsai, 2012; van Valkengoed et al., 2023). Construal level theory effectively links diverse distance perceptions with various outcomes, such as evaluating objects and events, predicting developments, and decision-making processes (Liberman & Trope, 2003; Loy & Spence, 2020; Trope & Liberman, 2010). By understanding the effects of framing approaches and tailoring messages to specific audiences, communicators can enhance the effectiveness of individual efforts and contribute to the global fight against climate change (Brügger, 2020; Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; Ma et al., 2023; Thomas & Tsai, 2012).

Informed by the social distance dimension of construal level theory, this dissertation focuses on the impact of the self- and social-framing messages in climate change communication, as this framing approach holds significant potential and is well documented for changing individuals' pro-environmental attitudes and behaviors across countries, although results of comparison of these two frames have been mixed (Chang et al., 2015; Florence et al., 2022; Loy & Spence, 2020; Ma et al., 2023). The following subsection reviews the definition of this framing strategy and provides specific examples, key features, and several instances that illustrate how the self-social frame has been operationalized in previous research.

Section 2.1.4 Definitions of Self- and Social-framing

Pro-environmental behavior often necessitates balancing personal interests with those of society or others (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014).

Examined through the lens of construal level theory, the distinction between self and others signifies varying social distances. In general, self-focused benefits (or costs) are perceived as proximal and internalized or experienced by the individual. In contrast, social-focused benefits (or costs) are more distant and externally motivated (Chang et al., 2015; Florence et al., 2022; Loy & Spence, 2020; Trope & Liberman, 2010).

Specifically, the self-framing refers to the presentation of information with a focus on the individual's personal interests, values, or well-being in the climate change context (Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014). This frame seeks to highlight the direct implications of climate change on an individual's life and is characterized by its emphasis on personal relevance, tangible benefits or consequences, and the individual's responsibility in addressing climate change (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Ma et al., 2023). An example of a self-framing climate change message may discuss how adopting energy-efficient appliances can lower an individual's utility bills while reducing his or her carbon footprint.

Social-framing, on the other hand, emphasizes collective interests, values, or the well-being of a broader group, such as a community, nation, environment, or even the global population (Brügger et al., 2016; Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Ma et al., 2023). This frame emphasizes the shared responsibility and interconnectedness of climate change and is marked by its emphasis on collective goals, social norms, and the broader implications of climate change on various publics. Importantly, the effectiveness of the social-framing messaging may be further amplified in collectivist

cultures such as China, where collective well-being and shared responsibility are deeply embedded in social norms, as suggested by the individualism-collectivism (IC) framework (Chu et al., 2020; Hofstede et al., 2005; Huang et al., 2023). In such contexts, messages emphasizing collective goals and shared responsibilities may resonate more strongly, thereby making climate change communication more impactful (Chu et al., 2020; Hofstede et al., 2005; Ma et al., 2023). One social-framing climate change message example is how collaborative efforts to reduce greenhouse gas emissions can lead to a healthier environment and improved living conditions for future generations.

To sum up, the self- and social-framing effects may exist across different forms of social distance (e.g., ethnicity, nationality, socioeconomic status). Also, the effectiveness of self- and social-framing strategies may vary depending on the target audience and the context in which the message is being delivered (Florence et al., 2022; Green & Peloza, 2014; Ma et al., 2023). For instance, Su and Shi (2023), in an extensive online survey that sampled 1,005 citizens from Hong Kong, found that perceived societal risk and collective efficacy concerning cancer significantly correlated with collective intentions to address cancers. These intentions encompassed a range of actions, such as donating to cancer-related charities, offering voluntary services to cancer prevention organizations, and backing public policies to prevent cancer. The next subsection further discusses the previous findings of the self-social frame in the context of climate change and how they were implemented practically in China.

Section 2.1.5 Application of Self- and Social-framing in Climate Communication

Mixed Findings of Self- and Social-framing Overall. According to a recent systematic review, self- and social-framing have emerged as the most researched framing strategy in pro-environmental behavior studies (Florence et al., 2022). In manipulating this frame in the climate change context, studies frequently portrayed an issue, outcome, or object from either a personal versus societal or environmental perspective or from an in-group versus out-group perspective (Carmi & Kimhi, 2015; de Dominicis et al., 2017; Florence et al., 2022; Jaeger & Weber, 2020; Ma et al., 2023; Schill & Shaw, 2016; Yocco et al., 2015). Moreover, current research on the self- and social-framing messages, both in the Chinese and other contexts, only involves one-time exposure comparisons between self- and social-framing messages (Chen, 2016; de Dominicis et al., 2017; Florence et al., 2022; Jaeger & Weber, 2020; Ma et al., 2023; Tan et al., 2022). Only one study explored how repeated exposure to the negative- and positive-framing messages about climate change impacts attitudes, behaviors, and policy preferences (Diamond & Urbanski, 2022), and no studies have examined the effects of repeated exposure to the self-social framing messages.

Before reviewing previous related single-exposure experiments, it is crucial to recognize that in the realms of climate change communication and pro-environmental behavior studies, many studies purporting to investigate self- and other-framing often conceptualize these framing approaches in the same manner as self- and social-framing. As highlighted in a systematic review by Florence et al. (2022), these studies “often described an issue, outcome or object from a personal versus societal or environmental perspective or from

an ingroup versus outgroup perspective" (Florence et al., 2022, p. 636). Essentially, these studies are also exploring self- and social-framing (e.g., Chen, 2019, 2020; De Dominicis et al., 2017; Florence et al., 2022; Green & Peloza, 2014; Kareklas et al., 2014; Schill & Shaw, 2016; Yocco et al., 2015).

True self- and other-framing studies, which contrast oneself with specific individuals excluding oneself, are uncommon in environmental communication research and, instead, more prevalent in the health communication context (Chen & Chen, 2022; Gillman et al., 2023; Huang & Li, 2023). Consequently, the self-other framing studies in environmental communication fundamentally investigate self- and social-framing messaging, rendering them relevant to the current dissertation. In the future, these fields will benefit from more precise conceptualization, as self-social and self-other framing approaches are inherently different and may have distinct impacts on climate change outcomes.

The results comparing the impact of the self- and social-framing messages in one-time exposure experiments in climate change communication have been inconsistent. Some studies reported higher effectiveness of self-framing, which may be attributed to the reason that individuals have less motivation to reduce the risk of climate change and, instead, expect others or more powerful organizations to take preventive actions when exposed to the social-framing messages (Bai et al., 2018; Bigsby et al., 2021; de Dominicis et al., 2017; Schill & Shaw, 2016; Singh et al., 2017). For example, an online survey of U.S. adults indicated that individuals who believe climate change impacts are unlikely to occur or will predominantly

affect other people in distant locations are less likely to be concerned about climate change impacts and to support climate adaptations (Singh et al., 2017).

Conversely, some other studies reported opposing results, demonstrating higher effectiveness of social-framing compared to its counterpart (Chen, 2016; Florence et al., 2022; Geng et al., 2019; Jaeger & Weber, 2020; Ma et al., 2023; Yocco et al., 2015; Yu et al., 2017). For instance, Jaeger and Weber (2020) conducted an online experiment with a representative German adult sample to compare the effectiveness of self-benefit appeals (e.g., health advantages for oneself) and social-benefit appeals (e.g., environmental benefits). The results demonstrated that, with a higher salience of environmental benefit arguments in individuals' minds as the mediating mechanism, the social-benefit framing was more effective in increasing green purchase intentions than the self-benefit framing.

Application of Self- and Social-framing in China. There were limited studies on the effects of the self- and social-framing messages in the Chinese context compared to the Western contexts, and the findings in this context are also mixed (Chen et al., 2020; Ma et al., 2023; Tan et al., 2022). For example, Chen et al. (2020) investigated the impact of self- and social-framing messages in green advertisements on individuals' purchase intentions of green products with a mainland Chinese adults sample in an online experiment. In the self-framing condition, individuals were exposed to product information emphasizing the personal health benefits, while the social-framing condition highlighted the product's environmental benefits. The self-framing message was more effective than the social one at motivating purchase intention.

However, in another study, Tan et al. (2022) conducted two online experiments to explore the effects of self- and social-framing messages and donations to a pro-environmental foundation, with a Chinese convenience sample (1,215 participants total) aged 17 to 30 years old. The donation behavior was measured by giving participants 200 tokens (i.e., payment) and asking them the number of tokens they would like to donate to this foundation. Tan et al. discovered that neither self- nor social-framing could significantly predict donation behaviors. One possible reason for this outcome is that donating may require a higher level of commitment than other pro-environmental behaviors, such as information seeking, sharing, and personal mitigation intentions. They, therefore, indicated that underlying principles of self- and social-framing' effectiveness in the Chinese context warrant further investigation.

Research has found that different types of self- and social-framing messages can influence the effectiveness of self- and social-framing messages in mainland China. Ma et al. (2023) conducted an online between-subjects experiment based on the extended parallel process model (EPPM), which divided climate change information into personal and collective threatening and efficacy messages. In this experiment, personal threatening messages focused on individual risks from climate change, while societal threat messages highlighted climate change's broader impacts. Personal efficacy involves an individual's assessment of their ability to mitigate climate change through recommended behaviors, while collective efficacy considers the effectiveness of society-wide actions (Chen, 2016). Ma et al. discovered that collective efficacy messages and personal threatening messages are more

effective at promoting climate change mitigation intentions than their counterparts in this study.

When comparing the impact of self- and social-framing messaging, the variance in results in different cultural contexts presents a challenging and intriguing issue. As mentioned earlier in this section, the literature has yet to delve deeply into the effects of repeated exposure to the self- and social-framing strategy. It is plausible that repeated exposure could offer further insight into the inconsistencies found in prior research. This aspect will be discussed in detail in the next section, highlighting the potential implications of two new research approaches: research on repeated exposure to the same framing messages and mixed use of two opposing frames.

Section 2.2 Repeated Exposure Research

This section covers the interaction of the self- and social-framing messaging and repeated exposure to this framing strategy. The overview of repeated exposure research and the theory explains its underlying mechanism: the inverted U-shaped model is first introduced. Then, the literature on exposure frequency is reviewed to inform the dissertation's research design. The impacts of repeated exposure to the self- and social-framing messages on individuals' attitudes and pro-environmental intentions and message fatigue as a factor in the inverted U-shaped model are all discussed thereafter. Finally, pro-environmental identity as a moderator that may influence the strength of the repeated exposure effects is examined.

This further section outlines the dissertation's primary hypotheses and research questions, identifying two critical knowledge gaps within the existing literature. The first gap concerns the lack of research on repeated message exposure in real-world situations, which is crucial for understanding the true effects of message exposure on individuals' attitudes and behavioral intentions. The second gap highlights the scarcity of studies examining the combined use of opposing message framing strategies, such as s self- and social-framing in climate change communication, to determine whether a mixed use of these framing strategies one after other yields more significant effects on individuals than either self- or social-framing alone. By addressing these gaps, this dissertation contributes to understanding the effects of repeated exposure to self- and social-framing messages on individuals' attitudes and behaviors in climate change communication.

Section 2.2.1 Defining Repeated Exposure

The repeated exposure literature directly relevant to climate change communication contains research from three disciplines: psychology, advertising, and risk communication. These areas are all with varying emphases, terms, designs, and theories (e.g., Diamond & Urbanski, 2022; Hassan & Barber, 2021; Lee, 2001; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017; Schmidt, 2015). One similarity among these areas is that they all recognize the value of examining repeated exposure effects instead of only focusing on one-time exposure since repeated exposure better resembles how an individual encounters information in real-world settings (Diamond & Urbanski, 2022; Hassan & Barber, 2021; Lee, 2001; Lu et al., 2015; Montoya et al., 2017; Schmidt, 2015).

In psychology, repeated exposure is termed the mere exposure effect, which states that repeated exposure to an object leads to individuals' increased evaluations, including attitudes, liking, familiarity, and recognition of the object (Hassan & Barber, 2021; Lee, 2001; Montoya et al., 2017; Zajonc, 1968). This effect was first documented by Zajonc (1968) and has been extensively supported in empirical studies and referenced in reviews (e.g., Bornstein, 1989; Hassan & Barber, 2021; Lee, 2001; Montoya & Horton, 2014; Montoya et al., 2017; Mrkva & van Boven, 2020).

Different from psychology research that broadly examines repeated exposures to all objects, repeated exposure in advertising studies mainly uses messages, especially identical messages, as the stimulus (Alwitt & Mitchell, 2022; Liu-Thompkins, 2019; Montoya et al., 2017; Schmidt & Eisend, 2015). The concept of advertising repetition is well-established in advertising literature. Advertising repetition is characterized by mostly the repeated use of the same stimuli due to the nature of advertising, where most of these advertisements are subjected to repeated viewing (for reviews, see Liu-Thompkins, 2019; Pechmann & Stewart, 1988; Schmidt & Eisend, 2015). This characteristic of employing identical stimuli distinguishes itself from the information prevalent in climate change communication, where messages are mostly similarly repeated (i.e., messages having similar theme, framing, or structure but with different supporting facts and statements) (Betts, 2019; Diamond & Urbanski, 2022; Kievik, 2020; Milfont, 2012).

Risk communication relates most closely to climate change communication compared to psychology and advertising research since climate change is a pressing risk issue the world

faces (Brügger et al., 2016; Chang et al., 2015; Eise et al., 2020; Florence et al., 2022; Moser, 2016; Nerlich et al., 2010). Therefore, repeated exposure studies in risk communication can provide the most referencing value for its application in climate change communication research. Drawing from previous studies that have directly investigated repeated exposure within climate change communication, repeated exposure can be defined as the process by which individuals encounter identical or similar climate change information (i.e., information having the same theme, framing, or structure but with different facts and statements), such as messages or images, multiple times (Diamond & Urbanski, 2022; Lu et al., 2015; Lu, 2022; Skurka et al., 2023). This phenomenon is particularly relevant in the age of social media, where climate change information is easily and repeatedly accessible (Agin & Karlsson, 2021; Koteyko et al., 2015; Moser, 2016).

After defining repeated exposure within climate change communication, the following subsection discusses and reviews trends and gaps in repeated exposure research and the primary theory, the inverted U-shaped model, which directly explains the underlying mechanism of repeated exposure (for a review, see Montoya et al., 2017), and relevant repeated exposure studies in risk communication.

Section 2.2.2 Trends and Theory in Repeated Exposure Research

Characteristics and Gaps of Repeated Exposure Research. In general, most existing repeated exposure studies in advertising and risk communication research have used identical stimuli, which is reasonable in some cases, such as advertising messages and health campaigns (Schmidt & Eisend, 2015; Shi & Smith, 2016; Tellis, 2004; Udry et al., 2022).

However, certain repeated exposure studies, such as repeated news research, are more appropriate to use similar messages, as news issues can be repeatedly exposed to news users for weeks, months, or even years when a topic is an evolving hot issue and covered extensively by different news outlets in different ways (Lecheler et al., 2015; Liu et al., 2019; Skurka et al., 2023). Climate change issues combine all these characteristics, as some highly influential slogans and message strategies, such as scientific consensus messages, are repeatedly presented, while most other information types, such as gain- or loss-framing, are repeated in similar forms (de Hoog & Verboon, 2020; Diamond & Urbanski, 2022; Milfont, 2012; Skurka et al., 2023).

Furthermore, the existing literature has limited the exploration of more diverse outcomes with repeated exposure, such as information seeking, sharing, information overload and avoidance, and other communicative behaviors (Kahlor et al., 2020; Kim & Grunig, 2011; Li, 2023; Soroya et al., 2021). With six communicative behaviors examined, STOPS can be an effective framework for understanding these communicative behaviors after repeated exposure to messages with different or the same strategies and characteristics (Kim & Krishna, 2014; Kim & Grunig, 2011). To date, STOPS only has very limited application in environmental issues (Jiang et al., 2017; Tao et al., 2020). This theory is reviewed and discussed in depth in section 2.3.3, guiding communicative outcomes and public segmentation approach. The following subsection reviews the inverted U-shaped model.

The Inverted U-Shaped Model. The two-factor theory, also commonly referred to as the inverted U-shaped model across disciplines, is a foundational framework for investigating

the effects of repeated exposure (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017; Skurka et al., 2023; Stang, 1975). This model is built on the affective model, which posits that humans have evolved to feel wary and uncertain when encountering new stimuli (Zajonc, 1968). This fear response decreases with repeated exposure without negative outcomes, leading to a more positive response than previous exposures.

Taken one step further, Harrison (1968) proposed that repeated encounters with a stimulus can give rise to response competition, which means that the novelty of the stimulus could elicit negative reactions due to inherent uncertainty or fear of the unknown. On the other hand, the absence of any adverse effects viewing a stimulus can simultaneously prompt positive reactions, owing to the perceived harmlessness or safety. This dichotomy of emotions, triggered by the same stimulus, creates an uncomfortable or aversive state due to the incompatibility of these contrasting responses. Thus, individuals find themselves in a disconcerting situation where they experience both apprehension due to the novelty and reassurance due to the lack of adverse effects. This dynamic interplay of contradictory responses can greatly influence individuals' overall perception and subsequent behaviors toward the stimulus (Berlyne, 1960, 1966, 1968, 1970; Montoya & Horton, 2014; Montoya et al., 2017).

The inverted U-shaped model shared with Zajonc's (1968) affective model that people have an innate fear of the unknown (e.g., Berlyne, 1960, 1966). The inverted U-shaped model posits that two positive and negative factors interact to influence the impact of

repeated exposure on affective and attitudinal responses. Positive factors (i.e., habituation and learning) result in favorable thoughts, while negative factors (i.e., redundancy or boredom) lead to unfavorable thoughts (Berlyne, 1970; Cacioppo & Petty, 1979; Montoya & Horton, 2014; Montoya et al., 2017; Stang, 1975). Although labels may differ, an inverted U-shaped model can best describe the effects of positive and negative repetition factors on attitudinal and affective responses (Lu, 2022; Lu et al., 2015; Schmidt, 2015). Specifically, the repetition effect is initially positive, and liking and attitudes towards the stimulus increase with exposure, reaching a peak as familiarity and learning are saturated. However, further exposure leads to boredom and negative thoughts that surpass positive thoughts, leading to a decline in positive responses. The following subsection reviews the role of message fatigue, which has been applied in the inverted U-shaped model as one negative factor (Lu, 2022; So & Song, 2023).

The Role of Message Fatigue. A growing number of scholars have begun to study the negative sides of information behavior, and message fatigue is one of them. Message fatigue is considered a consequence of overexposure (Jia et al., 2022; Kim & So, 2018; So et al., 2017; Song & So, 2023). It can be divided into two types: acute message fatigue, which refers to fatigue caused by multiple contacts in a short time, and chronic message fatigue, which is caused by multiple contacts over a long time (Cho & Salmon, 2007; Gonzalez et al., 2021; Kim & So, 2018; Lu, 2022; So & Alam, 2019; So et al., 2017; Song & So, 2023). So et al. (2017) defined message fatigue as “an average motivational state of being exhausted and bored by overexposure to similar, redundant messages over an extended period of time” (p.

6).

Message fatigue is prevalent in daily life, but research on this concept is scarce. So et al. (2017) summarized two possible reasons. First, most of the message-related research focuses on one-time exposure, thus ignoring individuals' understanding of real-life exposure to multiple messages over time in daily life (Cho & Salmon, 2007). Second, communication scholars seem to assume that more exposure leads to better persuasive effects. Indeed, some studies have found that repetition may lead to higher awareness and recognition (Jeong et al., 2012; Jo et al., 2017; Stephens & Rains, 2021). However, more and more studies are beginning to find that overexposure may bring the opposite effect (Guan et al., 2023; Kim & So, 2018; So, 2021; So & Alam, 2019; So et al., 2017; Song & So, 2023). Therefore, research on this construct is vital.

Advertising and psychology scholars viewed repetition as a phenomenon and therefore proposed the inverted U-shaped model, but message fatigue as a concept was first clearly conceptualized and operationalized in communication research recently (Guan et al., 2023; Kim & So, 2018; Lu, 2022; So, 2021; So & Alam, 2019; So et al., 2017; Song & So, 2023). So et al. (2017) conceptually and operationally defined message fatigue, created a scale and examined this scale's psychometric properties using safe sex and anti-obesity messages as examples. Gonzalez et al. (2021) found that message fatigue was positively correlated with inattention and reactance to anti–binge drinking messaging through a survey of college students. Later, Song and So (2023) conducted a replication and further extension of So et al. (2017) and offered a shortened message fatigue scale with adequate psychometric

properties.

In climate change communication, research on message fatigue is very limited. This is a significant knowledge gap since climate change messages are increasingly prevalent and repeated in real life, and some of the information is highly likely to be counterproductive. Thus, theories and campaigns that build on findings of previous one-time exposure-based communication may not hold true when applied in the real-world setting (Lu, 2023; Lu et al., 2015; So et al., 2017; So & Song, 2023; Song & So, 2023). Relevant research mainly focused on issue fatigue in the climate change context, which refers to the state of being exhausted and bored by overexposure to an issue instead of similar and redundant messages, thus different from message fatigue (Maibach et al., 2010; Morrison et al., 2018; Moser et al., 2016).

As one of the few studies examining message fatigue in the climate change context, Song and So (2023) conducted an online survey using a U.S. adult sample to test a shortened version of So et al. (2017) message fatigue scale and replicated their finding about message fatigue in the health context to the climate change context. They found that climate change message fatigue was positively associated with counterarguments and negatively associated with attention and message elaboration. While it is crucial to recognize the interconnectedness of climate change and health issues as most climate change threats appear on human health, and these two issues all ultimately lead to the survival of humankind (Levy & Patz, 2015; Parry et al., 2019; Verner, 2016), this research identified an important research gap that most of the current research on message fatigue is correlational research (Diamond

& Urbanski, 2022; Guan et al., 2022; Lu, 2022; Lu et al., 2015; So et al., 2017; Song & So, 2023). Understanding what frequency of message exposure may lead to message fatigue and what type of message may be more likely to cause or delay message fatigue is limited. Experimental studies are needed to answer these questions since correlation does not mean causation (Holland, 1986; Rohrer, 2018).

Experimental Research on Repeated Exposure in Risk Communication. Only in the recent decade have scholars examined the effects of repeated exposure in risk communication, and the inverted U-shaped model is the only theory that directly explains the mechanism of how repeated exposure impacts individuals among all theories applied in risk communication literature (Betts, 2019; Diamond & Urbanski, 2022; Kievik, 2020; Lu et al., 2015; Lu, 2022; Milfont, 2012; Shi et al., 2016). However, only a few of these studies have directly tested the inverted U-shaped model with a repeated exposure design and found mixed results (Lu et al., 2015; Lu, 2022; So & Song, 2023).

Another important characteristic of the repeated exposure research in the risk communication literature is that most of these studies examined multiple exposures within a single experiment (i.e., massed repetition) (e.g., Betts, 2019; Kievik et al., 2020; Lu et al., 2015; Lu, 2022). Limited studies have utilized a longitudinal design to examine the effects of repeated exposures with a break among each exposure on risk communication outcomes (Diamond & Urbanski, 2022; Shi et al., 2016). This is a critical gap because longitudinal designs can provide insights into how message impact evolves over time, capturing real-world dynamics unavailable in single-experiment designs (Diamond & Urbanski, 2022; Shi et

al., 2016; So & Song, 2023). Therefore, there is a significant need for more robust research in this area that utilizes longitudinal design to understand better the effects of repeated exposure, especially applying the inverted U-shaped model and exploring how repeated exposures interact with common message strategies in risk communication (Diamond & Urbanski, 2022; Lu et al., 2015; Lu, 2022).

One example of examining repeated exposures within a cross-sectional design is Lu et al. (2015). They conducted an online experiment on food risk where they used negative stimuli to investigate the inverted U-shaped model between the repetition of food risk messages and perceived risks. They randomly assigned a Chinese adult population sample to five conditions with varying repetitions, ranging from three to 30. The researchers found that perceived risk peaked at a moderate repetition frequency and decreased at a high frequency, suggesting that moderate exposure to risk information maintains higher perceived risk. Meanwhile, over-exposure can unexpectedly reduce perceived risk. Despite this being one of the few studies that directly tested the inverted U-shaped model in risk communication, their single-experiment design limits the application of their findings to the context of climate change.

Kievik et al. (2020) is another example. These researchers investigated the longitudinal effects of repeated realistic risk messages (e.g., an air aid alarm and online bullying) exposure on primary school children's actual self-protective behavior in the Netherlands. Their experiment had three conditions: behavioral training repetition, behavioral training, or no information. The study measured the students' self-protective behaviors

immediately after the experiment, after three weeks, and three months later. The results indicated a significant increase in both intentions and actual self-protective behaviors in the short-term and long-term due to repeated risk message exposure. It is important to note that the study's design, in which repeated exposures occurred within a single occasion, differs from repeated exposures to climate change information in real life, where individuals can be exposed to this information on a daily basis.

However, even in studies that utilized longitudinal design to examine repeated exposure, they did not directly employ the inverted U-shaped model. For example, Shi and Smith (2016) conducted an online longitudinal experiment to examine the impact of moderately repeated exposures (three exposures spaced out over time) to a fear appeal message on threat perceptions, efficacy perceptions, and behavioral intentions based on the extended parallel process model (EPPM) in the health context with a U.S. college student sample. Repeated exposure to a fear appeal message increased perceived susceptibility and perceived response efficacy of skin cancer. However, there was no change in all behavioral outcomes after three exposures to the message.

Despite this study using a longitudinal design to mimic realistic repeated exposure in daily life, the limited number of repetitions makes it impossible to test the inverted U-shaped model directly. Furthermore, since a video stimulus (i.e., "Dear 16-Year-Old Me," a popular video on social media made by the David Cornfield Melanoma Fund (DCMF), which was cased in Canada and is devoted to saving lives from melanoma) was repeatedly used in their experiment, its reference value for current research may be inadequate.

Experimental Research on Repeated Exposure to Climate Communication. Only four studies have explored the impact of repeated exposure on pro-environmental behaviors in the context of climate change using an experimental design. These four studies provide the foundation for the design of the current dissertation, although they contain several limitations that this dissertation aims to solve. As reviewed in the last subsection, Lu (2022) conducted the only climate change communication study examining message fatigue using the inverted U-shaped model with a cross-sectional design. However, this study found that different amounts of exposure did not affect acute message fatigue or subsequent behavioral intentions, thereby not supporting the inverted U-shaped model. Instead, Lu (2022) discovered that chronic message fatigue served as a moderator. Those with high chronic message fatigue would experience higher acute message fatigue, leading to lower compatibility and a weaker willingness to help polar bears and support climate change mitigation, even with minimal exposure.

Two factors may have contributed to the findings of the study. First, the experiment made participants read up to ten similar polar bear headlines in 100 seconds among 20 headlines, which may not reflect how individuals are exposed to climate change news in real life. Also, this study did not adopt a longitudinal design, which would have allowed exposure to be spread over different times, mitigating the rapid increase in acute message fatigue caused by massed spacing. As discussed earlier, climate change is a prolonged event, so individuals' exposure to relevant information is typically slow and frequent rather than rapid and in high volume. Therefore, sustained exposure to climate change information is crucial to

understanding its impact on attitudes and pro-environmental behaviors over time (de Hoog & Verboon, 2020; Diamond & Urbanski, 2022; Milfont, 2012).

So and Song (2023) focused specifically on two competing factors in the inverted U-shaped model: processing fluency and message fatigue in the context of climate change. Employing a longitudinal experimental approach with an online sample of 845 U.S. adults and five climate change message exposures with different frames (i.e., economic impact vs. heat dome vs. massive floods vs. food insecurity vs. infectious diseases vs. wildfire) spaced at the time interval of every 24 hours, this study discovered that the persuasive power of repeated exposure varies depending on the individuals' pre-existing favorability towards the issue. For those who already had favorable attitudes toward climate change issues, repetition made messages more persuasive by enhancing fluency and reducing message fatigue. Conversely, for those with negative predispositions, repetition undermined the messages' effectiveness by increasing fatigue and reducing fluency. This study offers significant insights into the design of this dissertation. Specifically, this dissertation further explores the influence of other factors on the effects of repeated message exposures in the context of climate change based on the inverted U-shaped model, as well as the different and combined effects of self-social frames based on the construal level theory.

Diamond and Urbanski (2022) examined the effects of repeated exposure to positively- or negatively-valenced news articles from major U.S. news sources (e.g., *The New York Times, The Washington Post*) on individual attitudes, behaviors, and policy support toward climate change in a U.S. adults' sample with a longitudinal online experiment. This

study's mediators were climate change concern, perceived importance, and self and societal efficacy. The data collection spanned over nine weeks. During the first five weeks, participants were asked to read a news article and respond to attention- and manipulation-check questions weekly. Then, they measured outcomes during weeks one, five, and nine. The researchers found that both message types increased climate change concern and perceived importance shortly after the experiment, with the effect lasting longer in the negatively-valenced group. In contrast, the positive group showed increases in self- and societal efficacy shortly after the experiment, but this effect did not persist over time. The study, however, showed minimal effects on individual behaviors and policy preferences.

Diamond and Urbanski's (2022) experimental design closely mimicked how individuals interact with climate change-related messages daily, employing a common message strategy in climate change communication (Baden et al., 2019; Florence et al., 2022; Howell, 2014; Moser, 2016; So & Song, 2023). While meaningful insights were gained, the study primarily focused on the impact of message valence in the short-term and long-term and, thus, did not directly test the inverted U-shaped model. Additionally, the effects of other message strategies and characteristics and the effects of a mixed-use of positively- and negatively-valenced messages warrant further investigation. These topics are further discussed in the next section, further exploring how climate change message strategies may interact with repeated exposure.

Most recently, Skurka et al. (2023) conducted two longitudinal repeated exposure experiments in the context of climate change with two US convenience adult samples. These

two experiments investigated the potential for psychological responses, such as emotions and issue salience, to either intensify or diminish when individuals are repeatedly exposed to threatening messages about climate change on consecutive days. The first experiment focused on the impact of different numbers of exposure (i.e., zero to three) to threat-containing news articles about climate change over three consecutive days. They found that the intensity of fear experienced by participants did not decrease with the number of repeated exposures to different threatening articles. However, the emotion of hope was not consistently influenced by message exposure, and issue salience remained uniformly high across all exposures.

Their second experiment extended the duration of the experiment to seven consecutive days and included a manipulation of high versus low threat messaging, as well as more outcome variables. Their results showed small but statistically significant effects, with fear and intentions demonstrating the inverted U-shaped relationships with repeated exposure. Specifically, outcomes of fear and intentions increased initially but reached a plateau after approximately six exposures. However, personal issue salience and personal efficacy exhibited linear increases over the seven-day exposure period. Interestingly, these trends over time were not significantly different between the high- and low-threat message conditions.

Skurka et al.'s (2023) research design, data collection, and measurement of outcome variables provide significant reference value for this dissertation. However, their study also differs from this dissertation in several key aspects. First, Skurka et al. (2023) manipulated the threat level of climate change messages, while this dissertation focuses on the contrast

between self- and social-framing. Second, Skurka et al.'s (2023) samples were drawn from US adults, whereas this dissertation focuses on Chinese adults. Considering the differences in cultural, political, and social contexts between China and the United States (Hornsey et al., 2016; Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022), the public's response to repeated climate change messages may vary. Moreover, Skurka et al.'s (2023) experiment employed a higher frequency of repeated exposure (i.e., once daily for seven days), while this dissertation aims to conduct a relatively lower frequency of exposure and longer time interval (i.e., once every three days for a total of six times). The difference in exposure frequency and time interval may affect the trend of outcome variables over time.

After discussing and reviewing prior research on repeated exposure, the primary theory, and the mediator, it is important to discuss an integrative aspect of repeated exposure: How many times should a message be repeated to reach its best persuasive power? Therefore, exposure frequency plays an important role in the process of repeated exposure and has received scholarly attention in all relevant disciplines (Kohli et al., 2005; Pedreño-Santos & Garcia-Madariaga, 2022; Schmidt & Eisend, 2015). The following subsection reviews relevant literature and provides a reference for this dissertation.

Section 2.2.3 Exposure Frequency

While most psychology and advertising scholars agree that the repeated exposure effect on responses is inverted U-shaped (Diamond & Urbanski, 2022; Lu, 2022; Lu et al., 2015; Montoya et al., 2017; Schmidt, 2015; Shi & Smith, 2015), there is still ongoing scientific discussion on the number of exposures for optimal individual response and which

moderators have an impact on the effectiveness of the optimum number of exposures, dividing into two schools of thought: the minimalists and the repetitionists (e.g., Kohli et al., 2005; Pedreño-Santos & Garcia-Madariaga, 2022; Schmidt & Eisend, 2015; Tellis, 2004).

The minimalists suggest that only a few exposures are necessary to reach the optimal individual response, typically ranging from one to three message exposures, while the repetitionists believe that more than three repetitions are crucial for the optimal individual response (Kohli et al., 2005; Schmidt & Eisend, 2015). The repetitionist view is supported by a meta-analysis of the effective frequency of advising repetition with 37 included studies, which demonstrated that fewer exposures do not achieve optimal positive responses, and repetition is necessary (Schmidt & Eisend, 2015).

This finding also aligns with research in psychology that insufficient repetition is inadequate for the optimal change in individual responses (Bornstein, 1989; Cacioppo & Petty, 1979; Lu et al., 2015; Montoya & Horton, 2014; Montoya et al., 2017). Psychological research on repetition effects has suggested a minimum of three exposures to detect the curvilinear patterns between repeated exposure to an object and affective and cognitive outcomes (Bornstein, 1989; Montoya et al., 2017). This is especially important when attempting to identify the nuanced relationship between repeated exposure and response measurements in curvilinear patterns, and it should be examined in the context of climate change (Diamond & Urbanski, 2022; Lu, 2022).

Overall, repeated exposure literature, both in advertising and psychology research, suggests that at least three to four exposures are required to observe the inverted U-shaped

model (Bornstein, 1989; Kohli et al., 2005; Lu et al., 2015; Montoya & Horton, 2014; Montoya et al., 2017; Pedreño-Santos & Garcia-Madariaga, 2022; Schmidt & Eisend, 2015; Tellis, 2004). Therefore, this dissertation tests whether attitudes and other factors change when repeated exposure to self- and social-framing climate change messages reaches three exposures. It is expected that after three exposures, individuals' positive responses to climate messages may change to negative or decrease significantly due to the message fatigue participants experience, as the inverted U-shaped model posits. The next subsection discusses how repeated exposure interacts with self- and social-framing climate change messages to influence key climate change outcomes.

Section 2.2.4 How Repeated Exposure Interacts Self- and Social-framing Strategy

The Impact of Repeated Exposure to Self- and Social-framing Messages on Climate Change Outcomes. In the context of self- and social-framing messaging in climate change communication, the inverted U-shaped model suggests that repeated exposure to self- and social-framing messages would initially lead to increased climate change outcomes. This outcome is a result of the positive influences of habituation and learning. However, as exposure continues past an optimum point, negative influences like redundancy and boredom come into play, leading to decreased outcomes (Berlyne, 1970; Cacioppo & Petty, 1979; Montoya & Horton, 2014; Montoya et al., 2017).

Before formulating the research question based on the inverted U-shaped model, a clear rationale and thought process must be established for this dissertation. This reasoning focuses on the significance of the interaction between time (i.e., numbers of exposure

frequency) and group (i.e., condition) within the specific context of climate change. The rationale comprises three main components, each aiming to verify the underlying assumptions of the inverted U-shaped model within this context.

The first step is to identify whether there is a significant interaction effect between exposure frequency and conditions specific to climate change attitudes and behaviors. For example, does heightened media attention after specific exposure interact with condition characteristics to influence climate change awareness or action differently across conditions? This aspect is crucial in substantiating the inverted U-shaped model in climate change communication, suggesting that the interactions between exposure frequency and condition are not merely additive but interactive.

The second component of this dissertation is to establish whether the main effects for each condition are significant with climate change outcomes over time. This involves statistical tests to determine if the mean values of climate change outcomes for each experimental condition significantly differ after each exposure. By examining the main effects of each condition over time—each exposed to climate change messages with different framing strategies—this dissertation aims to offer nuanced insights into how framing can shape public perceptions and actions related to climate change. This is the foundational step before further exploring the complex interaction effects between exposure frequency and condition.

Lastly, this dissertation examines whether there are significant main effects on time (i.e., numbers of repeated exposures) for all conditions concerning their climate change

outcomes. According to the inverted U-shaped model, climate change outcomes within each condition should vary over time due to an interplay of both positive and negative factors (Berlyne, 1970; Cacioppo & Petty, 1979; Montoya & Horton, 2014; Montoya et al., 2017). For instance, initial exposure may elevate concern and catalyze pro-environmental actions, but subsequent exposures might trigger message fatigue, leading to stagnation or even a decline in engagement. By evaluating the main effects over time within each condition (self and/or social frame conditions), this dissertation aims to deepen the understanding of the temporal dynamics that shape individual reactions to climate change messaging. This provides a robust foundation for the subsequent investigation into the intricate interaction effects between exposure frequency and condition.

By exploring these three aspects, the stage is set for the Research Question 1:

Research Question 1: Is the interaction between time and condition significant in affecting climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?

Also built on previous findings on the optimal number of exposures for optimal individual responses in psychology and advertising research, this conceptualization raises a crucial question for the present study: What is the exposure threshold at which the self- and social-framing condition, respectively, reach their peak impact on climate change outcomes?

Research Question 2: After how many exposures do the self- and social-framing conditions respectively reach their maximum impact on climate change outcomes,

including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?

After identifying whether a significant interaction exists between time and condition and establishing the exposure threshold for peak impact on climate change outcomes, this dissertation's next focus is to assess if the trajectory of mean scores over time for each condition aligns with the inverted U-shaped model's assumptions. Specifically, early exposure to climate change messages should generally produce an upward trend in favorable attitudes and behavioral intentions (Berlyne, 1970; Cacioppo & Petty, 1979; Montoya & Horton, 2014; Montoya et al., 2017). Individuals may start paying more attention, becoming more concerned, or even taking preliminary actions. The model suggests that the condition's mean score will peak at a certain point. After this point, one could expect a diminishing impact or even a reversal, implying that continued exposure may produce fatigue, cynicism, or desensitization. After peaking, the model posits that the mean scores will gradually decline. Thus, Hypothesis 1 is presented:

Hypothesis 1: As the number of repeated exposure increases, there will first be an increase and then a decrease in climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions for all three conditions.

A subsequent line of inquiry compares the effectiveness of the self- and social-framing messaging after repeated exposure. Cultural nuances, such as those found in China, can potentially shed light on this matter. China, predominantly a collectivist society,

emphasizes group harmony, interdependence, and shared responsibility (Hou, 1997; Jackson & Wang, 2013; Pan et al., 2021, 2022, 2023; Xu et al., 2022; Zeng, 2022). In the context of climate change, the social-framing messages underscoring collective efforts and societal benefits of addressing climate change could resonate potently with Chinese adults. As such, they might demonstrate positive evaluations and a greater willingness to participate in pro-environmental activities, viewing it as a shared responsibility rather than an individual task. Thus, the effectiveness of self-framing messages may wane more swiftly in this context.

However, while there is substantial research on repeated exposure and the inverted U-shaped model provides foundational understanding, the results of the impact of the self- and social-framing remain inconsistent and relatively unexplored in the context of repeated exposure (Chen, 2016; de Dominicis et al., 2017; Florence et al., 2022; Jaeger & Weber, 2020; Ma et al., 2023; Tan et al., 2022). Therefore, the intersection of these two aspects - self- and social-framing and repeated exposure - remains an unknown territory. Cultural differences, while informative, only provide indirect support. Consequently, it is necessary to pose research questions to delve deeper into this domain. Specifically, two instances of comparison arise, as suggested by the inverted U-shaped model. The first point is when the climate change outcomes for both conditions reach their peaks. It is worthwhile to investigate which framing, self or social, produces higher values for climate change outcomes at this stage. The second comparison point occurs after the conclusion of all six exposures. Here, examining which framing results in the lowest outcomes after all six exposures is crucial. Therefore, the third and fourth research questions ask:

Research Question 3: When individuals in each framing condition reach their highest levels of belief in climate change, their most positive attitudes, and their strongest intentions for both private and public pro-environmental behaviors, which messaging frame—self-framing or social-framing climate change messaging—leads to stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?

Research Question 4: After six repeated exposures, individuals in which frame condition—self-framing or social-framing climate change messaging—result in stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?

Mixed Use of Both Self and Social Framing Messages. While the effectiveness of using multiple frames has consistently been a focus in past research, due to the limitations in the experimental design (i.e., most previous climate change framing studies are cross-sectional, single-exposure experiments), existing studies have only been able to test congruent combinations (e.g., negative paired with abstract-focused in one message; concrete paired with social-focused in one message), with no ability to test the mixed use of opposing message frames over time (Chen et al., 2020; Grazzini et al., 2018; Outcault et al., 2018; van den Broek et al., 2017; Wang et al., 2019; White et al., 2011; Wolske et al., 2018; Yang et al., 2015). For instance, Yang et al. (2015) demonstrated the effectiveness of congruity between abstract-concrete and self-social frames, respectively, using a Chinese undergraduate student sample in a lab experiment. The results revealed that when green products were associated

with the benefit of society, abstract appeals were more effective in promoting purchase intentions. In contrast, both abstract and concrete appeals were less effective when green products were associated with self-benefits.

Yet, the effects of repeated alternating exposure to opposing message frames could differ from the effects of a single exposure to a particular frame or repeated exposure to a single frame message. The inverted U-shaped model can help to elucidate this distinction. Alternating the frames of the messages, such as providing a self-framing message followed by a social-framing message, may offer more novelty and variety among participants than only giving messages with the same frame (Bornstein, 1989; Montoya et al., 2017; Stang, 1974). Changes between different frames in each exposure could possibly slow down the increase of message fatigue, thereby reducing the impact of unfavorable thoughts on climate change outcomes. This leads to the proposition that the mixed use of self- and social-framing messages might result in lower message fatigue and higher climate change outcomes than using self- or social-framing alone.

Answering which framing strategy is most effective is crucial for three reasons. First, it can help design effective climate change communication strategies by determining if mixed-framing messages lead to lower or higher levels of message fatigue and climate change outcomes than single-frame messages. Second, it contributes to the broader literature on message design and persuasion by identifying potential barriers and facilitators to effective messaging in climate change communication. The findings to this question can be a foundation for future studies exploring the optimal balance and timing of self- and social-

framing messages in various communication contexts. Lastly, it bridges the gap between theory and practice by providing empirical evidence that can inform the development of evidence-based guidelines for journalists seeking to design engaging climate change communication coverage.

Building on the inverted U-shaped model and existing literature on the role of message fatigue as the negative factor in the theory (Lu, 2022; Skurka et al., 2023; So & Song, 2023; Song & So, 2017), Research Question five and Hypothesis two are formulated to investigate whether there are significant differences on the values of message fatigue and other climate change outcomes across all three conditions after six exposures.

Research Question 5: After six exposures, are there significant differences in message fatigue between participants exposed to mixed-framing messages compared to only self-framing and social-framing messages?

Hypothesis 2: Compared to conditions exposed to only one type of frame repeatedly, the mixed-use of both self- and social-framing messages will result in higher values for climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures.

To better understand the complex relationship between repeated exposure to self- and social-framing messages and climate change outcomes, it is critical to explore potential moderators that may shape the strength of this relationship. One promising moderator, pro-environmental self-identity, is identified. Delving into this moderator in the following

subsection uncovers nuanced aspects of climate change communication and contributes to refining message strategies.

Section 2.2.5 Pro-environmental Self-identity as a Moderator

The exploration of potential moderators in this context is motivated by the complexity and multidimensionality of individuals' responses to repeated exposure to framing messages (Diamond & Urbanski, 2022; Florence et al., 2022; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017). As such, this research aims to examine a promising moderator, pro-environmental self-identity, that has the potential to interact with repeated exposure to self-social framing messages, thus shaping climate change outcomes.

Self-identity is characterized by the labels individuals use to describe themselves and is molded by personal motivations and social interactions, including the expectations of others and the roles we perform (Ellmers et al., 2002; Stryker & Burke, 2000). Pro-environmental self-identity refers to an individual's perception of themselves as someone who acts in environmentally responsible ways and can influence one's attitudes and behaviors, driving them to act consistently with this self-conception (Dermody et al., 2015; van der Werff et al., 2013; Whitmarsh & O'Neill, 2010).

Studies have also established the moderating role of pro-environmental self-identity in predicting pro-environmental attitudes and intentions (Carfora et al., 2017; Lavuri et al., 2023; Tarinc et al., 2023). For example, Carfora et al. (2017) employed a longitudinal design to explore the moderating role of pro-environmental self-identity in predicting pro-environmental intentions and behaviors while controlling for past behavior. The study

involved a sample size of 240 participants in the U.S. in the first survey. After two weeks, a follow-up questionnaire was administered to 220 of the original participants, measuring their self-reported performance of the earlier outlined pro-environmental behaviors during the preceding fortnight. The findings suggested that pro-environmental self-identity significantly moderated the impact of perceived behavioral control on intentions and the effect of past behavior on both intentions and behaviors across pro-environmental behaviors.

The inverted U-shaped model posits that repeated exposure initially leads to favorable thoughts due to learning and habituation but eventually gives way to unfavorable thoughts due to redundancy and boredom. Individuals may interpret repeated exposure to similar messages differently (Berlyne, 1970; Cacioppo & Petty, 1979; Montoya & Horton, 2014; Montoya et al., 2017). Rather than perceiving this as redundancy leading to disengagement, individuals with high pro-environmental self-identity may see it as a necessary reinforcement of an urgent message worth being exposed by more people. They could perceive repeated climate change information as an echoing call for action that underscores the seriousness of the issue and the urgency of response. Consequently, the expected decline in response due to repeated exposure predicted by the inverted-U model could be moderated, sustaining, or even enhancing their engagement with climate change issues.

Another possible reason is the reinforcement of an individual's current pro-environmental self-identity. Repeatedly receiving messages aligned with one's pro-environmental self-identity may reinforce that identity. This consistent reinforcement might enhance the inclination to act in line with that identity, leading to stronger pro-environmental

behavioral intentions even after repeated exposures.

So and Song (2023) found similar moderating effects of individuals' pre-existing favorability towards climate change with a similar longitudinal experimental design in the US. Specifically, they found that message repetition bolstered persuasiveness by augmenting fluency and mitigating message fatigue for individuals already possessing favorable attitudes toward climate change issues. However, for those harboring negative predispositions, repetition detracted from the messages' effectiveness by escalating fatigue and diminishing fluency. Similarly, pro-environmental self-identity can be pivotal in shaping how individuals interpret and react to repeated messages. Hence, the following research question is proposed:

> **Research Question 6**: How does pro-environmental self-identity moderate the relationship between repeated exposure to different frames (i.e., self, social, or mixed framing conditions) and climate change outcomes, specifically in relation to climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures?

Section 2.3 Audience Segmentation Using Situational Theory of Problem Solving

This section first reviews research on climate change segmentation and identifies key gaps and directions that need scholarly attention. Then, this section provides a detailed introduction to the key concepts in STOPS and discusses why STOPS can provide unique insights compared to social approaches in climate change segmentation. How STOPS can be applied to segment potential audiences for climate change communication and how different publics may have varying levels of outcomes in response to climate change communication

are discussed. Subsequently, how the effects of repeated exposures to self and social framing messages about climate change may vary for different publics is identified. Furthermore, this section articulates the possible changes in public segments after longitudinal repeated exposure to climate change messages.

The literature reviewed in this section identifies two significant contributions of the proposed dissertation research. First, this dissertation is the first research testing the effects of self and social framing messages in the context of climate change for various publics. Results from this dissertation can enrich the climate change communication literature and enhance message effectiveness for the targeted publics for environmental communicators and policymakers. Second, this dissertation contributes to public relations literature by examining potential changes in public segments following longitudinal repeated exposure to messages about climate change, making the dissertation the first public segmentation research that aims to examine how messaging impacts how publics engage with issues (i.e., move from latent to aware publics) over time. This dissertation's longitudinal data collection offers a novel approach to understanding how publics may dynamically respond to climate change communication over time. For example, this dissertation's findings may inform scholars and journalists how to move latent publics to aware publics through public relations campaigns with repeated messaging communicated over time.

Section 2.3.1 Segmentation Section Overview

Defining Audience Segmentation. The concept of segmentation, as a fundamental element in marketing, was originally presented in the mid-1950s and has been defined as an

approach that is “based upon developments on the demand side of the market and represents a rational and more precise adjustment of product and marketing effort to consumer or user requirements” (Smith, 1956, p. 5). Marketing segmentation emphasizes creating products tailored to subsets of consumers with common desires and needs. The primary objective is to partition the broad consumer population into distinct, non-overlapping subgroups typically characterized by demographic attributes and anticipated product needs (Beane & Ennis, 1987; Bian et al., 2019; Hine et al., 2014; Jaiswal et al., 2022).

Once consumer segments are identified, marketers create messages and select communicators and channels most suited to each segment to influence purchasing decisions. In the digital era, segmentation remains an essential component of advertising strategies as marketers collaborate with technology companies like Google and Facebook to personalize and direct messages based on individuals’ online behaviors and profiles (Bian et al., 2019; Jaiswal et al., 2022). This process of customization and targeting soon became a key approach leveraged by marketers to enhance the efficacy, cost-effectiveness, and efficiency of their advertisements (Beane & Ennis, 1987; Bian et al., 2019; Hine et al., 2014; Jaiswal et al., 2022). Due to the effectiveness of segmentation in marketing, segmentation was soon introduced and flourished in other fields for different purposes, which is reviewed in the following subsections (Kreuter et al., 2022; Mancini et al., 2017; Mathijssen et al., 2012; Rimal et al., 2009; Thaker et al., 2023).

Audience Segmentation in Other Fields. Segmentation has been repurposed and effectively employed in diverse fields such as public health and politics (Mancini et al., 2017;

Rimal et al., 2009; Slater, 1996; Thaker et al., 2023). Though the objectives and goals of audience segmentation undergo significant modifications in these contexts, the strategic rationale and the efficiency derived from identifying a specific audience segment remain compelling and essentially unchanged. Reviewing how audience segmentation research evolved and developed in these fields clarifies how segmentation can contribute to theory and practices in climate change communication and inform the design of the current dissertation.

Health communicators have extensively embraced audience segmentation to design message campaigns encouraging engagement and behavioral changes. Examples include moderating alcohol consumption and increasing vaccination intentions (e.g., Kreuter et al., 2022; Mathijssen et al., 2012; Thaker et al., 2023; Williams et al., 2023). A meta-analysis also supported this rationale, showing that specifically crafted and directed health messages lead to a more substantial behavioral shift than generic, non-personalized messages in print media (Noar et al., 2007).

One frequently employed health communication segmentation theory is the Risk Perception Attitude (RPA) Framework for audience segmentation (Rimal & Real, 2003; Rimal et al., 2009; Mead et al., 2012; Su & Shi, 2022). PRA sorts individuals into four categories based on their perceptions of risk and beliefs about self-efficacy: responsive (those perceiving high risk and strong self-efficacy), avoidant (high-risk perception, low self-efficacy), proactive (low-risk perception, high self-efficacy), and indifferent (low-risk perception, low self-efficacy). Studies suggest that information seeking behavior for health-

related matters is linked to the segments individuals belong to (Mead et al., 2012; Rimal & Real, 2003; Su & Shi, 2023).

For instance, Su and Shi (2023) extended the RPA framework to social-level perceptions with an online survey conducted among Hong Kong citizens (N = 1,005). They categorized participants into four groups based on societal-level risk perceptions and efficacy. The comparison of demographic and psychological traits highlighted notable differences across these groups, especially in their individual-level risk perceptions, efficacy, cancer family history, and intentions to adopt preventative behaviors. Such audience segmentation empowers health communicators to craft messages that resonate with each societal-level risk-efficacy group (Rimal et al., 2003, 2009; Su & Shi, 2023).

Thus, segmentation can serve as a theoretically grounded and empirically driven framework and instrument in climate change communication (Hine et al., 2014; Jaiswal et al., 2022; Metag & Schäfer, 2018; Neumann et al., 2022). It assists strategic communicators in identifying and comprehending their target audiences, thereby enhancing public engagement in climate science and solutions and fostering public will for climate action (Hine et al., 2014; Jaiswal et al., 2022; Leiserowitz et al., 2021; Neumann et al., 2022).

Following this line of thought, the next section discusses public segmentation in climate change communication, primarily focusing on the Six Americas as a predominant approach. Then, through a review and reflection on existing literature, areas where climate change segmentation research requires further scholarly attention are highlighted. These areas are tied to the research questions that this dissertation aims to address.

Section 2.3.2 Climate Change Segmentation

Six Americas as the Dominant Approach. Despite the existence of substantial segmentation studies that use surveys with large national samples to identify subpopulations sharing similar characteristics regarding the climate change issue, the earliest and most dominant one is the Six Americas introduced by the Yale Project on Climate Change Communication (Hine et al., 2014; Leiserowitz et al., 2008, 2021, 2023; Metag & Schäfer, 2018; Neumann et al., 2022). Originating in 2008, this project explored segmentation methods based on 36 variables through a nationally representative sample of 2,164 U.S. residents. They divided the population into six distinctive segments - alarmed, concerned, cautious, disengaged, doubtful, and dismissive - based on varying climate change beliefs, concerns, and motivations (Leiserowitz et al., 2008).

As defined in the Six Americas studies, these segments present a range of climate change perspectives (Leiserowitz et al., 2008, 2021, 2023). The alarmed are convinced that climate change is real, caused by human activities, poses an urgent threat, and are ardent supporters of climate policies. Those concerned also believe in human-induced climate change and perceive it as a significant threat. They support climate policies but often see the impact of climate change as remote in both time and place; therefore, it is not their top priority. The cautious are those who are still contemplating the issues surrounding climate change. They are undecided about whether global warming is happening, whether humans cause it, and whether it is a severe problem. The disengaged segment of the population is not well-informed about global warming. They seldom or never hear about it in the media. The

doubtful are individuals who either do not believe global warming is occurring or see it as merely a natural cycle. They do not perceive it as a severe risk. Last, the dismissive are those who deny that global warming is happening, that humans cause it, or that it poses a threat. They are most likely to endorse conspiracy theories, such as theories depicting global warming as a hoax or aiming at global governance (Leiserowitz et al., 2008, 2021).

The measures and methodology of this line of research were employed in other countries and contexts beyond the U.S., such as Australia (Neumann et al., 2022), Germany (Metag et al., 2017), and India (Leiserowitz et al., 2023). For instance, a similar segmentation was conducted in India in 2022, where different conclusions were found compared to the United States (Leiserowitz et al., 2023). Specifically, Leiserowitz et al. (2023) identified four distinct audiences in India: the alarmed (54%), concerned (29%), cautious (11%), and disengaged (7%). These audiences aligned with their counterparts in the United States regarding their beliefs, attitudes, policy support, and behaviors related to global warming, yet notable differences existed. For instance, the distribution of these groups diverged; a significant majority (82%) of the Indian population fell into either the alarmed (54%) or concerned (29%) categories, while these two audience segments only constituted 53% of the U.S. population. Additionally, unlike the United States, the Indian populace does not include substantial percentages of doubtful or dismissive individuals. So far, the Six Americas approach has not been directly applied in China, and China may have a distinct segmentation pattern that does not necessarily align with these six categories defined by the Six Americas, possibly due to high levels of climate change beliefs among Chinese and China's unique

cultural and political environments (Hou, 1997; Pan et al., 2021, 2022, 2023; Xu et al., 2022; Zeng, 2022).

Another commonly used theory, the Risk Perception Attitude (RPA) framework, was borrowed from health communication research (Rimal & Real, 2003; Rimal et al., 2009). Mead et al. (2012) applied the RPA framework to categorize 523 U.S. parent and adolescent pairs into four segments in a survey based on their risk perceptions and personal efficacy beliefs regarding tackling climate change threats. These segments were identified as indifferent, proactive, avoidant, and responsive. Participants in these segments significantly differed in their information seeking behaviors. Specifically, participants in the responsive and avoidant groups were more inclined to seek information on climate change compared to the indifferent group.

Identified Gaps and Directions in the Climate Change Segmentation Literature. Currently, scholars have emphasized the pressing need for expanded international climate change segmentation research, accentuating the need for climate change audience segmentation at various scales - global, national, and local (Hine et al., 2014; Leiserowitz et al., 2021; Neumann et al., 2022). Given the global nature of climate change, a predominant focus on the U.S. does not adequately address the issue (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Supporting this viewpoint, existing studies suggest that the segmentation method used for the U.S. public may not necessarily be fitting for societies with diverse cultural and political landscapes (e.g., Leiserowitz et al., 2023; Metag et al., 2017; Neumann et al., 2022).

In response to this call, scholars suggest two possible approaches. First, examine the possible utilization of the Six Americas segmentation for cross-national comparisons with the same measures and methodology. Second, new audience segmentations for individual countries should be created, drawing upon the Six Americas approach as a model (Hine et al., 2014; Metag et al., 2017). Another area of concern in current climate change segmentation literature that scholars have identified is the scarcity of theory-driven studies: Most research only relies on empirical evidence and commonly used concepts in climate change communication studies to identify segments (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018).

Consequently, conducting segmentation research in China and identifying suitable segmentation theories for this context is paramount for two reasons. First, it allows for an emphasis on China, one of the most significant major energy consumers and emitters, thereby contributing to the global efforts to mitigate climate change and answering the call for global climate change segmentation research (Copsey et al., 2013; Gong et al., 2020; Ortega-Ruiz et al., 2022; Shan et al., 2020; Wang et al., 2016). Second, it enriches the theoretical reservoir of climate change segmentation by introducing new perspectives or models. One such promising theory could be the STOPS, a dominant segmentation theory from the field of public relations (Chon et al., 2023; Grunig, 1997; Jiang et al., 2019; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014) that has been successfully applied in an environmental issue China (i.e., PM2.5, resulting in haze and smog air pollution), showcasing the explanatory power of STOPS in the Chinese context. The following section introduces the key concepts and the

segmentation approach offered by STOPS and elaborates on what unique contribution this theory can make when segmenting climate change audiences.

Section 2.3.3 The Situational Theory of Problem Solving

Theoretical Overview. The situational theory of problem solving (STOPS), which originated and extended from the situational theory of publics (STP), is a public relations theory that explains publics' communicative actions in problematic life situations through situational antecedents (Chon et al., 2023; Chon & Park, 2021; Grunig, 1997; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014). Publics are groups of individuals who confront a shared problem, acknowledge the problem's existence, and collectively mobilize to tackle it (Grunig, 1997; Grunig & Hunt, 1984; Kim, 2006; Kim & Grunig, 2011). STOPS provides detailed profiles for each of the four publics the theory identifies. Specifically, nonpublics are those who perceive they are not facing a problematic situation. Latent publics are those who perceive a problem but have minimal involvement with the problem. Aware publics are those who are aware of the problem, but due to high constraint recognition or low involvement, they do not want to act actively toward addressing this problem. Finally, active publics recognize a problem, have low constraint recognition, and have high involvement (i.e., the problem is highly related to themselves) (Kim, 2011; Kim & Grunig, 2011; Kim et al., 2014).

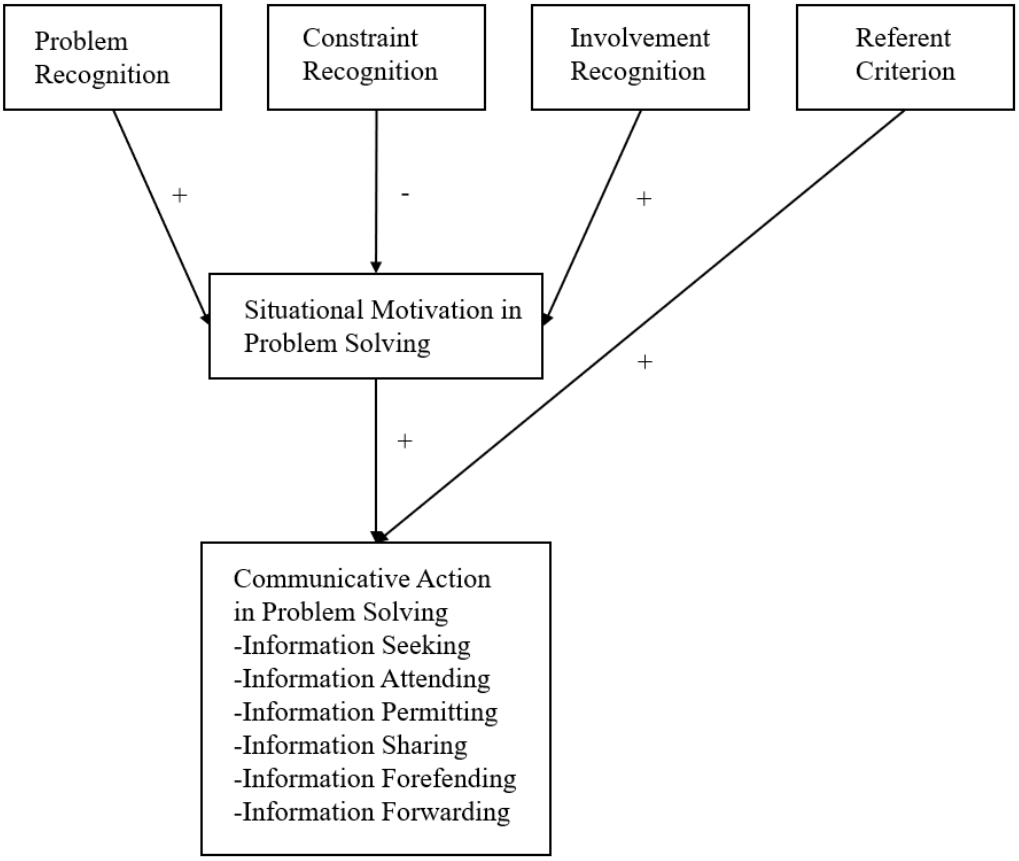
STOPS theorizes that when publics accept a situation as problematic, do not have many obstacles to obtaining information about how to address the problem, and believe that the problem is highly related to themselves, they will likely work to solve the problem through engaging in communicative actions in problem solving. Dozens of empirical studies

have supported the explanatory power and practical value of STOPS in different countries such as the U.S., China, South Korea, and Singapore and diverse contexts such as organizational crises, public health crises, organ donation issues, and cancer information seeking (e.g., Chon & Park, 2021; Jiang et al., 2019; Kim & Hong, 2021; Krishna & Kim, 2020; Lim et al., 2015; Shin & Han, 2016).

The STOPS model establishes a pathway from perceptions through motivation to communication, detailing three perceptual, cognitive, and situational antecedents (i.e., problem recognition, involvement recognition, and constraint recognition), one cognitive antecedent (i.e., referent criterion), and a motivational mediator (i.e., situational motivation in problem solving). This chain ultimately culminates in publics' level of engagement in communicative actions. Figure 1 summarizes all variables and pathways in the STOPS model; the constructs in the STOPS model are further detailed in the subsequent sections.

Figure 1

The STOPS model adapted from Kim & Grunig (2011)



Antecedents in STOPS. Three perceptual, cognitive, and situational antecedents served as the foundation for predicting situational motivation in problem solving and communicative actions to address a problematic situation. Problem recognition refers to publics' perceptions of whether a problem exists and whether an immediate solution exists (Grunig, 1997; Kim & Grunig, 2011). Consequently, publics may initiate communicative efforts to address an identified problem. Constraint recognition refers to perceived constraints (i.e., beliefs of having low personal efficacy to execute communicative behaviors or low efficacy to change anything about the problem) that can discourage publics' information behaviors, while involvement recognition refers to how much publics think they are related to the problem (Grunig, 1997; Kim & Grunig, 2011). The degree of individuals' perceived proximity (i.e., their perceived connection of self to the problematic situation) to the situation

can impact the likelihood and extent of their communicative actions (Kim & Krishna, 2014). A minimal perceived involvement tends to elicit passive communicative actions. Conversely, if publics lack confidence in their ability to carry out specific behaviors, they are also less likely to communicate about the problems they encounter.

Specifically, the model suggests that when publics notice a gap between their expectations and reality related to a contentious problem (i.e., having high problem recognition), recognize their personal stake in the problem (i.e., having high involvement recognition), and perceive few barriers to addressing the problem (i.e., having low constraint recognition), they are likely to feel motivated to think about the problem and prepared to invest cognitive resources in problem-solving efforts (i.e., having strong situational motivation in problem-solving). The effects of these three perceptual/cognitive and situational antecedents on situational motivation have been replicated in many prior studies in different countries such as the U.S., China, and South Korea and diverse contexts such as environmental issues, gun control, and racial discrimination (e.g., Chon & Park, 2021; Jiang et al., 2019; Kim & Hong, 2021; Krishna & Kim, 2020; Lim et al., 2015; Shin & Han, 2016; Tao et al., 2020).

For instance, to understand the environmental problem of PM2.5 air pollution in China, Jiang et al. (2019) extended the STOPS model by incorporating citizens' environmental engagement behavior as an outcome of their communicative action based on a national sample of 374 Chinese citizens. Problem recognition in this study was defined as the citizens' understanding of the severity of PM2.5 pollution and its detrimental effects on

health and economic stability. Constraint recognition was viewed as citizens' evaluation of their capacity to intervene in the PM2.5 issue and their comprehension of the problem's current state. On the other hand, involvement recognition was defined as the individuals' perceived personal link to the PM2.5 issue, including the extent of its impact on them or their acquaintances. Results supported all the proposed relationships within the STOPS. Rather than directly influencing environmental engagement, problem recognition, constraint recognition, and involvement recognition had a significant indirect impact via two core mediators in the model: situational motivation in problem solving and communicative actions in problem solving.

Another important antecedent, the referent criterion, refers to publics' judgments on whether they have similar past experiences to a problematic situation, which also directly affects situational motivation, affecting their communicative actions in problem solving (Grunig, 1997; Kim & Grunig, 2011). Problem solvers' past successful experiences dealing with similar problems can serve as a "referent" to mitigate the necessity for further communicative actions in problem solving (Kim & Grunig, 2011, p. 130). In climate change, a past successful experience could refer to any previous action or policy that an individual or group perceives as having positively contributed to mitigating climate change effects or promoting sustainable practices.

Problem solvers typically initiate with an inward, cognitive search for prior experiences (i.e., factual, experiential referent criterion). However, they might also invent a new referent, including wishful or willful thinking towards a goal in problem-solving (i.e.,

affective, expectational referent criterion) (Grunig, 1997; Kim & Grunig, 2011). Thus, the concept of the referent criterion encompasses both objective and subjective facets where publics could engage, potentially leading them to seek self-validating or self-satisfying referents and ultimately influencing their information interpretation and communicative actions in problem solving (Chon et al., 2023; Kim & Grunig, 2011).

In Jiang et al.'s (2019) study, the concept of referent criterion was defined as the ways citizens believe they should respond to the PM2.5 pollution problem and its resolution based on their past experiences and perceived resolutions. Their findings indicated a direct association between the referent criterion and communicative action. Additionally, communicative action significantly mediated the relationship between referent criterion and environmental engagement, suggesting that how individuals think they should respond to the problem (referent criterion) can substantially shape their communication actions and, indirectly, their environmental engagement.

Situational Motivation as the Mediator in STOPS. Situational motivation in problem solving directly affects publics' CAPS as an immediate antecedent (Grunig, 1997; Kim & Grunig, 2011). Defined as "the extent to which a person stops to think about, is curious about, or wants more understanding of a problem" (Kim & Grunig, 2011, p. 132), this concept is the mediator between situational perceptions and communicative actions in problem solving. According to Kim and Grunig (2011), this state is the readiness, cognitively, to undertake efforts to solve problems specific to a situation. This implies the

extent to which an individual is driven by a goal in addressing specific needs that arise in problematic situations.

In Jiang et al.'s work (2019), the concept of situational motivation for problem solving was conceptualized as the degree of curiosity, contemplative thought, and desire for understanding that citizens exhibited towards the PM2.5 issue. Their findings highlighted a positive correlation between situational motivation and citizens' communicative action for problem-solving. This correlation suggests that the greater an individual's curiosity and investment in understanding and solving the PM2.5 issue, the more likely they are to engage in communicative actions geared toward addressing the problem. Moreover, situational motivation mediated the relationship between perceptual and situational factors and communicative action, as suggested by the STOPS.

Communicative Action in Problem Solving. Communicative action in problem solving (CAPS) is the central dependent construct in this theory. According to STOPS, communication is "a purposive behavior to cope with a problematic life situation" (Kim & Krishna, 2014, p. 71), while problem solving is an effort to decrease the discrepancy or indeterminacy induced by these problematic situations. CAPS includes three types of communicative action, namely, information acquisition (information seeking and attending), information selection (information forefending and permitting), and information transmission (information forwarding and information sharing) (Chon et al., 2023; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014).

Information seeking describes “the planned scanning of the environment for messages about a specific topic” and has been regarded as the positive side of information acquisition (Grunig, 1997, p. 9). Information attending refers to acquiring the information given by others and then passively processing its content. Tao et al. (2020) conducted a survey where U.S. adult participants were presented with the definition of controversial sociopolitical issues. They were then asked to provide a specific example (e.g., immigration policy, Trump’s presidency, healthcare) and respond to variables within the STOPS theory. Tao et al. (2021) observed that irrespective of the issue, the more proactive publics were in addressing the controversial sociopolitical problem, the higher their likelihood to seek out and attend to information related to the controversial sociopolitical problems they provided.

Information forefending is the positive aspect of information selection. This concept refers to people making judgments about the content of information and then selecting the information they think is relevant to their situation (Kim & Grunig, 2011). Conversely, information permitting refers to how people passively accept information about a situation. Tao et al. (2020) found that regardless of the specific issue at hand, the more actively publics engaged in addressing a controversial sociopolitical problem, the more inclined they were to judge and select the information related to the issue.

Information forwarding usually occurs when people give information to others, even if the information is not requested. In contrast, information sharing only gives information to others when asked (Kim & Grunig, 2011; Kim & Krishna, 2014). In Jiang et al. (2019) research on PM2.5-related haze and smog air pollution in China, they found that a higher

level of CAPS in addressing the PM2.5 problem correlated with increased environmental engagement. Apart from predicting CAPS through situational antecedents and motivation, another important purpose of STOPS is to segment publics with different CAPS, which is introduced and discussed in the following subsections to compare with the current segmentation approach in climate change communication research.

While the STOPS's emphasis on proactive CAPS provides a promising direction for climate change research, empirical observations have indicated that individuals may also distance themselves from information related to climate change (Leiserowitz et al., 2021; Sweeny et al., 2010; Tao et al., 2020; Yang & Kahlor, 2013). This divergence draws our attention towards an alternate, less explored, and newly added dimension of CAPS in the STOPS, highlighting the roles of information avoidance and omission. These elements can act as significant impediments in climate change communication, obstructing the flow of critical information and stalling potential problem-solving actions. Consequently, the subsequent subsection discusses the concept of disengaged CAPS with climate change.

Disengaged CAPS with Climate Change. Regarding CAPS related to climate change, individuals' engagement extends beyond merely proactive behavior such as information selection, transmission, and acquisition to resolve the issue. It has been found that people may also partake in disengaged CAPS (Howell & Shepperd, 2016; Leiserowitz et al., 2021; Sweeny et al., 2010; Tao et al., 2020; Yang & Kahlor, 2013). Tao et al. (2020) introduced a withdrawal-oriented disengagement dimension to the STOPS model, referring to a deliberate decision by publics to distance themselves from information related to a

contentious issue. Drawing from Kahn's (1990) definition of engagement and disengagement in work roles, engagement implies a commitment of a problem solver in the context of controversial sociopolitical issues. When individuals are engaged, they actively select, transmit, and acquire problem-related information on physical, cognitive, and emotional levels. Conversely, disengagement refers to individuals actively distancing themselves from their communicative roles (Kahn, 1990). In a state of disengagement, individuals intentionally withdraw on physical, cognitive, and emotional levels from handling any information related to contentious issues. Thus, Tao et al. (2020) proposed the engagement and disengagement of CAPS as distinct yet interconnected constructs, both conceptually and operationally.

Accordingly, Tao et al. (2020) proposed disengaged CAPS as a second-order factor comprising two dimensions: information avoidance and information omission. Aligning with the STOPS's strategy of distinguishing between the active and passive components of each CAPS (Kim & Grunig, 2011), information avoidance is viewed as an active aspect of disengagement, while information omission is seen as a passive aspect (Yang & Kahlor, 2013).

Information avoidance specifically refers to behavior aimed at thwarting or delaying the acquisition of potentially unwanted but accessible information concerning contentious problems (Li, 2023; Sweeny et al., 2010). Information avoidance excludes instances where individuals merely opt out of seeking information, instead signifying purposeful avoidance of information (Howell & Shepperd, 2016; Li, 2023). Examples of information avoidance

include leaving a situation to dodge learning about issue-related information, declining to ask questions that might elicit such information, and instructing others not to disclose such information (Li, 2023; Sweeny et al., 2010).

Information omission refers to the passive disregard and overlooking of related yet undesired information (Ehrich & Irwin, 2005; Kinnick et al., 1996; Tao et al., 2021). Instances include passively allowing such information to go unnoticed, as when one 'sits through' media coverage (Kinnick et al., 1996). Prior research indicates that omission of information often arises when people become indifferent to social issues due to overexposure to repetitive and predominantly negative messages from the media and other sources (Ehrich & Irwin, 2005; Kinnick et al., 1996; Tao et al., 2021).

Furthermore, information avoidance and omission can be transient or permanent (Ehrich & Irwin, 2005; Sweeny et al., 2010). In other words, publics may temporarily evade or disregard issue-related information and revisit it later or intentionally avoid exposure to the information altogether. Tao et al. (2021) discovered that information avoidance and omission fit well within the disengagement factor in the measurement model of CAPS, and disengagement has a negative relationship with situational motivation, while it exhibits no significant association with referent criteria in the context of controversial issues identified by participants themselves.

The next subsection introduces the public segmentation approach suggested by STOPS and provides two exemplary studies to illustrate this approach's theoretical and

practical values, building foundations for subsequent discussions on how STOPS's segmentation can contribute uniquely to climate change segmentation literature.

Public Segmentation Using STOPS. Public segmentation is a tool for classifying publics for different strategies, and STOPS is the dominant approach in segmenting publics in public relations research (Chon et al., 2023; Grunig, 1997; Kim & Grunig, 2011; Kim et al., 2014). In the analysis of survey data, STOPS suggests implementing a midpoint split of the three situational variables as the starting point for segmenting publics (Kim, 2011). For instance, with a five-point Likert scale, the midpoint is three, allowing these three variables to be recorded in binary form (high equals 1 and low equals 0). The binary recordings of the three situational constructs are then combined or summed. This method results in the formation of four groups of publics for their different CAPS toward the problematic issue: nonpublic, latent public, aware public, and active public, based on the sum of the scores. For example, if on a five-point Likert scale, problem recognition scores higher than 3, constraint recognition (reversed) scores lower than 3, and involvement recognition scores higher than 3, the total score would be 2 (i.e., 1+0+1) and this individual should belong to the aware public. This straightforward method has been successfully verified and applied in dozens of public relations studies (e.g., Chon et al., 2021; Dam et al., 2021; Kim, 2011; Lee, 2019).

After identifying these four publics with three situational antecedents (i.e., problem recognition, involvement recognition, and constraint recognition), STOPS posits that these defined groups display differing CAPS related to the problem, suggesting that an individual's level of proactivity positively correlates with their engagement in CAPS about the problem

(Chon et al., 2023; Kim, 2011; Kim & Grunig, 2011). Specifically, it is anticipated that active publics, the most driven individuals within a population regarding a specific problem, would exhibit the most active levels of CAPS. Similarly, aware publics should display higher degrees of CAPS than the latent and nonpublic groups.

Beyond discerning publics' diverse CAPS, there is value in investigating if different groups of publics also have distinct patterns in their knowledge, beliefs, and actions (or intentions) concerning the problems under discussion. These facets frequently align with the target outcomes in the corresponding public relations context (e.g., climate change). Finding distinct cognitive and behavioral patterns among different publics can provide researchers and professionals with the resources needed to deploy customized communication strategies for each segmented public, taking into consideration the unique characteristics of each public (Chon et al., 2023; Kim, 2011; Kim & Grunig, 2011; Kim & Krishna, 2014).

Two exemplary studies can illustrate how to segment publics using STOPS and its theoretical and practical values. Dam et al. (2021) integrated the spiral of silence theory and STOPS in investigating the relationships between fear of isolation, public segmentation, and willingness to express opinions about COVID-19 on social media. They conducted an online survey of 338 U.S. adults and found that active publics were significantly more likely to seek information about COVID-19 than latent publics and non-publics. These findings have important practical implications, especially for health communicators. Effectively segmenting the general population into subgroups allows for more strategic and effective public health campaigns. For instance, health campaigns can target active publics who are already aware of

and engaged with the issue but do not perceive many barriers to promote desired health behaviors, such as adherence to COVID-19 prevention measures.

Kim et al. (2011) employed STOPS to segment the general population into four different publics concerning an organ donation issue with two separate survey datasets, consisting of 316 and 347 U.S. college student participants, respectively. Results suggested that health communicators could utilize the segmentation procedure outlined in this study to tailor their communication objectives and strategies for each specific subgroup. For instance, since a nonpublic refers to individuals who are neither aware of nor affected by the issue at hand, unless there are sufficient resources or a normative obligation, health communicators can safely exclude non-publics from their campaigns. On the other hand, the latent publics may be affected by the issue but are not yet aware of it. For this subgroup, the most effective campaign objective would be to increase problem recognition and, if resources allow, to enhance involvement recognition as well.

How STOPS Can Contribute to Climate Change Segmentation. No study has directly applied the STOPS to segment climate change publics. This dissertation argues that in addition to enriching the existing theoretical choices in climate change segmentation literature by introducing the STOPS model, the unique characteristics of STOPS can also contribute significantly to climate change segmentation for three reasons. First, the Six Americas segmentation approach might not be suitable for mainland China. China may have a distinct segmentation pattern that does not necessarily align with the six categories defined by the Six Americas, especially given the generally high levels of belief regarding climate

change and traditional Chinese culture emphasizing respect for nature (Hou, 1997; Pan et al., 2021, 2022, 2023; Xu et al., 2022; Zeng, 2022). As discussed earlier, the differing findings from the application of Six Americas in India serve as a pertinent example (Leiserowitz et al., 2023). Instead, the STOPS's segmentation is not based on climate change beliefs. Even nonpublics who are neither aware of nor affected by climate change may acknowledge that climate change is happening and human-caused (i.e., climate change beliefs).

Another important reason is the lack of attempts to segment communicative action in previous climate change segmentation literature. The STOPS model is unique in its detailed division of communicative actions, an aspect overlooked in the Six Americas framework. This is because effective communication about contentious sociopolitical issues is integral to civil discourse (Mittelstadt, 2016) and civil society (Yang & Taylor, 2013). Communication behaviors are instrumental in acquiring and interpreting climate change information, which could influence individuals' perceptions, beliefs, attitudes, and behaviors. Jiang et al. (2019) underscored the solid predictive power of STOPS' perceptual, cognitive variables, and CAPS in environmental engagement, as demonstrated by the study of the PM2.5 issue in China. An individual's CAPS could also influence others through interpersonal communication, such as information sharing and forwarding.

Last, an additional consideration is that segmentation should emphasize fundamental changes (Hine et al., 2014; Metag & Schäfer, 2018). Hine et al. (2014) advocated moving beyond superficial behavioral changes and focusing on approaches that can fundamentally transform how individuals perceive and respond to climate change. The perceptual variables

and communicative actions outlined in the STOPS model can exemplify these fundamental changes.

Applying STOPS in Climate Change Segmentation. Following prior studies, the current research defines active publics in the climate change context as individuals who both recognize the severity of climate change and feel personally involved with the issue. Also, active publics perceive no constraints in engaging in CAPS regarding climate change. Aware publics acknowledge climate change as an issue but do not actively participate in CAPS due to perceived constraints, such as financial limitations, lack of time, or the belief that their actions would not significantly impact climate change (Chon et al., 2023; Diamond & Urbanski, 2022; Lu, 2022). Latent publics consist of individuals who fail to recognize climate change as a problem due to factors such as climate change message fatigue or lack of concern and importance on the subject (Chon et al., 2023; Diamond & Urbanski, 2022; Kim & Grunig, 2011). Nonpublics are those individuals who do not identify climate change as a problem, possibly due to their geographic location, lifestyle, or lack of awareness (Chon et al., 2023; Kim, 2011; Kim & Grunig, 2011).

To bridge these concepts to the current study, this study posits that active publics' CAPS is driven by their high level of concern and perceived ability to communicate about climate change. Aware publics, while starting to grasp the severity of climate change, are still developing their responses and, thus, exhibit CAPS to a lesser degree than active publics. Despite being impacted, latent publics exhibit CAPS to a lesser degree than aware publics, primarily due to their inactive stance. Finally, nonpublics, who do not see climate change as

an issue exhibit the lowest levels of these behaviors. Therefore, the following hypothesis is presented:

Hypothesis 3: The more situationally active individuals are on climate change, the more information forefending (a), information permitting (b), information forwarding (c), information sharing (d), information seeking (e), information attending (f) they will engage in about climate change. Specifically, these information behaviors will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.

As discussed earlier in section 2.3.3, individuals may display disengaged CAPS towards climate change even in a generally high climate change country such as China, given the fact that the high mean value of climate change in the country still reserves the relatively negative opinions and attitudes towards climate change (Pan et al., 2021, 2022, 2023; Xu et al., 2022; Zeng, 2022). Also, a recent online national survey study in China with a quota sample of 1,469 participants that matched with location, age cohorts, and gender distribution found that around 20% of participants believe in conspiracy theories related to climate change, such as global warming as a plan of developed countries to contain and restrain the development of developing countries (Pan et al., 2022).

Therefore, this dissertation proposes that differing levels of disengagement may exist among various publics in China. Specifically, active publics are likely to display the lowest levels of disengagement, as their recognition of the problem, high involvement, and minimal perceived constraints typically encourage more engagement with the issue. Therefore, they

are expected to seek and disseminate information actively and are less likely to distance themselves from the problem. This trend is anticipated to extend across the spectrum of publics, with aware publics showing slightly higher levels of disengagement, latent publics demonstrating even more, and non-publics displaying the highest disengagement levels given their lack of problem recognition. Therefore, this study proposes the following hypothesis:

> **Hypothesis 4**: The more situationally active individuals are on climate change, the less information avoidance (a) and information omission (b) they will engage in about climate change. Specifically, these information behaviors will be the lowest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.

Having discussed the disengagement in the CAPS among different publics, it is important to consider whether other broader outcomes of varying publics would also be different. These outcomes encompass various perceptions, beliefs, attitudes, and actions concerning climate change, showing varying levels of engagement and concern. It is crucial to recognize that the dynamism within publics—understood through their evolution in recognizing and grappling with issues—might result in active publics deepening their involvement with climate change with their CAPS, thereby influencing their attitudes and other behaviors related to climate change. In contrast, latent publics might remain indifferent due to their lack of recognition of the issue. Therefore, these possible variations and their implications are discussed in the next subsection, using relevant studies and theoretical perspectives to substantiate the discussion.

Section 2.3.4 How Different Publics Have Other Distinct Outcomes

In addition to CAPS, different publics may have other distinct climate change outcomes. Chon et al. (2021) applied STOPS to segment employees into subgroups based on their situational perceptions about the COVID-19 pandemic. Chon et al. (2021) classified internal publics into active and inactive. Results indicate that out of the 476 U.S. employees, 71.4% were identified as active publics regarding the COVID-19 issue, while the remaining 28.6% were deemed inactive. Chon et al. (2021) found that these two employee groups have distinct negative external communications about their organizations and turnover intentions. This study underscores the practical implications for organizations regarding strategic resource allocations. By segmenting publics, communication practitioners can tailor their communication strategies and tactics to address the needs and concerns of each specific public effectively. This targeted approach enables organizations to engage with their key publics more meaningfully and positively, fostering a sense of involvement, trust, and collaboration during challenging times.

Building on Chon et al. (2021), this research expects that different publics may also have distinct levels of other key variables related to climate changes, including climate change beliefs, climate change concerns, climate change importance, climate change attitudes, and private and public pro-environmental behaviors. This is possible because active publics, with the highest level of problem recognition, involvement, and motivation for the climate change issue, are likely to hold stronger beliefs about the reality and seriousness of climate change (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018).

According to previous climate change communication research, individuals' heightened awareness and commitment to the issue often translate into a greater sense of urgency and importance, leading to more positive attitudes toward pro-environmental actions (Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2016; Rickard et al., 2016). As such, individuals with heightened awareness and commitment are generally more likely to engage in private and public pro-environmental behaviors to address climate change. In contrast, nonpublics, with their lack of problem recognition, are expected to show lower levels of beliefs, concerns, positive attitudes, and pro-environmental behaviors related to climate change.

Similarly, aware publics, those who acknowledge climate change as a growing concern but might perceive some constraints to action, are likely to present moderate levels of belief in, concern about, and prioritization of climate change issues (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Their attitudes may lean towards pro-environmental actions, yet these attitudes may not be as robust as those held by the active publics, owing to perceived limitations (Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2016; Rickard et al., 2016). Thus, their engagement in both individual and collective pro-environmental actions is expected to be somewhat restrained, though more pronounced than in less aware groups.

On the other hand, latent publics, those who are indeed affected by climate change but have yet to recognize it as a problem, may display lower levels of beliefs about and concern for climate change (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Therefore, they may express indifference or apathy towards pro-environmental actions

(Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2016; Rickard et al., 2016). The engagement of latent publics in both private and public pro-environmental behaviors is predicted to be minimal, given their lack of problem recognition. Based on the following reasoning, the following hypothesis is proposed:

> **Hypothesis 5**: The more situationally active individuals are on climate change, the higher climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions they will have about climate change. Specifically, these outcomes will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.

After discussing the nuanced understanding of different publics' distinct outcomes related to climate change, the next subsection focuses on another equally important research gap: the interaction of audience segmentation with repeated exposures to various climate change framing strategies. Specifically, how these repeated messages may have different longitudinal effects on varying publics' beliefs, attitudes, and behaviors. This neglected area of research holds the potential for a deeper comprehension of effective climate communication strategies, which is essential for longitudinal and sustained engagement in the fight against climate change (Bain et al., 2012; Hine et al., 2014).

Section 2.3.5 How Repeated Exposures to Self- and Social-framing Interact with Segments

While several studies have examined how different groups respond to climate change communications (Bain et al., 2012; Hine et al., 2014, 2016; Martel-Morin & Lachapelle, 2022; Metag & Schäfer, 2018; Roser-Renouf et al., 2015), there remains a scarcity of research that has systematically analyzed audience segments' responses to varied climate change messages, subsequently offering recommendations for optimal message content. Indeed, a deeper exploration of diverse message characteristics that may be most effective for enhancing climate change engagement in each identified segment is deemed critical (Bain et al., 2012; Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2010, 2016).

Bain et al. (2012) conducted two experiments that illustrated an effective strategy specifically for climate change deniers. Experiment 1, involving 155 U.S. climate change deniers, revealed that they were more likely to intend to take pro-environmental actions if they believed doing so would contribute to a more considerate, caring society and stimulate economic and technological development. This result indicates the potential for a shift in communication strategies - from trying to convince deniers of the reality of climate change to focusing on the positive societal outcomes of climate change mitigation efforts. The finding of experiment 1 was further replicated by experiment 2, involving 347 U.S. deniers. This research underscores the importance of tailoring climate change communication strategies to

different audience segments and the effectiveness of this approach for inspiring pro-environmental actions.

Equally crucial, yet largely untouched by previous research, is the investigation of the enduring impacts of targeted messaging on climate change audience segments (Hine et al., 2014; Metag & Schäfer, 2018; Moser, 2016). To date, no studies have sought to understand the longitudinal effects of tailored messages on the values, attitudes, beliefs, behaviors, or segment membership of audience members (Bayes et al., 2023; Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Delving deeper into the enduring impacts of tailored messaging is not merely a theoretical question but a pressing necessity for effective climate communication practices. It is essential because the fight against climate change is not a single event but a prolonged battle. Publics' perceptions and behaviors need to adapt continuously and sustainably over time in response to the evolving climate crisis. Therefore, understanding how targeted messaging affects individuals longitudinally could contribute significantly to sustaining and strengthening climate change engagement over time (Hine et al., 2014; Leiserowitz et al., 2021; Martel-Morin & Lachapelle, 2022; Metag & Schäfer, 2018; Moser, 2010, 2016).

Moreover, people are not static. Our beliefs, attitudes, and behaviors are fluid, molded by our experiences and the information we receive (Bayes et al., 2023; Hine et al., 2014; Leiserowitz et al., 2021). Consequently, longitudinal message effects research on each segment is needed to uncover how repeated exposure to targeted climate change messages may gradually influence and potentially transform these aspects of publics. By studying

enduring impacts, we could evaluate the effectiveness of climate change communication over time and develop insights to refine and adapt our strategies as our audience evolves.

In summary, exploring the longitudinal impacts of targeted climate change messaging on audience segments is imperative. This exploration could significantly enrich our strategies for climate change communication and contribute to our overall efforts to mitigate and adapt to climate change. This dissertation aims to bridge these gaps by probing the interaction of repeated exposures to self- and social-framing (i.e., self-framing focuses on benefits or costs perceived as proximal and internalized or experienced by the individual while social-framing is more distant and externally motivated. See definitions in detail in section 2.1.3) and public segmentation. For instance, in the scenario where the self-framing condition is employed, it is hypothesized that upon viewing self-framing messages six times, the outcomes for the aware public in this group may significantly surpass those of the aware public in social groups. This hypothesized finding could be due to the cumulative impact of repeated exposure to self-framing messages fostering a more profound sense of personal relevance and engagement with the issue of climate change. Given the absence of direct evidence to support these thoughts, this research proposes the following research question:

Research Question 7: How do the effects of repeated exposures to self- and social-framing messages on all outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions, in three different framing conditions differ among various publics after six exposures?

Having discussing the largely unexplored terrain of longitudinal impacts of self- and social-framing messages on audience segments, the next subsection discusses an aspect that, while closely related, offers a new dimension to our understanding of climate change communication: the potential for change in audience segmentation over time, due to longitudinal repeated exposure. This aspect asks us to challenge the assumption of static segmentation and instead acknowledge the fluidity of audience beliefs, attitudes, and behaviors among segments. The key question then arises: Can prolonged, targeted messaging incites a shift in audience segmentation over time, possibly leading to a dynamic and evolving public? The following section attempts to illuminate further this vital yet largely uncharted terrain of climate change communication research.

Section 2.3.6 Potential Changes in Audience Segments After Repeated Exposure

Existing research on climate change communication has predominantly employed cross-sectional designs, which capture community climate change values, beliefs, behaviors, and policy preferences at a single point in time (Bain et al., 2012; Bayes et al., 2023; Hine et al., 2014, 2016; Metag & Schäfer, 2018; Moser, 2010, 2016). While such methodology is valuable for providing a broad snapshot of public opinion, it is inherently limited in tracking longitudinal changes and understanding the transformative effects of repeated message exposure. This forms a crucial gap in our understanding as it cannot provide insights into how repeated exposure to specific messages might affect these variables or how individuals might shift from one public segment to another in response to prolonged exposure to targeted messaging (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). Considering

this, a significant gap in our understanding remains unaddressed: the potential for individuals to transition between different public segments over time under the influence of sustained, targeted messaging. This consideration is especially crucial given the understanding of public segments as fluid rather than fixed entities.

Some longitudinal studies have attempted to monitor the changes in segment proportions over time, represented by the Six Americas project (Leiserowitz et al., 2021; Metag & Schäfer, 2018; Roser-Renouf et al., 2016), which is new to STOPS research, where no studies have tracked changes in segment proportions over time for any topics. For example, Leiserowitz et al. (2021)'s reports have provided insights into how societal and political trends have shaped the distribution of the American public across different climate change interpretive communities over several years. In 2008, the alarmed comprised 18% of the public and the dismissive only 7%. However, the percentages of alarmed and concerned decreased due to shifts in political ideologies and party lines, while the doubtful and dismissive groups expanded by 2011. From 2011 onwards, public opinion on climate change started to slowly rebound, particularly among Democrats. This trend accelerated after 2015, leading to an increase in the alarmed segment to 26% by the end of 2020, while the dismissive segment shrunk to 8%.

These studies, however, do not specifically investigate how targeted climate change messages may contribute to these shifts. In other words, we know that public segments shift, but we have less insight into how strategic communication efforts may directly contribute to these shifts. Over time, repeated exposure to specific messages could drive individuals to

move among different segments (Hine et al., 2014). For example, suppose a member of the aware publics group regularly encounters messages emphasizing the severity of climate change and the urgency for action over time. In that case, they might move to the active segment as these messages influence their situational perceptions and motivations toward the issue. In line with STOPS, the repeated message exposure could amplify their problem recognition, stir their sense of involvement, and reduce their constraints recognition – the key variables that determine publics' activeness in CAPS.

However, it is also important to acknowledge the potential for message fatigue, which could, paradoxically, lead to disengagement over time. This occurs when individuals are repeatedly exposed to similar messages to the point where they become desensitized or overwhelmed, leading to a decrease in message effectiveness (Jia et al., 2022; Kim & So, 2018; So et al., 2017). For example, an aware public continuously exposed to urgent and alarming climate change messages might initially become more engaged, driven by the increasing recognition of the problem's seriousness. However, if this bombardment continues without respite, they might eventually experience fatigue, a sense of hopelessness, or even a perceived inability to make a difference, as outlined by the inverted U-shaped model in section 2.2.2. This saturation could cause them to disengage, leading them to transition from an aware to a latent state, where they acknowledge the issue but do not actively seek information or participate in problem-solving.

Understanding these dynamics could enable us to design more effective public relations campaigns and better navigate the complex landscape of climate change

communication. It could offer a clearer roadmap for climate change communication strategies, indicating how to sway public opinion, motivate actions, and sustain engagement over time. Addressing this gap, this study proposed the following research question:

Research Question 8: To what extent, if any, will the overall proportion of each public change for each condition after six repeated exposures in each condition?

Building on the insights and gaps identified in the literature, the next chapter shifts focus to the methods employed in this dissertation. The methods chapter outlines the research design, sample selection, data collection procedures, and statistical analyses to test the research questions and hypotheses.

Chapter 3 Method

This method chapter outlines a pilot and a main study. The pilot study is designed to validate the manipulation of climate change messages framed as either self- or social-focused, adapted from leading Chinese news outlets. The first section of this chapter outlines the specific details of the pilot study, including participant recruitment, procedures, stimulus development, measures, and data analysis procedures. The main study in the second section, formatted as a longitudinal between-subjects experiment, consists of six separate exposures spaced three days apart, consistent with prior longitudinal research. Participants, Chinese individuals over 18, were randomly assigned to one of three conditions, either containing self- or social-framing messages or a mix of both framing messages six times at three-day intervals. The second section delves into the main experiment's details, covering sample size planning, participant recruitment, experimental procedures, and measures.

Section 3.1 Pilot Study

The pilot study was designed to prepare for the main experiment. After securing IRB approval from the University of Maryland, participants, all of whom were Chinese residents, were recruited through Credamo, a data collection platform with a national panel similar to Qualtrics in China, which has been utilized extensively in communication studies (e.g., Rui et al., 2023; Shi et al., 2023; Yang & Kim, 2023). These participants were each exposed to 12 climate change messages that share the same information for the first part but have distinct self- and social-framing parts each, adapted from major Chinese media outlets, such as *The Paper News*, *The People's Daily*, *Xinhua News Agency*, *Science and Technology Daily*, and

Sina.com. The framing effectiveness of these messages was evaluated through a set of specific measures. The insights and validated messages gathered from this pilot study is used to inform and shape the subsequent main experiment, ensuring that the research is methodologically robust and contextually relevant.

Section 3.1.1 Participants

Two pre-screening criteria were applied during the data-gathering stage of the pilot study. First, participants must be Chinese residents due to the study's focus on the effects of climate change messaging in China. Second, to ensure the validity of responses, a minimum approval rating (e.g., a credit score of at least 90 on the platform, which means that 90% of the surveys they previously participated in on this platform were completed and passed attention check questions) was required for participant eligibility. Compensation for completing the pilot study was set at ¥10 (around $1.4) for an approximately 20-minute commitment, in line with the suggestions by this platform. Those who agreed to participate answered demographic details at the outset and were debriefed regarding the true research objectives upon completion. They could retract their responses before being redirected to Credamo for compensation processing. The sample size is 40 to ensure sufficient power for comparing means. A quota sampling approach was adopted to ensure gender representation aligns with census data. Per China's 2021 seventh census data, male participants should comprise around 51% of the sample (National Bureau of Statistics of China, 2021). Quota sampling offers superior sample quality than convenience sampling, although it is not as

robust as a probability sample (Cumming, 1990; Szolnoki & Hoffmann, 2013; Yang & Banamah, 2014).

Section 3.1.2 Stimulus

Initially, 12 climate change messages were adopted from major Chinese news outlets. Appendix A shows both the Chinese version, their sources, and the translated English version. The English translation was further vetted for accuracy and clarity by another bilingual individual native in Chinese and another native English speaker. Each message had undergone some level of modification with a parallel approach. Specifically, this approach started with selecting 12 climate change news articles. These original articles inherently emphasized self- or social-framing messaging. Then, the sections of these articles that emphasized a specific framing were modified, transforming them to highlight the alternate frame. This process created two versions of each news article: one with the self-framing and another with the social-framing. The non-framed background information in both versions remained consistent. The distinction between the two versions was solely in the modified section, where one emphasized the self-framing, and the other underscored the social-framing. The only difference was that the self-framing version uses “you” or “yourself,” while the social-framing version used corresponding terms like “society,” “all of us,” or “ourselves,” chosen based on readability. This approach ensured that the only difference for different conditions is the framing of the message; everything else is the same.

For instance, a news article that discussed World Car-Free Day was selected in the self-frame condition, emphasizing the positive outcomes if the participants reduce their car

usage. To create an equivalent social-framing version, the latter part of this article was adjusted to accentuate the positive outcomes if all of us reduce our car usage. This approach ensured that the two messages were identical except for their framing approaches, eliminating most potential confounds. To facilitate distinction for readers, the differing parts of the self-framing and social-framing were highlighted by using boldface and underlining, as shown in Appendix A. Participants read normal texts in Chinese.

Each message was restricted to a word count of around 190-200 in Chinese to ensure consistency in length across all messages for four reasons. First, one of the most popular social media platforms that distributes news in China, Sina Weibo, initially had a 140-word limit, similar to X (i.e., the social media platform formally known as Twitter; Nip et al., 2016; Wang & Shi, 2018). However, in 2016, similar to X, Sina Weibo relaxed this restriction (Yu et al., 2017). Despite the change, most posts on the platform remain relatively short (Gao et al., 2021; Gong et al., 2022; Xu et al., 2023). Additionally, presenting short stimuli may help reduce the cognitive load on participants, which is especially important for a longitudinal study. Third, some individuals might not have the habit of reading news regularly, especially long news articles, because mobile phones are the most used source for news reading in China instead of computers, which is unsuitable for reading long texts (Yan & Schroeder, 2020; Yu, 2021; Zhang et al., 2022). Finally, if the messages were too long, participants might miss the key points, affecting the manipulation of the two groups.

Additionally, one thing to note is that only the Chinese version of each message is around 190-200 characters since the participants only read them in Chinese, resembling the

length of news information people see on social media. However, there is no word limit on the English translations, as they are meant only for readers of this dissertation to understand the meaning of each message and were directly presented to the participants in the experiments.

Section 3.1.3 Procedure

There were 24 messages (i.e., 12 have the base information plus the social-framing, and 12 have the base information plus self-framing). Forty participants were randomly assigned to one of two conditions for each base message, each with 20 participants. Each condition viewed either the self-framed or social-framed version of the base messages, but not both, to ensure that participants were not exposed to the same base information. Depending on their condition assignment, each participant randomly viewed 12 messages, whether self- or social-framing. After viewing each message, participants responded to questions specific to that message with a unified framing perception scale, with one indicating a strong focus on self-framing and seven indicating strong perceived social-framing.

Section 3.1.4 Measures

Participants were asked to evaluate the framing of messages related to climate change using a unified 7-point Likert scale, adapted from Ma et al. (2023), van der Linden (2015), and Bostrom et al. (2019). The central question was, “To what extent do you believe the message you just read describes the issue of climate change by emphasizing impacts and actions?” This scale was designed to measure framing on a continuum: one indicates a strong

emphasis on individual impacts, responsibilities, and actions, signifying self-framing, while seven denotes a strong emphasis on impacts, responsibilities, and actions relevant to groups, the environment, and society, indicating social-framing. A midpoint value of four suggests a neutral or balanced emphasis between individual and group impacts and actions. This approach allows participants to place each message more accurately on a spectrum from self- to social-framing. This process continued until all participants in both conditions had viewed 12 messages and answered the corresponding questions. Demographic data, including gender, age, and education level, was collected at the start of the survey experiment. Upon completing the survey, participants were debriefed and thanked for participating.

Section 3.1.5 Date Analysis

The focus is to compare the mean scores of the unified framing perception scale among all participants for the self-and social-framing messages. These two conditions each had 20 participants for each message. This comparison was instrumental in identifying six base messages that effectively capture the intended framing, both self and social.

Specifically, six messages with two versions, each demonstrating the lowest perceived self-framing scores and the highest social-framing scores, were selected from the initial pool of 24 base messages (i.e., 12 have the base plus the social-framing, and 12 have the base plus self-framing). These messages were chosen mainly based on the mean differences between the two versions of each message. However, the value of high scores (i.e., extreme cases) on self- vs. social-framing was also considered. This consideration means that even when the

two versions of one message had high mean difference, if one of the values of the scores falls into the midpoint of the framing score (e.g., around 4), then this message was not selected.

When the pilot study was completed, six base messages, chosen for their distinct framing as evidenced by the participants' mean differences, were utilized in the main experiment. This process ensures that the chosen stimuli are both effective and reliable for the dissertation's objectives. The following section elaborates on the details of the main experiment, including participant recruitment, experimental design, measures, and data analysis procedures. These were built upon the insights and validated messages obtained from the pilot study.

Section 3.2 Main Study

The main study explores the cumulative effects of different framing strategies on participants' climate change outcomes through a longitudinal experimental design. Utilizing a sample size determined by power analysis, the main study focused on Chinese residents and used a three-day interval among the six experimental sessions. To reference all research questions and hypotheses in this dissertation, Table 1 is presented below again.

Table 1

List of Hypotheses and Research Questions

H or RQ	Content
Research Question 1	Is the interaction between time and condition significant in affecting climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?

H or RQ	Content
Research Question 2	After how many exposures do the self- and social-framing conditions respectively reach their maximum impact on climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?
Hypothesis 1	As the number of repeated exposure increases, there will first be an increase and then a decrease in climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions for all three conditions.
Research Question 3	When individuals in each framing condition reach their highest levels of belief in climate change, their most positive attitudes, and their strongest intentions for both private and public pro-environmental behaviors, which messaging frame—self-framing or social-framing climate change messaging—leads to stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?
Research Question 4	After six repeated exposures, individuals in which frame condition—self-framing or social-framing climate change messaging—result in stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?
Research Question 5	After six exposures, are there significant differences in message fatigue between participants exposed to mixed-framing messages compared to only self-framing and social-framing messages?

H or RQ	Content
Hypothesis 2	Compared to conditions exposed to only one type of frame repeatedly, the mixed-use of both self- and social-framing messages will result in higher values for climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures.
Research Question 6	How does pro-environmental self-identity moderate the relationship between repeated exposure to different framing messages (i.e., self, social, or mixed framing conditions) and climate change outcomes, specifically in relation to climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures?
Hypothesis 3	The more situationally active individuals are on climate change, the more information forefending (a), information permitting (b), information forwarding (c), information sharing (d), information seeking (e), information attending (f) they will engage in about climate change. Specifically, these information behaviors will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.
Hypothesis 4	The more situationally active individuals are on climate change, the less information avoidance (a) and information omission (b) they will engage in about climate change. Specifically, these information behaviors will be the lowest in members of an active

H or RQ	Content
	public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.
Hypothesis 5	The more situationally active individuals are on climate change, the higher climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions they will have about climate change. Specifically, these outcomes will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.
Research Question 7	How do the effects of repeated exposures to self- and social-framing messages on all outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions, in three different framing conditions differ among various publics after six exposures?
Research Question 8	To what extent, if any, will the overall proportion of each public change for each condition after six repeated exposures in each condition?

Section 3.2.1 Sample Size Planning

A power analysis for repeated measures ANOVA with within-between interactions was conducted to prepare for the main experiment using the GPower 3.1 version. The results suggest a minimum sample size of 219 to achieve a statistical power of at least .8, assuming an alpha of .05 and a small effect size (d = 0.10). This calculation is specific to three

conditions undergoing six different measures over time and assumes a correlation of 0.5 among repeated measures and a nonsphericity correlation of 0.5.

Repeated measures ANOVA inherently assumes sphericity that the variances of the differences between all combinations of related conditions are equal (Dixon, 2008; Huynh & Mandeville, 1979; Pirmoradi et al., 2022; Watson et al., 2021). A violation of this assumption requires the non-sphericity correlation. If the assumption holds, a value of 1 is used (Huynh & Mandeville, 1979; Pirmoradi et al., 2022). The degree of non-sphericity can be quantified by epsilon (ϵ), where $\epsilon < 1$ indicates a violation of sphericity (Dixon, 2008; Huynh & Mandeville, 1979). In this study, the lowest value for ϵ is 0.17 according to the formula 1/(T-1), where T is the total number of measurements over time. Violation of sphericity can lead to an inflated Type I error rate, making the F-test too liberal (Dixon, 2008; Huynh & Mandeville, 1979). Given that each measurement in this dissertation happened after each exposure to different messages over time, it is plausible that the degree of violation of the sphericity assumption could be significant. To account for this potential bias, a conservative estimate of a 0.5 correlation among repeated measures is used in the sample planning stage, given that the impact of the stimuli may vary between exposures over time (So & Song, 2023).

After data collection, the assumption of sphericity was assessed using Mauchly's Test of Sphericity. Details about this procedure are elaborated in the data analysis section. Acknowledging that longitudinal studies are susceptible to participant drop-out, I aim to mitigate this issue by collecting an initial sample that accounts for 15% of potential attrition

for each wave, resulting in the estimated overall attrition rate of 62.29% (Barry, 2005; Gustavson et al., 2012; Shi et al., 2023). Therefore, a total of 750 participants were initially recruited. This decision is informed by prior research considering drop-out rates in longitudinal studies (Diamond & Urbanski, 2022; Shi & Smith, 2016; So & Song, 2023).

Section 3.2.2 Participants

The main experiment commenced upon completing the pilot study. Individuals who participated in the pilot study were excluded from the main study. Data collection was taken place on the Credamo platform. Two pre-screening criteria were implemented, similar to those used in the pilot study. First, only Chinese residents were recruited, aligning with the study's focus on climate change messaging in China. Second, a minimum approval rate (i.e., a credit score of at least 90 on the platform) was mandated for participant recruitment to ensure credible responses. In addition, as per platform recommendations to minimize drop-out rates, only participants who have completed 100 or more tasks on the platform were eligible to participate.

As the platform suggests, compensation was ¥7 (around $1) for every 15 minutes of participation per experimental session. Furthermore, A quota sampling strategy was applied to limit the gender ratio of participants, which is 51% male, similar to the pilot study.

Section 3.2.3 Stimulus

The stimulus for the main experiment consisted of the 12 messages finalized in the pilot study, including six self-framing messages and six social-framing messages that share common base information. A random order was predetermined for these six base messages.

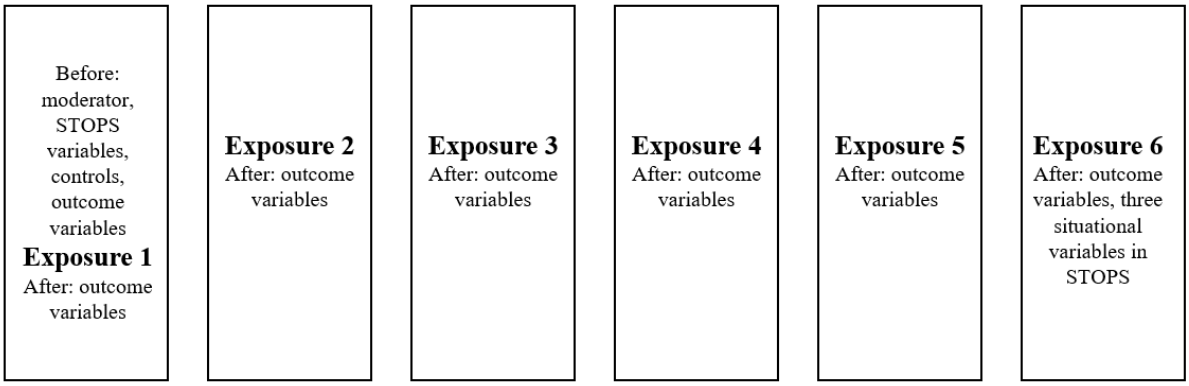
Then, in both the self-framed message condition and the social-framed message conditions, participants read the base message in the same order but with different framing versions. For the mixed-use framing condition, participants shared the order used in the self-framing message condition and the social-framing message condition. However, each base message's self- or social-framing was random (i.e., self, social, self, self, social, and social), ensuring a balance of three self and three social frames in all six exposures in the mixed-use framing condition. This guaranteed no repetition of background information in mixed-use framing condition.

Section 3.2.4 Procedure

The overall procedure of the main experiment is illustrated in Figure 2 below. Participants were initially presented with the IRB informed consent and a study overview for the first session. They were informed that this study would be conducted across six sessions, meaning there would be five subsequent follow-up sessions after the initial session. Participants were further notified that they would receive separate compensation for each completed session. They were encouraged to attend upcoming session notifications and participate actively. Additionally, participants were prompted to follow the Credamo official account on WeChat to stay updated. The overview also clarified the dissertation's objective, which is to understand participants' attitudes toward the issue of climate change. Participants were asked to provide demographic information immediately if they decided to proceed.

Figure 2

Cadence of Surveys over Duration of Main Experiment



Note. Moderator indicates pro-environmental self-identity; STOPS variables include constraint recognition, involvement recognition, problem recognition, information seeking, information attending, information permitting, information sharing, information forefending, information forwarding, information omitting, information avoidance; outcome variables include message fatigue, climate change beliefs, climate change attitudes, private and public pro-environmental intentions; controls include age, gender, education, frequency of exposure to climate change news, and income.

Subsequently, participants were to answer questions about STOPS, control, and outcome variables. These measures are detailed later in this chapter. After these initial measures, participants were randomly assigned to one of three conditions: self-framing, social-framing, or mixed-use framing. Participants in each condition were exposed to different stimuli related to their given condition. Upon viewing the stimuli, participants answered questions about the outcome variables again.

Before the second session, participants received a follow-up reminder three days after the first session, encouraging them to continue participating in the upcoming sessions. During the second session, participants returned to the conditions to which they were initially

assigned during the first session. They once again viewed the messages corresponding to their respective conditions. Upon completing the viewing, they answered questions related to the outcome variables. The procedure remained consistent for sessions two through five.

In the sixth and final session, participants returned to their original conditions and viewed the corresponding messages one more time. After viewing, they responded to questions about the outcome variables and questions related to STOPS. Appendix B shows instructions for all six sessions.

The time interval between each session was set at three days for several reasons. First, this decision is guided by methodological literature recommendations, specifically, the one examining longitudinal research implementation (Hopwood et al., 2022). Also, a comprehensive review of experimental studies involving repeated message exposures on similar topics and designs was conducted. Previous studies have all opted for relatively short time intervals (Diamond & Urbanski, 2022; So & Song, 2023; Shi & Smith, 2016). Specifically, So and Song (2023) used a design involving five exposures, each separated by a 24-hour interval. Shi and Smith (2016) utilized three exposures with a three-day interval between each, while Diamond and Urbanski (2022) employed a longer time frame with seven exposures, each separated by one week.

Second, given the frequent occurrence of climate change information in daily life, where people encounter climate-related messages regularly (Baden et al., 2019; Diamond & Urbanski, 2022; Florence et al., 2022; Howell, 2014; Moser, 2016; So & Song, 2023), a

three-day interval is considered appropriate. This interval is a reasonable frequency given how often most individuals typically come across climate change information daily.

Third, existing methodological literature on longitudinal research (Hopwood et al., 2022) suggests that it is generally better to measure longitudinal changes too frequently than not frequently enough. This is particularly important to avoid underestimating the effects of psychological processes. Hence, these considerations collectively informed the choice of a three-day time interval between each session in this study.

Six exposures were chosen also because this number of exposures can ensure that the mixed use of self- and social-framing condition is balanced, with both self- and social-framing being exposed three times. Moreover, six exposures are sufficient to observe the hypothesized inverted U-shaped effect on climate change outcomes changing from weak to strong and becoming weak again, which adequately addresses the research questions this dissertation aims to explore.

The absence of a control condition in this study is a deliberate choice and can be justified for two primary reasons. First, prior research on message framing has already well-documented the effects of self- and social-framing on individuals, compared to irrelevant or no message (Chen, 2016; Florence et al., 2022; Geng et al., 2019; Jaeger & Weber, 2020; Ma et al., 2023; Yocco et al., 2015; Yu et al., 2017). The focus of this dissertation is not to replicate this basic premise but rather to explore how the effects of different framing strategies accumulate through repeated exposures. Therefore, there is no need to include a control condition to demonstrate the effectiveness of self- and social-framing messages

compared to no or irrelevant messages. Second, the main experiment measured climate outcomes both before and after the first exposure to the stimulus in the first session. These pre-experiment measures essentially act as a control condition, allowing for assessing changes attributable to the framing strategies employed.

Section 3.2.5 Measures

This section presents the measures employed in the main experiment. First, the current dissertation employs several variables rooted in STOPS to understand participants' cognitive and behavioral responses to climate change messages. These variables have been established in previous literature (Grunig, 1997; Jiang et al., 2017; Kim & Grunig, 2011) and are detailed below. Then, moderators, outcome variables, and control variables are also presented.

Constraint Recognition. Two items were utilized for constraint recognition, adapted from Jiang et al. (2017) and Kim and Grunig (2011). Participants were asked to rate their level of agreement with the statements "I don't believe I could make a difference in climate change" and "I don't believe that I could influence the way climate change is solved" on a 6-point Likert scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree).

Involvement Recognition. Involvement recognition was assessed using three items adapted from Jiang et al. (2017) and Kim and Grunig (2011). Participants rated their agreement with statements such as "In my mind, I see a close connection between myself and climate change," "I feel climate change affects or could affect me personally," and "I believe

climate change could involve me or someone close to me at some point," using the same 6-point Likert scale.

Problem Recognition. Problem recognition was measured through three items adapted from Jiang et al. (2017) and Kim and Grunig (2011). The items are "I feel that something needs to be done to improve the situation for climate change," "The current state (or situation) is largely different from what I believe it should be regarding climate change," and "I believe people need to pay more attention to climate change." These items were rated on a 6-point Likert scale.

Information Seeking. For information seeking, participants were asked to evaluate their agreement with three statements: "I regularly check to see if there is any new information about climate change online," "I regularly visit websites relevant to climate change," and "I would search information about climate change on social media." Responses were recorded on a 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Attending. Information attending was assessed using three items: "I pay attention to climate change when a news report appears," "I attend to news when they cover climate change," and "I take some time listening if someone tries to give information about climate change." Participants rated their agreement with these statements on a 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Permitting. Information permitting was measured by asking participants to rate their agreement with two items: 'I am willing to look at things from a

different viewpoint on the issue of climate change" and 'I listen to even contradicting opinions on climate change." These items were rated on a 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Sharing. For information sharing, participants indicated their level of agreement with the statements 'Unless people ask me, I may not initiate a conversation about climate change' and 'I talk about this problem only when others bring about the topic of climate change." These items were rated on a 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Forefending. Three items measured information forefending: "I know where to go when I need updated information regarding climate change," "I have learned enough about climate change to judge the value of updated information," and "I express my opinions confidently about what should be done to deal with climate change." These items applied the same 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Forwarding. Information forwarding was measured using three items: "I have posted my opinion and experience on climate change online," "I make sure that my friends know about climate change," and "I bring the issue of climate change to the attention of people I know." Participants rated these statements on a 7-point Likert scale adapted from Jiang et al. (2017) and Kim and Grunig (2011).

Information Omitting. Information omitting was operationalized using a scale adapted from the works of Yang and Kahlor (2013) and Tao et al. (2020) with five items. The

scale includes items such as “I avoid information about climate change,” “When it comes to climate change, I don’t want to know more,” “I refuse to listen to information about climate change,” “I tune out information about climate change,” and “I ignore information about climate change.” Participants were asked to rate their level of agreement with these statements on a 7-point Likert scale.

Information Avoiding. The measure for information avoiding was adapted from Howell and Shepperd (2016). This variable was assessed using eight items, including “I would rather not know about climate change,” “I would avoid learning about climate change,” “Even if it will upset me, I want to know about climate change" (reversed), “When it comes to climate change, [sometimes] ignorance is bliss,” “I want to know about climate change” (reversed), “I can think of situations in which I would rather not know about climate change,” “It is important to know about climate change” (reversed), and “I want to know about climate change immediately” (reversed). Participants rated their agreement with these items on a 7-point Likert scale.

Pro-environmental Self-identity. To measure pro-environmental self-identity, this dissertation incorporated a four-item scale adapted from Whitmarsh and O'Neill (2010) and measured on a 7-point Likert scale. Specifically, the scale comprised the following statements: “I think of myself as an environmentally-friendly consumer,” “I think of myself as someone who is very concerned with environmental issues,” “I would be embarrassed to be seen as having an environmentally friendly lifestyle,” and “I would not want my family or friends to think of me as someone who is concerned about environmental issues.” The latter

two statements were reverse-scored; higher values on this scale indicate stronger pro-environmental self-identity.

Message Fatigue. This dissertation utilized an eight-item scale adapted from Song and So (2023) to assess message fatigue, each measured on a 7-point Likert scale. The scale included statements such as "At this point, I've heard about problems related to climate change more than I ever needed to," "There are simply too many messages about climate change nowadays," "After hearing them for years, messages about climate change seem repetitive," "Messages about climate change are all beginning to sound the same to me," "I'm sick of hearing about problems associated with climate change," "I'm tired of hearing about the importance of climate change," "I find messages about climate change to be dull and monotonous," and "Messages about climate change are tedious."

Climate Change Beliefs. Climate change beliefs were measured with six items adapted from previous research (Cook & Lewandowsky, 2016; Deryugina & Shurchkov, 2016; Ma et al., 2023). Specifically, respondents were asked to use a 7-point Likert-type scale (1 = strongly disagree, 7 = strongly agree) to indicate the extent to which they agree or disagree with the following statements: (1) The climate will always be changing and what we will observe is just a natural fluctuation (reverse coded); (2) The burning of fossil fuels over the next 50 years will cause serious damage to the planet's climate; (3) Human CO2 emissions will cause climate change; (4) Humans will be too insignificant to have an appreciable impact on global temperature (reverse coded); (5) Climate change will be a process that is underway; (6) Climate change will not be happening (reverse coded).

Climate Change Attitudes. In terms of attitudes, this dissertation assessed climate change concerns and the perceived importance of addressing climate change. A two-item measure was employed for climate change concern, asking participants, "I feel concerned about climate change" and "I worry about climate change." This scale was adapted from Busch and Chávez (2022) and was scored on a 7-point Likert scale. Likewise, to measure participants' perception of the importance of climate change, a two-item measure was utilized: "I feel that climate change is an important issue to address" and "climate change is an important issue to me." This was adapted from Hart and Feldman (2016), and participants responded on a 7-point Likert scale.

Private Pro-environmental Behavioral Intentions. This dissertation employed a three-item measure adapted from Bradley et al. (2020) and Shi et al. (2023) to assess private pro-environmental intentions. Participants were asked to indicate on a 7 Likert scale (1 = Very Unlikely, 7 = Very Likely) how likely they are to engage in specific behaviors within the next month. The first item focused on transportation choices to reduce carbon emissions, asking participants about their likelihood of opting for low-carbon commuting methods like public transportation, cycling, or walking. The second item probed intentions related to sustainable consumption, specifically regarding choosing recyclable and reusable products. Finally, the third item will center on energy-saving behaviors, asking participants how likely they are to reduce personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances. These three items ask how likely they are to engage in "choose low-carbon commuting methods like public

transportation, cycling, or walking to reduce carbon emissions?" "opt for recyclable and reusable products when making purchases?" and "reduce your personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances?"

Public Pro-environmental Behavioral Intentions. This dissertation utilized a multi-item measure to measure participants' public pro-environmental behavioral intentions. Participants were asked to express their willingness to support various climate-friendly policies and activities on a 7-point Likert scale ranging from 1 (Strongly Oppose) to 7 (Strongly Support). The first set of items assesses policy support, including backing policies limiting emissions from power plants, advocating for increased government investment in renewable energy research, and implementing a carbon tax. These items are adapted from Diamond (2020) and Diamond and Urbanski (2022). In addition to policy support, the measure includes items to assess other forms of public pro-environmental behavioral intentions. Specifically, participants were asked about their willingness to volunteer for pro-environmental activities and to participate in climate change campaigns. These items are adapted from Smith et al. (2007) and Shi et al. (2023) and ask participants how likely they are to engage in "support policies that limit emissions from power plants?" "support increased government investment in renewable energy research?" "support implementing a carbon tax?" "volunteer for pro-environmental activities?" and "participate in climate change campaigns?"

In the upcoming data analysis, this dissertation included several control variables to better isolate the effects of the main variables under study. Demographic variables associated with climate change outcomes, such as age, gender, education, and income, were controlled. Another key control variable was the frequency of exposure to climate change news. This variable is especially crucial given the context of the current experiment (Diamond, 2020; Diamond & Urbanski, 2022), as prior research by Hornsey et al. (2018) has shown that these factors significantly correlate with climate change outcomes.

It is worth noting that while efforts are made to control for these variables, this dissertation cannot fully account for external information that participants may encounter during the experiment's duration. There is the potential that participants might consume other media related to climate change, thereby confounding the impact of the treatments applied in this study. To mitigate this limitation, the research design will employ a combined within and between-subjects approach and will include control measures for participants' climate media consumption habits.

Cultural Worldview of Individualism Versus Communitarianism. Another control variable included in this study was the cultural worldview of individualism versus communitarianism as it closely relates to the study's design (i.e., self-social framing messages). Those with a communitarian mindset tend to value collaboration and collective efforts in pursuing goals, while individuals with an individualistic mindset prioritize personal efforts in achieving their objectives. Generally, individuals strongly inclined towards individualism are less inclined to endorse societal norms or governmental actions, fearing

these may impinge on personal liberties (Kahan, 2012; Wang et al., 2017). Such individuals often downplay risks that could affect the wider group, concerned that acknowledgment might lead to more governmental intervention. Within the context of climate change, people with an individualistic stance are more prone to overlook the risks climate change poses, preferring policies that accommodate their personal lifestyle choices, like increased driving or energy usage. Conversely, those aligned with a communitarian perspective are more attentive to the potential impacts of climate change on others and future generations and, thus, are more likely to support government measures that prioritize collective well-being, even if it means compromising some individual freedoms.

Communitarianism worldview was measured on five items, adapted from Kahan (2012) and Wang (2017): “The government should do more to advance society’s goals,” “The government should help those in need,” “The government should tell people how to live their lives,” and “It’s society’s responsibility to make sure everyone’s basic needs are met.” The last item was constructed based on communitarianism: “The government should guide individuals to make choices good for society.” Those who score high on this scale will be considered as having a stronger communitarian worldview than those who score low. Egalitarianism was measured by three items based on Kahan (2012) and Wang (2017): “Everyone in our country should enjoy equal rights,” “Our society will be better if the distribution of wealth is equal,” and “We need to reduce the inequalities among different classes.” Those who score high on this scale were considered to have a stronger egalitarian worldview than those who score low.

Section 3.2.6 Summary

This method chapter outlines the pilot study and the main study. The first section details the pilot study, including participant recruitment, procedures, stimulus development, measures, and data analysis procedures. The main study is a longitudinal between-subjects experiment with six separate exposures spaced three days apart. The second section of the chapter elaborates on the details of the main experiment, addressing sample size planning, participant recruitment, experimental procedures, and measures. Having detailed the method employed in both the pilot and main studies, the next chapter presents the results obtained from these experiments and the characteristics of the samples.

Chapter 4 Results

This dissertation chapter begins by presenting a summary figure outlining the hypotheses, research questions, and corresponding findings. Following the summary, section 4.1 reports how data was prepared for further analysis. Section 4.2 details the pilot study's results and how the main study's experimental stimuli were selected. Section 4.3 first describes the characteristics of both the initial and final samples and then elucidates the approach undertaken to address the issue of participant dropout in the main study. Subsequently, the results of the reliability tests were reported. The second finally detailed the findings for each research hypothesis and question, supported by the necessary figures and tables to facilitate a thorough understanding of the data.

Figure 3

Summary of Hypotheses and Research Questions and Findings

H or RQ	Content	Supported or not	Summary
Research Question 1	Is the interaction between time and condition significant in affecting climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	Repeated exposures do not exhibit significant interaction effects between time and condition on climate change outcomes.
Research Question 2	After how many exposures do the self- and social-framing conditions respectively reach their maximum impact on climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	Both framing conditions tend to reach their peak on climate change outcomes after six exposures, while the only exception is public pro-environmental intentions in the self-framing condition, which reached the highest values after the first exposure.

Hypothesis 1	As the number of repeated exposure increases, there will first be an increase and then a decrease in climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions for all three conditions.	Not Supported	Most climate change outcomes show a consistent increase after repeated exposures rather than an initial increase followed by a decrease.
Research Question 3	When individuals in each framing condition reach their highest levels of belief in climate change, their most positive attitudes, and their strongest intentions for both private and public pro-environmental behaviors, which messaging frame—self-framing or social-framing climate change messaging—leads to stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	The self-framing and social-framing conditions show no significant differences in strengthening climate change beliefs, attitudes, and pro-environmental behavioral intentions at peak response levels (i.e., after six exposures).

Research Question 4	After six repeated exposures, individuals in which frame condition—self-framing or social-framing climate change messaging—result in stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	The self-framing and social-framing conditions show no significant differences in terms of strengthening climate change beliefs, attitudes, and pro-environmental behavioral intentions after six exposures.
Research Question 5	After six exposures, are there significant differences in message fatigue between participants exposed to mixed-framing messages compared to only self-framing and social-framing messages?	N/A	Although message fatigue in the mixed-framing condition was slightly lower than in the self-framing and social-framing conditions, there were no significant differences after six exposures.
Hypothesis 2	Compared to conditions exposed to only one type of frame repeatedly, the mixed-use of both self- and	Partially Supported	After six exposures, mixed-framing messages lead to significantly higher

	social-framing messages will result in higher values for climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures.		values for climate change outcomes. However, the statistical analysis was only significant for comparing mixed-framing and self-framing conditions.
Research Question 6	How does pro-environmental self-identity moderate the relationship between repeated exposure to different framing messages (i.e., self, social, or mixed framing conditions) and climate change outcomes, specifically in relation to climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures?	N/A	Pro-environmental self-identity does not significantly interact with different framing strategies to affect climate change outcomes after six exposures, although it independently influences the climate change outcomes.

Hypothesis 3	The more situationally active individuals are on climate change, the more information forefending (a), information permitting (b), information forwarding (c), information sharing (d), information seeking (e), information attending (f) they will engage in about climate change. Specifically, these information behaviors will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.	Supported	The level of situational activity on climate change significantly influences communicative behaviors, with higher activity levels correlating with more positive information behaviors.
Hypothesis 4	The more situationally active individuals are on climate change, the less information avoidance (a) and information omission (b) they will engage in about climate change. Specifically, these information	Supported	The level of situational activity on climate change significantly influences passive communicative behaviors, with higher activity levels correlating with

	behaviors will be the lowest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.		less information avoidance and omission.
Hypothesis 5	The more situationally active individuals are on climate change, the higher climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions they will have about climate change. Specifically, these outcomes will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.	Supported	The level of situational activity on climate change significantly influences climate change outcomes, with higher activity levels correlating with more positive climate change outcomes.

Research Question 7	How do the effects of repeated exposures to self- and social-framing messages on all outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions, in three different framing conditions differ among various publics after six exposures?	N/A	Different framing conditions do not interact significantly with the type of publics to influence climate change outcomes after six exposures; individuals' type of publics predict outcomes independently of framing.
Research Question 8	To what extent, if any, will the overall proportion of each public change for each condition after six repeated exposures in each condition?	N/A	Six repeated exposures to climate change messaging significantly shift the overall proportion of each public in each condition, particularly increasing the proportion of the Active public.

Section 4.1 Data Preparation

This section details the data preparation process, including handling missing values, ensuring reliability, and assessing assumptions (e.g., normality, linearity, and homoscedasticity).

For handling missing values, this dissertation took a conservative approach, given the potential for bias from imputations (i.e., a set of methods used to fill in missing data with substituted values, such as mean or median imputation, multiple imputation, and model-based imputation) (Diamond & Urbanski, 2022; Fitzmaurice et al., 2012). The main study had an individual-level panel retention rate (i.e., the proportion of participants from the original panel study who remained in the study over the course of the research) of 44.53%, from 750 in the initial sample to 334 in the final sample, indicating that just under half of the individuals from the first wave of the study subsequently provided data at each wave.

Specifically, the study began with an initial sample of 750 participants in the first wave. In the second wave, the number of participants decreased to 464, representing a retention rate of 61.87% from the first to the second wave. The third wave saw a further decrease to 441 participants, with a retention rate of 95.04% from the second to the third wave. In the fourth wave, the number of participants declined to 393, indicating a retention rate of 89.12% from the third to the fourth wave. The fifth wave had 345 participants, with a retention rate of 87.79% from the fourth to the fifth wave. Finally, in the sixth wave, the number of participants stood at 334, with a retention rate of 96.81% from the fifth to the sixth wave.

To mitigate the risk of biased estimates because of participants' dropouts, which could be exacerbated by large panel attrition, complete-case methods (i.e., analyzing only those cases for which there is no missing data across all waves of the study) were applied to delete partial responses from participants who dropped out between Wave 2 and Wave 6 (Fitzmaurice et al., 2012). Specifically, if participants failed to respond to a session, they were not invited to subsequent sessions, and their prior responses were excluded from the final analysis.

The nature of the study informed this decision. Unlike longitudinal surveys that track changes in participants' perceptions and intentions over time—where missing values might be estimated—this study is a longitudinal experiment that measures the impact of time and repeated exposures on changes in participants' perceptions and intentions. The omission of exposures cannot be compensated for through imputation since the missing data can introduce bias and reduce the statistical power of the analyses (Fitzmaurice et al., 2012). For instance, missing the second session would affect a participant's responses in subsequent sessions, resulting in only five exposures compared to others who experienced all six sessions. Therefore, this dissertation applied complete-case methods commonly used in previous longitudinal experiments in communication studies (Diamond & Urbanski, 2022; Shi & Smith, 2015; Skurka et al., 2023).

Furthermore, to check whether participants were dropping out randomly (i.e., missing completely at random, MCAR), independent samples t-tests were conducted to compare the final sample and the dropout sample on control variables, including gender, age, education,

annual family income, communitarianism worldview, egalitarianism worldview, and frequency of encountering climate change information to examine whether the main characteristics of the participants exhibited any large differences that signify systematic reasons for participants' dropout in section 4.3.2.

To ensure the reliability of each variable in the study, Cronbach's alpha was calculated for each scale used to measure all the variables in the main study. A Cronbach's alpha of 0.7 or higher is generally considered acceptable for research purposes, indicating a reliable scale (Taber, 2018). The reliability values for all included variables measured at different waves were reported in section 4.3.3, and all of them were higher than 0.7.

Upon completing data collection, Mauchly's test of sphericity should be conducted to assess the assumption of sphericity for ANOVA with repeated measures (Grieve, 1984). This assumption demands that the differences among all pairs of conditions within subjects remain constant. In simpler terms, sphericity means that the spread of the differences between any two conditions is uniform (i.e., compound symmetry) across all combinations.

However, the compound symmetry covariance structure assumption is highly restrictive and often unrealistic for longitudinal data. A SAS procedure, PROC MIXED, can estimate the covariance matrix without making any assumption about the covariance structure using an unrestricted or unstructured covariance matrix (Fitzmaurice et al., 2012). Also, the normality assumption was checked before the repeated measures ANOVA and independent samples ANOVA by ensuring that the scatter plots of all possible pairs of the responses generally have a linear trend (Fitzmaurice et al., 2012). Finally, homoscedasticity (i.e.,

homogeneity of variances, an assumption of equal or similar variances in different conditions being compared) was checked for variables that were examined with ANOVAs and t-tests using Levene's test for equality of variances (Karim et al., 2023; Manfei et al., 2017). Test results confirmed that the homogeneity of variances was met for all involved variables.

Section 4.2 Pilot Study Results

In the pilot study conducted among 40 adult residents in China, the final sample showed a diverse demographic profile. Education levels varied, with 12.5% holding associate degrees, 62.5% holding bachelor's degrees, and 25% holding master's degrees, indicating a well-educated cohort. Gender distribution was balanced, with an equal split of 50% male and 50% female participants because of the quota sampling. Participants ranged from 19 to 57 years, with an average age of 31.60 years and a standard deviation of 9.20.

Then, the responses were analyzed to determine suitable stimuli by comparing the mean scores of framing perception across all participants for both the self-framing and the social-framing message versions. Each of the 40 participants was exposed to 12 messages, resulting in two groups of 20 participants for each message. The selection of effective stimuli was based on identifying six base messages that exhibited the most distinct framing effects: messages with the lowest perceived self-framing scores and the highest social-framing scores for two framing versions should be chosen. Notably, each base message (i.e., messages selected from news outlets) had undergone some level of modification with a parallel approach (i.e., creating two versions of each base message: one with the self-framing and another with the social-framing).

Table 2 presented the perceived framing for the 12 messages, each available in both self- and social-framing versions. Participants rated these messages on a 7-point Likert scale, where higher scores indicated stronger perceptions of social-framing, and lower scores suggested stronger perceptions of self-framing. Six messages were selected based on the largest mean differences and their values of high scores (i.e., extreme cases) on self- and social-framing, including messages one, four, five, seven, eight, and ten, their mean differences were highlighted in Table 2. For instance, message one exhibited a mean difference of 4.25 between the self-framing version (mean = 1.70) and the social-framing counterpart (mean = 5.95). Similarly, message five showed the largest mean difference of 5.05, with the self-framing version rated at a mean of 1.55 and the social-framing version at 6.60, further underscoring the effectiveness of different framing versions in influencing participants' framing perceptions. The selection of these six messages with the largest mean differences between the two framing versions allows for examining how distinct framing strategies—emphasizing individual versus collective actions and impacts—can influence participants' climate change attitudes and intentions in the following main experiment. These six messages, validated for their framing effectiveness through the pilot study, are the stimuli for the subsequent main experiment. The selected messages are in Appendix A: Pilot Study Stimuli.

Table 2

Results of Perceived Framing of Different Message Versions

Message Name	Mean	SD	Min	Max	N	Mean Difference

Message 1 self-framing	1.70	0.57	1	3	20	**4.25**
Message 1 social-framing	5.95	0.83	4	7	20	
Message 2 self-framing	3.25	1.83	1	6	20	2.55
Message 2 social-framing	5.80	1.15	3	7	20	
Message 3 self-framing	2.40	0.82	1	4	20	3.10
Message 3 social-framing	5.50	1.00	3	7	20	
Message 4 self-framing	1.80	0.52	1	3	20	**4.40**
Message 4 social-framing	6.20	0.77	4	7	20	
Message 5 self-framing	1.55	0.69	1	3	20	**5.05**
Message 5 social-framing	6.60	0.75	4	7	20	
Message 6 self-framing	1.60	0.75	1	3	20	2.43
Message 6 social-framing	4.03	2.55	1	7	20	
Message 7 self-framing	1.95	0.51	1	3	20	**3.80**
Message 7 social-framing	5.75	0.97	3	7	20	
Message 8 self-framing	2.05	0.89	1	3	20	**3.70**
Message 8 social-framing	5.75	1.25	2	7	20	
Message 9 self-framing	2.20	0.77	1	3	20	3.35
Message 9 social-framing	5.55	0.95	4	7	20	
Message 10 self-framing	2.10	0.85	1	3	20	**3.60**
Message 10 social-framing	5.70	0.80	4	7	20	
Message 11 self-framing	2.55	1.36	1	6	20	2.55
Message 11 social-framing	5.10	1.52	1	7	20	
Message 12 self-framing	2.15	0.81	1	4	20	3.50
Message 12 social-framing	5.65	1.18	3	7	20	

Note. The mean differences in bold are the messages that were selected for the main study

because of the high mean differences.

Section 4.3 Main Study Results

This section details the results of the main study, including the descriptive statistics for demographics, addressing dropouts by comparing the characteristics of the initial sample and final sample, and results for each research question and hypothesis with statistical analyses such as repeated exposures ANOVA, analysis of response mean profile, and two-way independent ANOVA.

Section 4.3.1 Descriptive Statistics for Demographics in the Final Sample

For the final sample shown in Table 3, the gender distribution remained relatively balanced, with 52.7% of participants being male and 47.3% female. The average age of participants was 26.13 years, ranging from 17 to 62. The communitarianism worldview had a mean of 5.66, and egalitarianism had a mean of 5.62, both ranging from one to seven. A significant majority of participants, 62.6%, hold a bachelor's degree, with an additional 18% possessing a master's degree, underscoring a sample with a high level of educational attainment. The sample showed a broad spectrum of household income before taxes, with the largest segment, 33.8%, earning between ¥35,000 to ¥104,993 ($5,000 to $14,999) annually. This was followed by 21.6% of participants in the ¥105,000 to ¥174,993 ($15,000 to $24,999) brackets, indicating a concentration in the lower to middle-income ranges.

The mean scores for communitarianism and egalitarianism worldviews in this final sample were 5.65 and 5.62, respectively, on a scale from 1 to 7, which are very high. These results are similar to the findings of an online survey with 516 Chinese adult participants

(Wang et al., 2017), which found communitarianism and egalitarianism worldview scores of 6.22 and 6.32, respectively, on a 1-to-7 scale. Wang et al. also discovered that those who held a communitarian worldview (vs. individualistic) and an egalitarian worldview (vs. hierarchical) were significantly positively correlated with support for climate policies, aligning with the high mean values of private and public pro-environmental intentions found in this dissertation. The high levels of communitarianism and egalitarianism worldviews among the Chinese population may be related to the extensive reporting on the Chinese government's climate change actions (Pan et al., 2021, 2023; Xu et al., 2022) and the sample's high educational level, as a previous review study suggested (Wang & Zhou, 2020).

In the final sample, most participants regularly engaged with climate change information, illustrating a significant level of awareness and concern. Specifically, 32.6% of the participants reported encountering information about climate change a few times a week; an additional 28.0% did so daily. This finding indicates that over half of the sample accessed climate change content regularly or daily. Fewer participants encountered such information less frequently, with 15.4% a few times a month, 9.3% once a week, 5.4% once a month, and 6.0% rarely. Only 3.3% of participants reported encountering climate change information multiple times a day.

The dissertation's findings on the frequency of encountering climate change information are generally consistent with previous research. In this dissertation, 60.6% of participants reported encountering such information at least a few times a week, which is similar to the findings of a study that found 72% of adult Internet users in China get news

online at least once a week (Hölig et al., 2021). The China Climate Change Communication Annual Report (2021) found that 74.1% of Chinese respondents reported paying attention to climate change issues, although the report does not specify the frequency of encountering climate change information. The dissertation's results also showed a slightly higher overall frequency compared to the Climate Change in the American Mind survey report (Leiserowitz et al., 2021).

Table 3

Comparative Table of Descriptive Statistics for the Initial and Final Samples

Variable	Initial Sample in Session 1	Final Sample in Session 6
Gender	Male: 51.2%, Female: 48.8%	Male: 52.7%, Female: 47.3%
Age	Mean: 28.70, SD: 8.76, Min-Max: 17-68	Mean: 26.13, SD: 7.61, Min-Max: 17-62
Education	Mean: 4.81, SD: 0.88, Min-Max: 2-7	Mean: 4.92, SD: 0.80, Min-Max: 2-7
Annual family income before taxes	Mean: 3.93, SD: 2.35, Min-Max: 1-11	Mean: 3.37, SD: 1.94, Min-Max: 1-11
Communitarianism worldview	Mean: 5.62, SD: 0.64, Min-Max: 2.60-7.00	Mean: 5.66, SD: 0.61, Min-Max: 3.60-7.00
Egalitarianism worldview	Mean: 5.61, SD: 0.88, Min-Max: 1.67-7.00	Mean: 5.62, SD: 0.91, Min-Max: 1.67-7.00
Frequency of encountering climate change information	1 (rarely): 5.5%, 2 (once a month): 4.5%, 3 (a few times a month): 10.3%, 4 (once a	1 (rarely): 6.0%, 2 (once a month): 5.4%, 3 (a few times a month):15.4%, 4 (once a

	week): 9.5%, 5 (a few times a week): 32.8%, 6 (daily): 33.7%, 7 (multiple times a day): 3.7%	week): 9.3%, 5 (a few times a week): 32.6%, 6 (daily): 28.0%, 7 (multiple times a day): 3.3%

Section 4.3.2 Addressing Dropout Issue

To assess whether the missingness in the sample was completely at random (MCAR), independent samples t-tests were conducted to compare the final sample (n = 334) and the dropout sample (n = 414) on control variables, including gender, age, education, annual family income, communitarianism worldview, egalitarianism worldview, and frequency of encountering climate change information.

The results revealed no significant differences between the final sample and the dropout sample in terms of gender ($t(746) = -0.69$, $p = .494$), communitarianism worldview ($t(746) = -1.50$, $p = .135$), egalitarianism worldview ($t(746) = -.371$, $p = .711$), and frequency of encountering climate change information ($t(746) = .819$, $p = .413$). However, significant differences were found for age ($t(744.87) = 7.61$, $p < .001$), education ($t(742.48) = -3.20$, $p = .001$), and annual family income ($t(744.03) = 6.27$, $p < .001$).

The final sample (M = 26.13) was significantly younger than the dropout sample (M = 30.77), while the final sample (M = 4.92) had a significantly higher level of education compared to the dropout sample (M = 4.72). Additionally, the final sample (M = 3.37) had a significantly lower annual family income compared to the dropout sample (M =4.39).

These differences suggest that younger, more educated individuals with lower family incomes were more likely to continue participating in the study. One possible explanation for this finding is that younger, more educated individuals may be more frequent users of mobile devices (Tang et al., 2021), which could have made it easier for them to continue participating in the research. Additionally, economic factors, possibly related to incentives for continued participation, might have influenced the composition of the final sample.

While the dropout may essentially be random concerning most of the measured variables, such as gender, communitarianism worldview, egalitarianism worldview, and frequency of encountering climate change information, the significant differences in age, education, and annual family income suggest that financial incentives, age, education, or economic conditions could have played a role in retaining participants in future longitudinal studies. Although the dropout may not be entirely systematic, the differences in age, education, and annual family income between the final and dropout samples are acknowledged and discussed when interpreting the findings.

Section 4.3.3 Reliability Test Results

Reliability tests for all variables measured at different times in the study demonstrated consistently high internal consistency, with Cronbach's alpha values between 0.72 and 0.89. Table 4 presented alpha values for variables measured once or twice throughout the main study. In Table 5, variables measured six or seven times, including message fatigue, climate change beliefs, attitudes, and private and public pro-environmental behavioral intentions, displayed high reliability across all measurement points.

Table 4

Reliability Alpha Values for Variables Measured Once or Twice

Variable	Pre-exposure	Exposure 6
Constraint recognition	0.82	0.89
Involvement recognition	0.85	0.82
Problem recognition	0.83	0.80
Information seeking	0.81	N/A
Information attending	0.87	N/A
Information permitting	0.82	N/A
Information sharing	0.84	N/A
Information forefending	0.75	N/A
Information forwarding	0.89	N/A
Information omitting	0.87	N/A
Information avoiding	0.74	N/A
Pro-environmental self-identity	0.77	N/A
Communitarianism worldview	0.82	N/A
Egalitarianism worldview	0.76	N/A

Note. "N/A" indicates that a second measurement time was not applicable for these variables.

Table 5

Reliability Alpha Values for Variables Measured Six or Seven Times

Variable	Pre-exposure	Exposure 1	Exposure 2	Exposure 3	Exposure 4	Exposure 5	Exposure 6
Message fatigue	0.80	N/A	0.76	0.82	0.73	0.76	0.77
Beliefs	0.79	0.79	0.74	0.80	0.82	0.78	0.82
Attitudes	0.76	0.82	0.81	0.77	0.76	0.77	0.79
Private pro-environmental intentions	0.84	0.79	0.72	0.80	0.73	0.82	0.75
Public pro-environmental intentions	0.83	0.76	0.80	0.81	0.74	0.83	0.86

Note. "N/A" indicates that a second measurement time was not applicable for the variable.

Section 4.3.4 Results for Research Question One

To investigate Research Question 1, which explored whether the interaction between exposure frequency and condition significantly affects various climate change outcomes—including beliefs, attitudes, and private and public pro-environmental behavioral intentions—this study utilized repeated measures of ANOVA and analysis of mean response profiles in SAS software. Specifically, the repeated measures ANOVA uncovered whether there was a significant interaction effect between exposure frequency and condition on climate change outcomes. However, repeated measures ANOVA can only display whether an interaction effect existed. It cannot reveal more details. To better model the time trend across conditions, analysis of response profiles was applied to characterize the patterns of change in the mean response over time in the condition and to determine whether the shapes of the mean response profiles differed among the conditions (i.e., whether they are parallel and flat in the mean responses) in this balanced design (i.e., all subjects are measured at the same set of n occasions) longitudinal experiment (Fitzmaurice et al., 2012).

The overarching findings from the analyses of these variables revealed a consistent pattern across the board. Notably, no significant interaction effects existed between exposure frequency and condition or significant condition effects for any of the outcomes examined. This indicated that the changes for all climate change outcomes observed over time in response to repeated exposures were statistically consistent across different conditions, regardless of the specific message framing employed. However, significant exposure frequency effects were identified for all climate change outcomes in each condition for each climate change outcome, suggesting that repeated exposures significantly changed climate change beliefs, attitudes, and

both private and public pro-environmental behavioral intentions. This section is organized into subsections for results for each climate change outcome.

Climate Change Beliefs. The analysis of climate change beliefs through repeated measures ANOVA did not reveal significant interaction effects between exposure frequency and condition ($p = .82$), nor were there significant condition effects ($p = .11$), as shown in Table 6 below. However, a significant exposure frequency effect was identified for the reference condition (i.e., self-framing) ($p < .0001$), indicating that beliefs towards climate change significantly changed over time. Specifically, the absence of significant condition effects suggests that participants in the three framing conditions did not differ significantly in their climate change beliefs at baseline or across the exposures. The lack of a significant interaction between exposure frequency and framing condition further implied that the increasing rate of beliefs over time was consistent across all conditions, without any condition responding differently across each exposure.

Table 6

Repeated Measure ANOVA Results for Climate Change Beliefs

Effect	Num DF	Den DF	Chi-square	F value	Pr > ChiSq	Pr > F
Condition	2	331	4.26	2.13	0.1191	0.1207
Time	6	331	96.39	16.06	<.0001	<.0001
Interaction	12	331	7.52	0.63	0.8218	0.8197

In Table 7, the analysis of mean response profiles for climate change beliefs revealed more details about the mean differences among each condition and exposure time. It can characterize the patterns of change in the mean response over time in the condition and

determine whether the shapes of the mean response profiles differed among the conditions. The comparison to exposure 0 (i.e., the pre-exposure measure of climate change beliefs) showed significant belief growth after each exposure across all framing conditions except for the second exposure. This finding underscored a universal trend of increasing climate change beliefs with each additional exposure to relevant information. Despite this overall increase, no significant differences were found when the increments in beliefs at each exposure were examined for differences among the three framing conditions (i.e., the interaction effect).

Table 7

Analysis of Mean Response Profiles for Climate Change Beliefs

Effect	Condition	Time	Estimate	SE	DF	T value	Pr > |t|
Intercept			5.89	0.05	331	101.11	<.0001
Condition	3 (mixed)		0.07	0.08	331	0.91	0.3622
Condition	2 (social)		0.06	0.08	331	0.75	0.4515
Condition	1 (self)		0	.	.	.	.
Time		6	0.20	0.05	331	3.71	0.0002
Time		5	0.16	0.05	331	3.11	0.0021
Time		4	0.15	0.05	331	3.01	0.0028
Time		3	0.09	0.05	331	1.81	0.0710
Time		2	0.04	0.04	331	0.90	0.3682
Time		1	0.16	0.03	331	4.47	<.0001
Time		0	0	.	.	.	.
Interaction	3	6	0.11	0.07	331	1.48	0.1395
Interaction	3	5	0.09	0.07	331	1.25	0.2112

Interaction	3	4	0.06	0.07	331	0.88	0.3784
Interaction	3	3	0.09	0.07	331	1.25	0.2136
Interaction	3	2	0.04	0.06	331	0.69	0.4937
Interaction	3	1	-0.04	0.05	331	-0.84	0.4018
Interaction	2	0	0	.	.	.	.
Interaction	2	6	0.04	0.08	331	0.54	0.5865
Interaction	2	5	0.05	0.08	331	0.71	0.4771
Interaction	2	4	0.05	0.07	331	0.71	0.4798
Interaction	2	3	0.06	0.07	331	0.86	0.3882
Interaction	2	2	0.01	0.06	331	0.16	0.8741
Interaction	2	1	0.00	0.05	331	0.05	0.9594
Interaction	1	0	0	.	.	.	.
Interaction	1	6	0	.	.	.	.
Interaction	1	5	0	.	.	.	.
Interaction	1	4	0	.	.	.	.
Interaction	1	3	0	.	.	.	.
Interaction	1	2	0	.	.	.	.
Interaction	1	1	0	.	.	.	.
Interaction	1	0	0	.	.	.	.

Overall, the results of these two analyses suggested that while repeated exposures consistently enhance climate change beliefs for all participants, the degree of belief increase triggered by each exposure was not statistically different across different conditions. Essentially,

although all participants, irrespective of conditions, demonstrated an upsurge in climate change beliefs from the pre-exposure measurement, the magnitude of belief increase at each subsequent exposure did not differ significantly among the conditions.

Climate Change Attitudes. The examination of climate change attitudes through repeated measures ANOVA, as summarized in Table 8, did not demonstrate significant interaction effects between exposure frequency and condition ($p = .23$) or significant condition effects ($p = .47$). However, a significant time effect was identified for the reference condition (i.e., self-framing) ($p < .0001$), indicating that attitudes towards climate change significantly changed over time. This outcome suggested a significant trend of positive shifts in climate change attitudes with each additional exposure to the messages.

Table 8

Repeated Measure ANOVA Results for Climate Change Attitudes

Effect	Num DF	Den DF	Chi-Square	F value	Pr > ChiSq	Pr > F
Condition	2	331	1.50	0.75	0.4731	0.4739
Time	6	331	227.61	37.93	<.0001	<.0001
Interaction	12	331	15.23	1.27	0.2289	0.2351

Further details provided by the analysis of mean response profiles for climate change attitudes, presented in Table 9, illuminated the mean differences among each condition and exposure time. Despite the overall improvement in climate change attitudes from the pre-exposure measure, no significant differences were observed when examining the increments in attitudes at each exposure for differences among the three conditions (i.e., the interaction effect).

Table 9

Analysis of Mean Response Profiles for Climate Change Attitudes

Effect	Condition	Time	Estimate	SE	DF	T value	Pr > |t|
Intercept			5.43	0.07	331	76.22	<.0001
Condition	3 (mixed)		0.02	0.10	331	0.19	0.8512
Condition	2 (social)		0.06	0.10	331	0.63	0.5286
Condition	1 (self)		0	.	.	.	.
Time		6	0.49	0.07	331	7.39	<.0001
Time		5	0.46	0.07	331	6.78	<.0001
Time		4	0.42	0.07	331	5.91	<.0001
Time		3	0.35	0.07	331	4.83	<.0001
Time		2	0.28	0.07	331	3.93	0.0001
Time		1	0.16	0.06	331	2.75	0.0063
Time		0	0	.	.	.	.
Interaction	3	6	0.14	0.09	331	1.54	0.1236
Interaction	3	5	0.10	0.10	331	1.03	0.3037
Interaction	3	4	0.10	0.10	331	1.04	0.2975
Interaction	3	3	0.08	0.10	331	0.75	0.4541
Interaction	3	2	0.07	0.10	331	0.73	0.4645
Interaction	3	1	-0.00	0.08	331	-0.02	0.9842
Interaction	3	0	0	.	.	.	.
Interaction	2	6	-0.00	0.09	331	-0.00	0.9964
Interaction	2	5	-0.03	0.10	331	-0.29	0.7712
Interaction	2	4	-0.04	0.10	331	-0.41	0.6832

Interaction	2	3	-0.13	0.10	331	-1.29	0.1969
Interaction	2	2	-0.08	0.10	331	-0.77	0.4437
Interaction	2	1	0.07	0.08	331	0.88	0.3798
Interaction	2	0	0	.	.	.	.
Interaction	1	6	0	.	.	.	.
Interaction	1	5	0	.	.	.	.
Interaction	1	4	0	.	.	.	.
Interaction	1	3	0	.	.	.	.
Interaction	1	2	0	.	.	.	.
Interaction	1	1	0	.	.	.	.
Interaction	1	0	0	.	.	.	.

These results overall indicated that while participants' attitudes towards climate change became significantly more positive over time, the rate of attitudinal change did not significantly vary across conditions after each exposure. All participants, irrespective of conditions, showed a significant increase in positive attitudes towards climate change from the pre-exposure measurement after each exposure. However, the magnitude of attitude improvement at each subsequent exposure did not differ significantly among the conditions.

Private Pro-environmental Intentions. The analysis of private pro-environmental intentions through repeated measure ANOVA, as summarized in Table 10, indicated no significant interaction effects between exposure frequency and condition ($p = .92$) and no significant condition effects ($p = .19$). However, a significant time effect was identified for the reference condition (i.e., self-framing) ($p < .0001$), indicating that private pro-environmental

intentions significantly changed over time. This outcome demonstrated a general trend of growing commitment to private pro-environmental actions with each additional exposure to the messages.

Table 10

Repeated Measure ANOVA Results for Private Pro-environmental Intentions

Effect	Num DF	Den DF	Chi-square	F value	Pr > ChiSq	Pr > F
Condition	2	331	3.30	1.65	0.1918	0.1934
Time	6	331	31.73	5.29	<.0001	<.0001
Interaction	12	331	6.02	0.50	0.9150	0.9132

Further insights were provided by analyzing mean response profiles for private pro-environmental intentions, detailed in Table 11, which clarified the mean differences among each condition and exposure time. Despite the overall increase in intentions from the pre-exposure measure, no significant differences were found when analyzing the increments in intentions at each exposure for differences among the self-, social-, and mixed-framing conditions (i.e., the interaction effect).

These results indicate that while participants' intentions to engage in private pro-environmental behaviors increased over time, the rate of intention growth did not significantly vary across conditions. All participants showed a significant increase in private pro-environmental behavioral intentions from the pre-exposure measurement, irrespective of conditions. However, the magnitude of intention improvement at each subsequent exposure did not differ significantly among the conditions.

Table 11

Analysis of Mean Response Profiles for Private Pro-environmental Intentions

Effect	Condition	Time	Estimate	SE	DF	T value	Pr > |t|
Intercept			5.89	0.07	331	86.00	<.0001
Condition	3 (mixed)		0.06	0.10	331	0.60	0.5512
Condition	2 (social)		0.07	0.10	331	0.71	0.4756
Condition	1 (self)		0	.	.	.	.
Time		6	0.15	0.06	331	2.32	0.0210
Time		5	0.11	0.06	331	1.72	0.0861
Time		4	0.09	0.05	331	1.62	0.1058
Time		3	0.08	0.06	331	1.39	0.1667
Time		2	0.07	0.06	331	1.22	0.2248
Time		1	0.12	0.05	331	2.33	0.0203
Time		0	0	.	.	.	.
Interaction	3	6	0.10	0.09	331	1.12	0.2616
Interaction	3	5	0.12	0.09	331	1.32	0.1866
Interaction	3	4	0.10	0.08	331	1.42	0.1579
Interaction	3	3	0.10	0.08	331	1.28	0.2019
Interaction	3	2	0.09	0.08	331	1.19	0.2345
Interaction	3	1	0.02	0.08	331	0.29	0.7746
Interaction	3	0	0	.	.	.	.
Interaction	2	6	-0.01	0.09	331	-0.09	0.9309
Interaction	2	5	0.02	0.09	331	0.27	0.7839
Interaction	2	4	0.03	0.08	331	0.42	0.6739

Interaction	2	3	0.02	0.08	331	0.22	0.8265
Interaction	2	2	0.04	0.08	331	0.56	0.5772
Interaction	2	1	-0.01	0.07	331	-0.17	0.8643
Interaction	2	0	0	.	.	.	.
Interaction	1	6	0	.	.	.	.
Interaction	1	5	0	.	.	.	.
Interaction	1	4	0	.	.	.	.
Interaction	1	3	0	.	.	.	.
Interaction	1	2	0	.	.	.	.
Interaction	1	1	0	.	.	.	.
Interaction	1	0	0	.	.	.	.

Public Pro-environmental Intentions. The investigation into public pro-environmental behavioral intentions via repeated measure ANOVA, outlined in Table 12, did not reveal significant interaction effects between exposure time and condition ($p = .24$) nor significant condition effects ($p = .11$). However, a significant time effect was identified for the reference condition (i.e., self-framing) ($p < .0001$), indicating that public pro-environmental intentions significantly changed over time. This finding illustrated a consistently significant increasing trend in public environmental actions with each additional message exposure.

Table 12

Repeated Measure ANOVA Results for Public Pro-environmental Intentions

Effect	Num DF	Den DF	Chi-square	F value	Pr > ChiSq	Pr > F
Condition	2	331	4.46	2.23	0.1074	0.1090

Time	6	331	52.23	8.70	<.0001	<.0001
Interaction	12	331	14.96	1.25	0.2439	0.2499

Further detail was provided by analyzing mean response profiles for public pro-environmental intentions, as indicated in Table 13. This analysis highlighted the mean differences between each condition and the exposure time. Despite the overall improvement in intentions from the pre-exposure measure, when analyzing the increments in intentions at each exposure for differences among the three conditions (i.e., assessing the interaction effect), no significant differences were observed, except for specific time points for mixed-framing condition which showed significant increases at later exposures (i.e., times six, five, and four).

Table 13

Analysis of Mean Response Profiles for Public Pro-environmental Intentions

Effect	Condition	Time	Estimate	SE	DF	T value	Pr > |t|
Intercept			5.41	0.07	331	73.37	<.0001
Condition	3 (mixed)		0.07	0.10	331	0.64	0.5237
Condition	2 (social)		0.04	0.11	331	0.40	0.6884
Condition	1 (self)		0	.	.	.	.
Time		6	0.05	0.07	331	0.71	0.4758
Time		5	0.01	0.06	331	0.20	0.8420
Time		4	0.00	0.07	331	0.05	0.9567
Time		3	0.12	0.06	331	2.14	0.0335
Time		2	0.15	0.06	331	2.82	0.0051
Time		1	0.19	0.05	331	3.94	<.0001

Time		0	0	.	.	.	.
Interaction	3	6	0.25	0.10	331	2.66	0.0082
Interaction	3	5	0.23	0.09	331	2.56	0.0110
Interaction	3	4	0.21	0.09	331	2.24	0.0257
Interaction	3	3	0.07	0.08	331	0.84	0.4039
Interaction	3	2	0.02	0.08	331	0.26	0.7946
Interaction	3	1	0.01	0.07	331	0.10	0.9174
Interaction	3	0	0	.	.	.	.
Interaction	2	6	0.1304	0.10	331	1.37	0.1723
Interaction	2	5	0.1458	0.09	331	1.65	0.1001
Interaction	2	4	0.1456	0.09	331	1.57	0.1173
Interaction	2	3	0.01974	0.08	331	0.24	0.8113
Interaction	2	2	-0.02475	0.08	331	-0.31	0.7583
Interaction	2	1	-0.03130	0.07	331	-0.47	0.6412
Interaction	2	0	0	.	.	.	.
Interaction	1	6	0	.	.	.	.
Interaction	1	5	0	.	.	.	.
Interaction	1	4	0	.	.	.	.
Interaction	1	3	0	.	.	.	.
Interaction	1	2	0	.	.	.	.
Interaction	1	1	0	.	.	.	.
Interaction	1	0	0	.	.	.	.

This pattern suggested that while participants' intentions to engage in public pro-environmental behaviors generally increased over time, the extent of intention growth did not significantly vary across conditions for most exposure times. Specifically, all participants, irrespective of conditions, demonstrated an increase in public pro-environmental behavioral intentions from the pre-exposure measurement, with mixed-framing condition showing a more pronounced increase at specific later exposures, indicating some variations in response to the number of message exposures.

Section 4.3.5 Results for Research Question Two

To address Research Question two, which inquired after how many exposures the self- and social-framing conditions reach their maximum impact on climate change outcomes, the mean values for these two conditions were reported for each outcome at different exposures. The objective was to identify at which exposure each outcome—climate change beliefs, climate change attitudes, private pro-environmental intentions, and public pro-environmental intentions—reached its highest mean value, indicating the point of maximum impact for each condition.

In summary, across the climate change outcomes, as shown in Table 14 for the self-framing condition and Table 16 for the social-framing condition, the sixth exposure emerged where these variables achieved their maximum impact, indicating the cumulative effect of repeated message exposure. The only exception was public pro-environmental intentions in the self-framing condition, as shown in Table 15, which reached the highest values after the first exposure.

Table 14

Descriptive Statistics for Climate Change Outcomes Across Exposures in Self-framing Condition

Variable	N	Min	Max	Mean	SD
Attitudes before exposure	113	2.25	7.00	5.43	.82
Attitudes after exposure 1	113	3.00	7.00	5.59	.80
Attitudes after exposure 2	113	3.25	7.00	5.71	.70
Attitudes after exposure 3	113	3.25	7.00	5.78	.68
Attitudes after exposure 4	113	3.25	7.00	5.81	.63
Attitudes after exposure 5	113	3.25	7.00	5.82	.65
Attitudes after exposure 6	113	3.25	7.00	5.85	.65
Beliefs before exposure	113	4.20	7.00	5.89	.61
Beliefs after exposure 1	113	4.80	7.00	6.06	.60
Beliefs after exposure 2	113	4.60	7.00	5.93	.58
Beliefs after exposure 3	113	4.00	7.00	5.99	.62
Beliefs after exposure 4	113	4.20	7.00	6.05	.59
Beliefs after exposure 5	113	4.40	7.00	6.06	.57
Beliefs after exposure 6	113	4.40	7.00	6.09	.56
Private intentions before exposure	113	3.00	7.00	5.89	.77
Private intentions after exposure 1	113	3.00	7.00	6.00	.69
Private intentions after exposure 2	113	4.00	7.00	5.95	.64
Private intentions after exposure 3	113	4.00	7.00	5.96	.63
Private intentions after exposure 4	113	4.00	7.00	5.97	.60
Private intentions after exposure 5	113	4.00	7.00	5.99	.64
Private intentions after exposure 6	113	4.00	7.00	6.04	.62
Public intentions before exposure	113	2.60	7.00	5.41	.73

Public intentions after exposure 1	113	2.80	7.00	5.60	.76
Public intentions after exposure 2	113	2.80	7.00	5.57	.76
Public intentions after exposure 3	113	2.80	7.00	5.54	.75
Public intentions after exposure 4	113	3.20	7.00	5.42	.69
Public intentions after exposure 5	113	3.20	7.00	5.42	.70
Public intentions after exposure 6	113	3.20	7.00	5.46	.68

Table 15

Descriptive Statistics for Climate Change Outcomes Across Exposures in Social-framing Condition

Variable	N	Min	Max	Mean	SD
Attitudes before exposure	110	2.50	7.00	5.49	.75
Attitudes after exposure 1	110	2.50	7.00	5.73	.79
Attitudes after exposure 2	110	2.50	7.00	5.69	.77
Attitudes after exposure 3	110	2.50	7.00	5.71	.79
Attitudes after exposure 4	110	4.00	7.00	5.87	.60
Attitudes after exposure 5	110	4.00	7.00	5.92	.62
Attitudes after exposure 6	110	4.00	7.00	5.98	.62
Beliefs before exposure	110	4.00	7.00	5.96	.63
Beliefs after exposure 1	110	4.60	7.00	6.12	.59
Beliefs after exposure 2	110	4.60	7.00	6.01	.58
Beliefs after exposure 3	110	4.20	7.00	6.11	.58
Beliefs after exposure 4	110	4.80	7.00	6.16	.56

Beliefs after exposure 5	110	4.80	7.00	6.18	.56
Beliefs after exposure 6	110	4.80	7.00	6.20	.54
Private intentions before exposure	110	2.33	7.00	5.95	.68
Private intentions after exposure 1	110	2.67	7.00	6.06	.68
Private intentions after exposure 2	110	2.67	7.00	6.07	.66
Private intentions after exposure 3	110	2.67	7.00	6.05	.68
Private intentions after exposure 4	110	2.67	7.00	6.08	.67
Private intentions after exposure 5	110	2.67	7.00	6.08	.68
Private intentions after exposure 6	110	2.33	7.00	6.10	.63
Public intentions before exposure	110	2.60	7.00	5.45	.82
Public intentions after exposure 1	110	3.20	7.00	5.61	.76
Public intentions after exposure 2	110	3.20	7.00	5.59	.75
Public intentions after exposure 3	110	3.20	7.00	5.60	.76
Public intentions after exposure 4	110	3.20	7.00	5.60	.74
Public intentions after exposure 5	110	3.20	7.00	5.61	.75
Public intentions after exposure 6	110	3.00	6.80	5.63	.76

Section 4.3.6 Results for Hypothesis One

Hypothesis 1 posited that as the number of repeated exposures increases, there would initially be an increase followed by a decrease in climate change beliefs, attitudes, and both private and public pro-environmental behavioral intentions across all three framing conditions. To test this hypothesis, tables detailing the mean values for each variable within each condition at different exposures and time plots of mean responses were presented to demonstrate the

overall trends visually. In time plots of mean responses, straight lines joined successive points to illustrate the trend over time. When multiple conditions were involved, as in this dissertation, this strategy was carried out separately for each condition. By overlaying these separate time plots, evaluating possible differences in means between the conditions became straightforward. Consequently, this provided direct insight into which exposure yielded the maximum effect for each condition and how each condition's climate change outcomes evolved with increased exposure.

The time plots of mean responses and tables of summary statistics for each variable effectively illustrated the cumulative effect of repeated exposures across all framing conditions in Figures 4 to 7 and Tables 14 to 16. Contrary to Hypothesis 1, the results revealed that nearly all outcomes across each condition did not exhibit the anticipated pattern of increase followed by decrease (i.e., the inverted U-shaped). Instead, the outcomes were predominantly cumulative, with trends showing generally consistent growth in response to repeated exposures. While certain outcomes experienced a temporary decline or plateau in early exposures before resuming an upward trajectory (e.g., climate change beliefs and public pro-environmental behavioral intentions), the general pattern across six exposures indicated increased measured outcomes within each condition, not supporting Hypothesis 1 for the inverted U-shaped curves.

Table 16

Descriptive Statistics for Climate Change Outcomes Across Exposures in Mixed-Framing Condition

Variable	N	Min	Max	Mean	SD
Attitudes before exposure	111	3.50	6.75	5.45	.69
Attitudes after exposure 1	111	2.50	7.00	5.61	.75

Attitudes after exposure 2	111	4.00	6.75	5.81	.60
Attitudes after exposure 3	111	4.00	7.00	5.87	.59
Attitudes after exposure 4	111	4.25	7.00	5.97	.54
Attitudes after exposure 5	111	4.25	7.00	6.03	.53
Attitudes after exposure 6	111	4.25	7.00	6.09	.54
Beliefs before exposure	111	3.00	7.00	5.97	.62
Beliefs after exposure 1	111	4.60	7.00	6.09	.57
Beliefs after exposure 2	111	4.80	7.00	6.05	.54
Beliefs after exposure 3	111	4.40	7.00	6.15	.55
Beliefs after exposure 4	111	5.00	7.00	6.19	.53
Beliefs after exposure 5	111	5.00	7.00	6.23	.54
Beliefs after exposure 6	111	4.80	7.00	6.28	.53
Private intentions before exposure	111	4.00	7.00	5.94	.72
Private intentions after exposure 1	111	4.33	7.00	6.08	.67
Private intentions after exposure 2	111	4.33	7.00	6.11	.67
Private intentions after exposure 3	111	4.33	7.00	6.12	.62
Private intentions after exposure 4	111	4.67	7.00	6.14	.61
Private intentions after exposure 5	111	4.67	7.00	6.17	.48
Private intentions after exposure 6	111	4.67	7.00	6.20	.49
Public intentions before exposure	111	3.40	7.00	5.48	.80
Public intentions after exposure 1	111	3.40	7.00	5.67	.80
Public intentions after exposure 2	111	3.80	7.00	5.66	.66
Public intentions after exposure 3	111	3.80	7.00	5.67	.68

Public intentions after exposure 4	111	3.80	7.00	5.69	.67
Public intentions after exposure 5	111	3.80	7.00	5.71	.67
Public intentions after exposure 6	111	3.80	7.00	5.78	.63

Figure 4

Time Plot of Mean Responses for Climate Change Beliefs

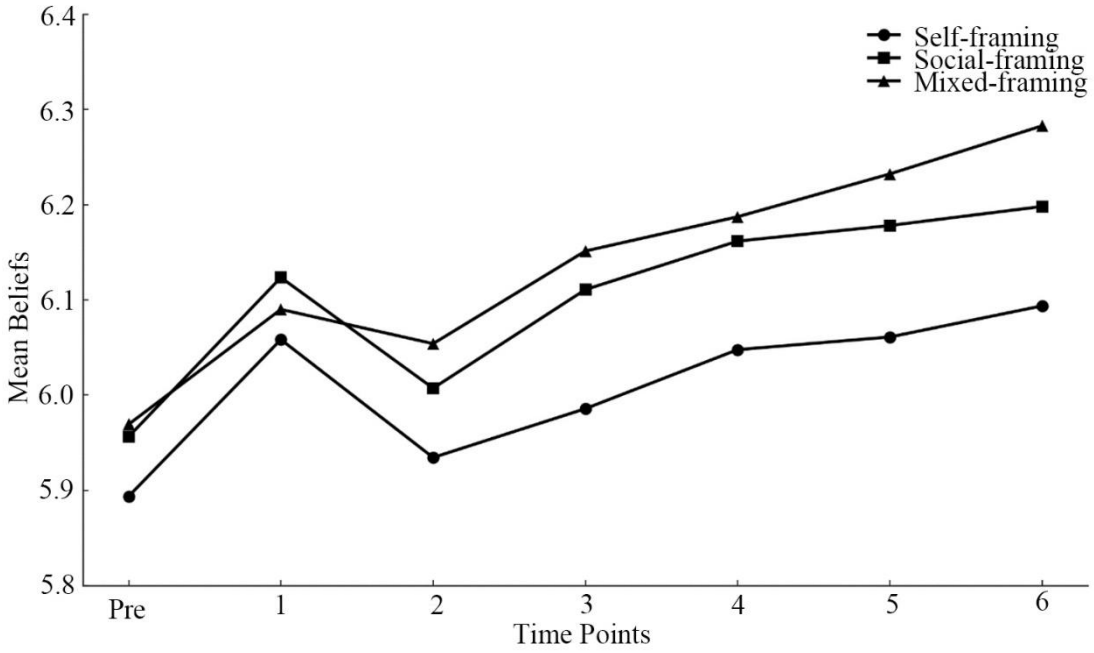


Figure 5

Time Plot of Mean Responses for Climate Change Attitudes

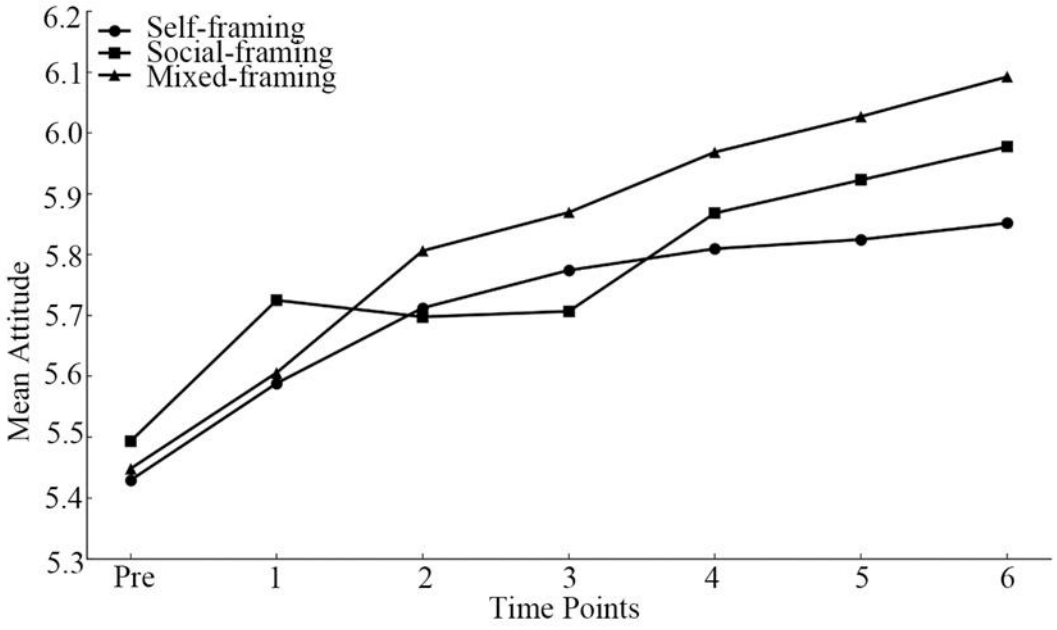


Figure 6

Time Plot of Mean Responses for Private Pro-environmental Intentions

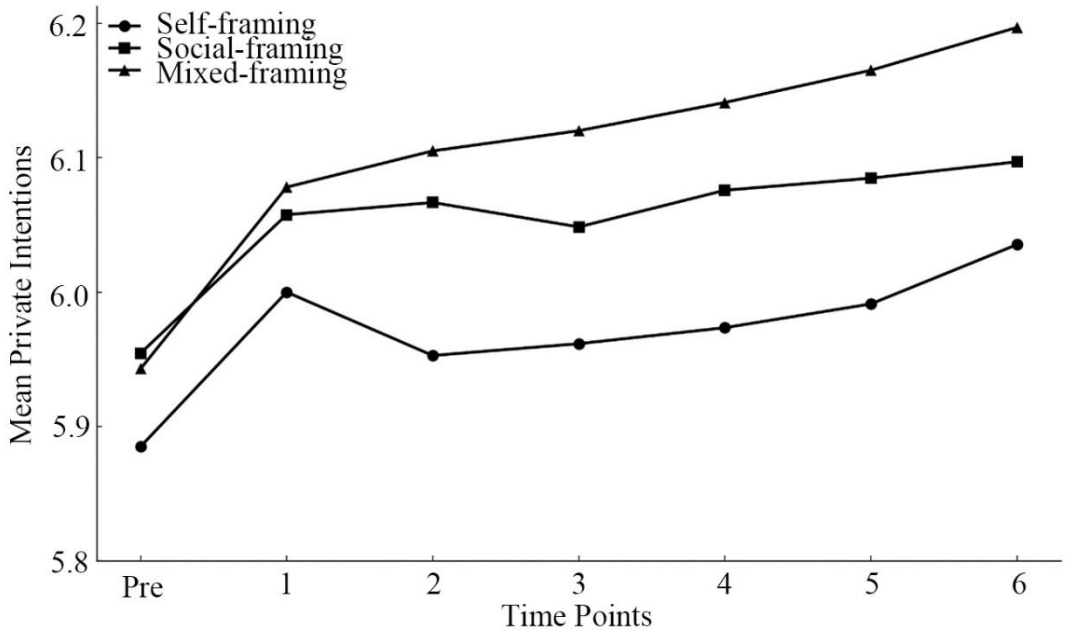
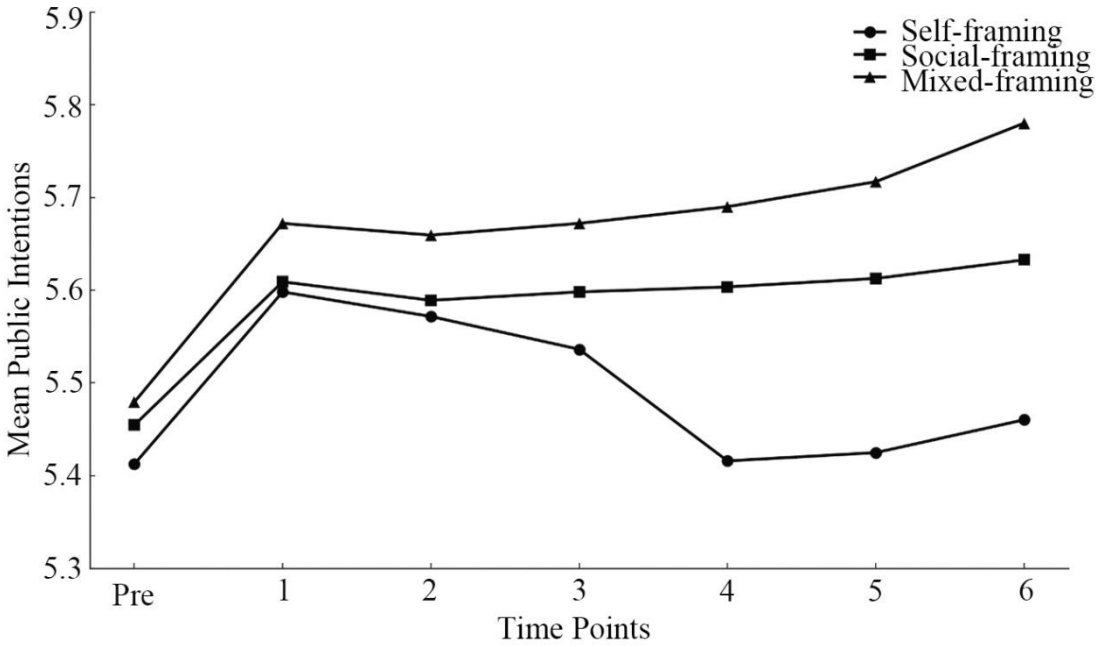


Figure 7

Time Plot of Mean Responses for Public Pro-environmental Intentions



Section 4.2.7 Results for Research Question Three

Research Question three sought to determine which messaging frame—self-framing or social-framing—leads to stronger outcomes in climate change beliefs, attitudes, and private and public pro-environmental behavioral intentions when individuals in each framing condition reach their highest response levels. Utilizing the data already analyzed for hypothesis one, which included figures and tables for each variable across all conditions, it was observed that except for the social-framing condition's public pro-environmental behavioral intentions peaking after the first exposure, all other outcomes in all conditions reached their highest point at the sixth exposure.

Independent t-tests were conducted for each outcome to directly compare which frame condition produced stronger outcomes at these peak points, comparing the self-framing and social-framing conditions at the sixth exposure. Levene's tests for homoscedasticity (i.e.,

homogeneity of variance) were conducted for all climate change outcomes, and the results confirmed that the assumption of homoscedasticity was not violated. Therefore, student's t-tests were applied (Karim et al., 2023). Consistency was maintained by using the values from the sixth exposure for public pro-environmental behavioral intentions because only the social-framing condition's public pro-environmental behavioral intentions peaked after the first exposure. The results of these t-tests and condition means are presented in Tables 15, 16, and 17.

Table 17

T-tests Results for All Climate Change Outcomes

	T value	DF	Pr > |t|
Attitudes	-1.474	221	.142
Beliefs	-1.414	221	.159
Private Intentions	-.735	221	.463
Public Intentions	-1.790	221	.075

Results reveal that there were no significant differences between the self-framing and social-framing conditions at the point of maximum impact (i.e., sixth exposure for most variables). However, there was a tendency for the social-framing condition to achieve slightly higher means than the self-framing condition in all variables, as shown in Figures 2 to 5 and Tables 15 and 16, although these differences were not statistically significant.

Section 4.2.8 Results for Research Question Four

Research Question four, which inquired which frame condition—self-framing or social-framing—results in stronger climate change beliefs, attitudes, and pro-environmental behavioral

intentions after six repeated exposures, was inherently addressed by the findings from Research Question three. The findings suggested that social-framing tends to yield marginally higher outcomes at the peak response level, but the differences between self- and social-framing climate change messaging are not statistically significant. This finding indicated that both framing approaches effectively enhanced climate change communication outcomes after repeated exposures, with no clear superiority of one framing over the other in generating stronger beliefs, attitudes, or pro-environmental intentions for six exposures.

Section 4.2.9 Results for Research Question Five

Research Question five examined whether there were significant differences in message fatigue between participants exposed to mixed-framing messages compared to only self-framing and social-framing messages. To answer this question, mean values of message fatigue for different framing conditions before the first exposure and after six exposures were presented in Table 18, and one-way independent ANOVA was conducted for message fatigue, comparing the values of message fatigue in the self-framing, social-framing, and mixed-framing conditions after the six exposures.

Table 18

Mean Statistics for Message Fatigue in Different Conditions before and after Six Exposures

	N	Mean	SD	SE
Self-framing pre-exposure	113	3.19	1.06	.10
Self-framing after six exposures	113	3.50	.67	.06
Social-framing pre-exposure	110	3.20	.96	.09
Social-framing after six exposures	110	3.46	.76	.07
Mixed-framing pre-exposure	111	3.15	.92	.09

Mixed-framing after six exposures	111	3.46	.89	.09
Total pre-exposure	334	3.18	.98	.05
Total after six exposures	334	3.47	.78	.04

ANOVA test showed no significant differences among three message fatigue conditions after six exposures (F (2, 331) = .062, p = .903). Compared with message fatigue values before the first exposures, all three conditions experienced an increase in message fatigue after six exposures, as shown in Table 18. Although message fatigue in the mixed-framing condition was slightly lower than in the self-framing and social-framing conditions, there were no significant condition differences after six exposures for message fatigue.

Section 4.2.10 Results for Hypothesis Two

Hypothesis two posited that the mixed use of both self- and social-framing messages would lead to higher values for climate change beliefs, attitudes, and private and public pro-environmental behavioral intentions after six exposures compared to conditions exposed to only one type of framing repeatedly. The two-way ANOVA test, followed by post hoc analysis using the Least Significant Difference (LSD) post hoc tests, was employed to assess this hypothesis across all climate change outcomes in Tables 19 to 21.

Table 19

Mean Values for Climate Change Outcomes after Exposure 6 in All Three Conditions

		N	Mean	SD	SE
Attitudes	Self	113	5.85	.64	.06
	Social	110	5.98	.62	.05

	Mixed	111	6.09	.54	.05
	Total	334	5.97	.61	.03
Beliefs	Self	113	6.09	.55	.05
	Social	110	6.20	.54	.05
	Mixed	111	6.28	.53	.05
	Total	334	6.19	.54	.03
Private intentions	Self	113	6.04	.62	.05
	Social	110	6.10	.62	.05
	Mixed	111	6.20	.48	.04
	Total	334	6.11	.58	.03
Public intentions	Self	113	5.46	.68	.06
	Social	110	5.63	.75	.07
	Mixed	111	5.78	.64	.06
	Total	334	5.62	.71	.03

Table 20

Two-way ANOVA results for Climate Change Outcomes after Exposure 6 in All Three Conditions

		Sum of squares	DF	Mean square	F value	P value
Attitudes	Between conditions	3.24	2	1.62	4.43	.013
	Within conditions	121.26	331	.37		

	Total	124.50	333			
Beliefs	Between conditions	2.01	2	1.01	3.38	.035
	Within conditions	98.40	331	.30		
	Total	100.41	333			
Private intentions	Between conditions	1.48	2	.74	2.18	.114
	Within conditions	112.71	331	.34		
	Total	114.19	333			
Public intentions	Between conditions	5.74	2	2.87	5.92	.003
	Within conditions	160.74	331	.49		
	Total	166.49	333			

Table 21

Multiple Comparison Results for Climate Change Outcomes after Exposure 6 in All Three Conditions

			Mean Difference	SE	P value
Attitudes	Self	Social	-.13	.08	.123
		Mixed	-.24	.08	.003

	Social	Self	.13	.08	.123
		Mixed	-.12	.08	.159
	Mixed	Self	.24	.08	.003
		Social	.12	.08	.159
Beliefs	Self	Social	-.10	.07	.154
		Mixed	-.19	.07	.010
	Social	Self	.10	.07	.154
		Mixed	-.08	.07	.249
	Mixed	Self	.19	.07	.010
		Social	.08	.07	.249
Private intentions	Self	Social	-.06	.08	.431
		Mixed	-.16	.08	.039
	Social	Self	.06	.08	.431
		Mixed	-.10	.08	.204
	Mixed	Self	.16	.08	.039
		Social	.10	.08	.204
Public intentions	Self	Social	-.17	.09	.065
		Mixed	-.32	.09	.001
	Social	Self	.17	.09	.065
		Mixed	-.15	.09	.117
	Mixed	Self	.32	.09	.001
		Social	.15	.09	.117

The ANOVA and subsequent post hoc analyses provided a detailed comparison across the self-framing, social-framing, and mixed-framing conditions at the sixth exposure, which was identified as the peak for most climate change outcomes. Notably, the mixed-framing condition consistently exhibited the highest mean values across nearly all variables at this point.

The results lend partial support to Hypothesis two, indicating that a mixed-framing approach—leveraging both self- and social-framing messages—more effectively enhanced climate change beliefs, attitudes, and pro-environmental intentions compared to singular framing strategies. However, it is crucial to note that while the mixed-framing condition often exhibited the highest values among the three conditions, these outcomes were statistically significant compared to the self-framing condition in most cases but did not consistently show statistical significance when compared to the social-framing condition across all variables.

Section 4.3.11 Results for Research Question Six

Research Question six asked how pro-environmental self-identity moderated the relationship between repeated exposure to different frames (i.e., self, social, or mixed framing conditions) and climate change outcomes after six exposures. A two-way ANOVA was conducted to address this question. The results in Table 22 demonstrated that pro-environmental self-identity had a significant main effect on all outcomes, indicating that individuals with a higher pro-environmental self-identity are more likely to exhibit higher outcomes following six exposures.

However, except for private pro-environmental behavioral intentions, there was no significant interaction effect between identity and the different framing strategies for other outcomes. This lack of interaction suggests that while pro-environmental self-identity independently influenced the outcomes, it did not differentially affect the impact of self- versus

social-framing on these outcomes. In other words, regardless of whether messages are self-framed or social-framed, an individual's pro-environmental self-identity predicted higher outcomes, except for private pro-environmental intentions.

Table 22

Two-way ANOVA Results for Pro-environmental Self-identity after Exposure 6 in All Three Conditions

Source	Dependent variable	Sum of squares	df	Mean square	F	P value
Corrected model	Attitudes	31.36	45	.69	2.15	.000
	Beliefs	21.87	45	.48	1.78	.003
	Private intentions	32.54	45	.72	2.55	.000
	Public intentions	42.48	45	.94	2.19	.000
Intercept	Attitudes	5124.19	1	5124.19	15844.24	.000
	Beliefs	5578.84	1	5578.84	20457.26	.000
	Private intentions	5536.34	1	5536.34	19526.66	.000
	Public intentions	4731.14	1	4731.14	10987.57	.000
Condition	Attitudes	1.75	2	.87	2.71	.068
	Beliefs	.34	2	.17	.63	.531
	Private intentions	.64	2	.32	1.14	.321
	Public intentions	2.91	2	1.45	3.38	.035

Identity	Attitudes	17.89	15	1.19	3.68	.000
	Beliefs	13.18	15	.87	3.22	.000
	Private intentions	20.27	15	1.35	4.76	.000
	Public intentions	22.91	15	1.52	3.54	.000
Interaction	Attitudes	9.69	28	.34	1.07	.373
	Beliefs	8.60	28	.30	1.12	.305
	Private intentions	13.01	28	.46	1.63	.025
	Public intentions	13.30	28	.47	1.10	.333
Error	Attitudes	93.14	288	.32		
	Beliefs	78.54	288	.27		
	Private intentions	81.65	288	.28		
	Public intentions	124.01	288	.43		
Total	Attitudes	12040.75	334			
	Beliefs	12902.20	334			
	Private intentions	12580.59	334			
	Public intentions	10728.280	334			

Section 4.3.12 Results for Hypotheses Three to Five

Hypotheses three to five collectively proposed that the level of situational activity on climate change (i.e., nonpublic, latent public, aware public, and active public) would influence various communicative behaviors and climate change outcomes. As discussed in the literature review section, the summation method proposed by Kim (2011) was employed. This method involves segmenting the entire sample based on three situational variables (i.e., problem recognition, involvement recognition, and constraint recognition).

In this dissertation, participants were segmented using three situational variables measured on a 6-point Likert scale (Kim, 2011). The scale's midpoint, which was 3.5, serves as the cut-off point for re-coding each variable into high (=1) and low (=0) categories. For example, a participant with a rating of 5 for problem recognition, 4 for involvement recognition, and 3 for constraint recognition would have their responses recorded as high (=1), high (=1), and low (=1), respectively. Constraint recognition was reversed in coding so that a low score aligns with high activity. These recorded values were then summed, resulting in a score ranging from 0 to 3. This sum categorized participants as one of four publics: nonpublic (0), latent public (1), aware public (2), or active public (3). Specifically, nonpublics were those who perceived they were not facing a problematic situation. Latent publics were those who perceived a problem but had minimal involvement with the problem. Aware publics were aware of the problem, but due to high constraint recognition or low involvement, they did not want to act actively toward addressing this problem. Finally, active publics recognized a problem, had low constraint recognition, and had high involvement (i.e., the problem is highly related to themselves) (Kim, 2011; Kim & Grunig, 2011; Kim et al., 2014).

Participants were categorized into four distinct publics, as shown in Table 23. Using one-way ANOVA and examining the mean values across these publics for each climate change outcome, significant differences were observed in communicative behaviors and climate change outcomes among different publics, as shown in Tables 24 and 25.

Table 23

Proportions of Different Publics in All Three Conditions

		Frequency	Percent	Cumulative Percent
Public types	Nonpublic	21	6.3	6.3
	Latent public	45	13.5	19.8
	Aware public	90	26.9	46.7
	Active public	178	53.3	100.0
	Total	334	100.0	

Table 24

Mean Statistics for Different Publics in All Three Conditions

		N	Mean	SD
Information seeking	Nonpublic	21	3.13	1.52
	Latent public	45	3.91	1.37
	Aware public	90	4.39	1.46
	Active public	178	4.71	1.18
	Total	334	4.42	1.37
Information attending	Nonpublic	21	4.38	1.17
	Latent public	45	5.15	.72

	Aware public	90	5.44	.84
	Active public	178	5.70	.68
	Total	334	5.47	.84
Information permitting	Nonpublic	21	4.560	.93
	Latent public	45	4.97	.96
	Aware public	90	5.06	.85
	Active public	178	5.35	.76
	Total	334	5.17	.85
Information sharing	Nonpublic	21	2.86	1.20
	Latent public	45	2.93	1.21
	Aware public	90	3.74	1.45
	Active public	178	3.77	1.29
	Total	334	3.59	1.36
Information forefending	Nonpublic	21	3.90	1.31
	Latent public	45	4.38	1.01
	Aware public	90	4.59	1.15
	Active public	178	4.81	.98
	Total	334	4.63	1.08
Information forwarding	Nonpublic	21	2.79	1.43
	Latent public	45	3.41	1.29
	Aware public	90	3.82	1.21
	Active public	178	4.26	1.17
	Total	334	3.93	1.28

Information omission	Nonpublic	21	2.59	.96
	Latent public	45	2.57	.96
	Aware public	90	2.04	.69
	Active public	178	1.90	.61
	Total	334	2.07	.75
Information avoidance	Nonpublic	21	3.13	.73
	Latent public	45	2.97	.73
	Aware public	90	2.53	.64
	Active public	178	2.36	.58
	Total	334	2.54	.67
Attitudes	Nonpublic	21	4.49	1.04
	Latent public	45	4.95	.80
	Aware public	90	5.47	.66
	Active public	178	5.68	.57
	Total	334	5.45	.75
Beliefs	Nonpublic	21	5.64	.56
	Latent public	45	5.65	.80
	Aware public	90	5.97	.62
	Active public	178	6.02	.53
	Total	334	5.93	.61
Private intentions	Nonpublic	21	5.28	1.05
	Latent public	45	5.69	.77
	Aware public	90	5.90	.75

	Active public	178	6.07	.58
	Total	334	5.92	.72
Public intentions	Nonpublic	21	4.80	.95
	Latent public	45	5.21	.82
	Aware public	90	5.40	.76
	Active public	178	5.60	.70
	Total	334	5.44	.78

Table 25

One-way ANOVA Results for Different Publics in All Three Conditions

		Sum of squares	DF	Mean square	F value	P value
Information seeking	Between conditions	62.00	3	20.66	11.96	.000
	Within conditions	570.03	330	1.72		
	Total	632.04	333			
Information attending	Between conditions	38.91	3	12.97	21.60	.000
	Within conditions	198.11	330	.60		
	Total	237.03	333			
	Between	15.34	3	5.11	7.44	.000

	conditions					
	Within conditions	226.92	330	.68		
	Total	242.27	333			
Information permitting	Between conditions	38.60	3	12.86	7.30	.000
	Within conditions	581.52	330	1.76		
	Total	620.12	333			
Information sharing	Between conditions	19.49	3	6.49	5.76	.001
	Within conditions	372.03	330	1.12		
	Total	391.52	333			
Information forefending	Between conditions	59.73	3	19.91	13.41	.000
	Within conditions	489.72	330	1.48		
	Total	549.45	333			
	Between conditions	22.19	3	7.39	14.53	.000
	Within conditions	167.93	330	.50		

	Total	190.12	333			
	Between conditions	21.60	3	7.20	18.32	.000
	Within conditions	129.68	330	.39		
	Total	151.28	333			
Information forwarding	Between conditions	40.94	3	13.64	30.21	.000
	Within conditions	149.05	330	.452		
	Total	189.99	333			
	Between conditions	6.88	3	2.29	6.27	.000
	Within conditions	120.57	330	.365		
	Total	127.45	333			
Information omission	Between conditions	14.76	3	4.92	10.10	.000
	Within conditions	160.68	330	.48		
	Total	175.44	333			
	Between conditions	15.79	3	5.26	9.24	.000

	Within conditions	188.01	330	.57
	Total	203.81	333	

Overall, the results supported hypotheses three to five, demonstrating that the level of situational activity significantly influenced how individuals engaged with information related to climate change and their beliefs, attitudes, and intentions toward addressing climate change. Specifically, being part of an active public correlated with higher engagement in positive communicative behaviors and lower engagement in information avoidance and omission, alongside stronger climate change beliefs, attitudes, and pro-environmental intentions.

Section 4.3.13 Results for Research Question Seven

Research Question seven explored how the effects of repeated exposures to self- and social-framing messages on key outcomes—specifically, climate change beliefs, attitudes, and private and public pro-environmental behavioral intentions—vary among different publics (nonpublic, latent public, aware public, active public) after six exposures. Two-way ANOVAs were conducted to test for the interaction effects between framing conditions and types of public on these climate change outcomes after the specified exposures in Table 26.

Table 26

Two-way ANOVA Results for Different Publics in Different Conditions

Source	Dependent variable	Sum of squares	DF	Mean square	F value	P value
Corrected model	Attitudes	28.54	11	2.59	8.70	.000
	Beliefs	7.99	11	.72	2.53	.004

	Private intentions	14.69	11	1.33	4.32	.000
	Public intentions	23.37	11	2.12	4.78	.000
Intercept	Attitudes	5676.02	1	5676.02	19045.24	.000
	Beliefs	6378.57	1	6378.57	22224.88	.000
	Private intentions	6024.25	1	6024.25	19494.53	.000
	Public intentions	5031.88	1	5031.88	11320.50	.000
Condition	Attitudes	3.08	2	1.54	5.16	.006
	Beliefs	.46	2	.23	.80	.449
	Private intentions	.97	2	.48	1.57	.209
	Public intentions	1.52	2	.76	1.72	.181
Type	Attitudes	18.67	3	6.22	20.89	.000
	Beliefs	3.79	3	1.26	4.41	.005
	Private intentions	11.70	3	3.90	12.62	.000
	Public intentions	14.85	3	4.95	11.13	.000
Interaction	Attitudes	2.66	6	.44	1.49	.181

	Beliefs	2.24	6	.37	1.30	.254
	Private intentions	2.90	6	.48	1.56	.157
	Public intentions	2.80	6	.46	1.05	.392
Error	Attitudes	95.96	322	.29		
	Beliefs	92.41	322	.28		
	Private intentions	99.50	322	.30		
	Public intentions	143.12	322	.44		
Total	Attitudes	12040.75	334			
	Beliefs	12902.20	334			
	Private intentions	12580.59	334			
	Public intentions	10728.28	334			

The analysis did not reveal significant interaction effects between framing conditions and types of publics across all climate change outcomes. This finding indicates that the different framing of messages did not interact with the types of publics to produce distinct changes in climate change outcomes after six exposures.

Section 4.3.14 Results for Research Question Eight

Research Question eight explored the impact of six repeated exposures to climate change messaging on the composition of different publics (i.e., nonpublic, latent public, aware public, active public). To address this research question, participants were segmented twice based on their responses to the three situational variables before and after all exposures to climate change messaging. Initially, participants were categorized into one of the four publics using their pre-experiment measurements of the three situational variables, with a separate segmentation for each experimental condition. These segmented publics were then designated as different categorical variables. Subsequently, after six exposures to climate change messages, the same segmentation process was repeated using the post-exposure measurements of the three situational variables. Finally, descriptive statistics were presented to track the proportional changes in each type of publics for each framing condition, and McNemar-Bowker Chi-square tests were performed to check if these proportional changes were statistically significant before and after six exposures with paired sample.

The findings in Table 27 revealed significant shifts in public segments after the six exposures in all conditions. Specifically, there was a decrease in the nonpublic group from 6.3% to 3.6%, and the latent public group saw a reduction from 13.5% to 4.8%. Meanwhile, the aware public group decreased from 26.9% to 18.6%. Most notably, the active public group experienced a substantial increase, rising from 53.3% to 73.1%. McNemar-Bowker Chi-square tests in Table 28 verified a statistically significant association between the time points (i.e., before and after exposures) and public segmentation. This finding indicates that the changes in public segmentation before and after six exposures were statistically significant. Then, shifts in public

segments after the six exposures in each framing condition were compared in the following subsections.

Table 27

Proportional Changes in Types of Publics in All Framing Conditions

	Before exposure	Percent	Cumulative percent	After six exposures	Percent	Cumulative percent
Nonpublic	21	6.3	6.3	12	3.6	3.6
Latent public	45	13.5	19.8	16	4.8	8.4
Aware public	90	26.9	46.7	62	18.6	26.9
Active public	178	53.3	100.0	255	73.1	100.0
Total	334	100.0		334	100.0	

Table 28

McNemar-Bowker Chi-square Tests for Proportional Changes in Types of Publics in All Framing Conditions

	Value	DF	P value
McNemar-Bowker Test	52.85	6	.000

Self-framing Condition. The findings in Table 29 revealed significant shifts in public segments after the six exposures in the self-framing condition. Specifically, there was a decrease

in the nonpublic group from 9.7% to 5.3%, and the latent public group saw a reduction from 13.3% to 3.5%. Meanwhile, the aware public group decreased from 26.5% to 19.5%. Most notably, the active public group experienced a substantial increase, rising from 50.4% to 71.7%. McNemar-Bowker Chi-square tests in Table 30 verified a statistically significant association between the time points (i.e., before and after exposures) and public segmentation in the self-framing condition. This finding indicated that the changes in public segmentation before and after six exposures were statistically significant in the self-framing condition.

Table 29

Proportional Changes in Types of Publics in Self-framing Condition

	Before exposure	Percent	Cumulative percent	After six exposures	Percent	Cumulative percent
Nonpublic	11	9.7	9.7	6	5.3	5.3
Latent public	15	13.3	23.0	4	3.5	8.8
Aware public	30	26.5	49.6	22	19.5	28.3
Active public	57	50.4	100.0	81	71.7	100.0
Total	113	100.0		113	100.0	

Table 30

McNemar-Bowker Chi-square *Tests for Proportional Changes in Types of Publics in Self-framing Conditions*

	Value	df	P value
McNemar-Bowker Test	22.13	6	.001

Social-framing Condition. The findings in Table 31 revealed significant shifts in public segments after six exposures in the social-framing condition. Specifically, there was a decrease in the nonpublic group from 4.5% to 3.6%, and the latent public group saw a reduction from 13.6% to 5.5%. Meanwhile, the aware public group decreased from 25.5% to 19.1%. Most notably, the active public group experienced a substantial increase, rising from 56.4% to 71.8%. McNemar-Bowker Chi-square tests in Table 32 verified a statistically significant association between the time points (i.e., before and after exposures) and public segmentation in the social-framing condition. This finding indicated that the changes in public segmentation before and after six exposures were statistically significant in the social-framing condition.

Table 31

Proportional Changes in Types of Publics in Social-framing Condition

	Before exposure	Percent	Cumulative Percent	After six exposures	Percent	Cumulative Percent
Nonpublic	5	4.5	4.5	4	3.6	3.6
Latent public	15	13.6	18.2	6	5.5	9.1
Aware public	28	25.5	43.6	21	19.1	28.2
Active public	62	56.4	100.0	79	71.8	100.0

Total	110	100.0	110	100.0

Table 32

McNemar-Bowker Chi-square *Tests for Proportional Changes in Types of Publics in Social-framing Conditions*

	Value	df	P value
McNemar-Bowker Tests	18.06	6	.006

Mixed-framing Condition. The findings in Table 33 revealed significant shifts in public segments after the six exposures in the social framing condition. Specifically, there was a decrease in the nonpublic group from 4.5% to 1.8%, and the latent public group saw a reduction from 13.5% to 5.4%. Meanwhile, the aware public group decreased from 28.5% to 17.1%. Most notably, the active public group experienced a substantial increase, rising from 53.2% to 75.7%. McNemar-Bowker Chi-square tests in Table 34 verified a statistically significant association between the time points (i.e., before and after exposures) and public segmentation in the mixed-framing condition. This finding indicated that the changes in public segmentation before and after six exposures were statistically significant in the mixed-framing condition.

Table 33

Proportional Changes in Types of Publics in Mixed Framing Condition

	Before exposure	Percent	Cumulative percent	After six exposures	Percent	Cumulative percent
Nonpublic	5	4.5	4.5	2	1.8	1.8

Latent public	15	13.5	18.0	6	5.4	7.2
Aware public	32	28.8	46.8	19	17.1	24.3
Active public	59	53.2	100.0	84	75.7	100.0
Total	111	100.0		111	100.0	

Table 34

McNemar-Bowker Chi-square Tests for Proportional Changes in Types of Publics in Mixed-framing Conditions

	Value	df	P value
McNemar-Bowker Tests	21.29	6	.002

Section 4.4 Summary

This chapter presents the characteristics of the final sample and details the analytical process and findings for each research question and hypothesis. In summary, repeated exposure to climate change messages indeed enhanced their persuasive effects. However, this increase did not follow the inverted-U model's predicted pattern of initial growth followed by a decline. Instead, there was a consistent overall upward trend, suggesting the need to reassess the model's application in climate contexts, at least for this study's sample. Furthermore, after six exposures, the mixed-framing condition slightly outperformed self- and social-framing conditions, indicating the potential benefits of diversified communication strategies. Situational activity

levels in climate change have also emerged as significant predictors of positive and negative communicative behaviors and outcomes, with more engaged individuals showing stronger beliefs, attitudes, and intentions. Lastly, the results identified that six exposures were sufficient to shift public segmentation, which was measured before the experiment, resulting in a greater percentage of individuals becoming more active in climate change issues.

The next discussion chapter elaborates on the implications of these findings by exploring the possible underlying reasons, how they compare with previous studies, and their impact on theory and practice. This final chapter also considers the contributions these results make towards future research and practices, setting the stage for enhanced strategies in repeated climate change communication in China.

Chapter 5 Discussion and Conclusion

Climate change poses an unprecedented threat to humanity, and China, the world's largest emitter of greenhouse gases, plays a crucial role in the global fight against this crisis. Recent data underscores the urgency. In August 2023, Beijing, the capital city of China, experienced its most prolonged heatwave on record, with temperatures soaring above 35°C for 27 consecutive days, surpassing the previous record set in 2000 (Reuters, 2024). This heatwave, along with other extreme weather events across the country, has had severe consequences for public health, agriculture, and the economy. As public awareness and engagement are critical to addressing climate change, effective communication strategies are essential. Therefore, this dissertation examines the impact of repeated exposure to self- and social-framing messages on climate change outcomes and public segmentations in China, offering theoretical and practical implications.

The data collection begins with a pilot experiment to validate the manipulation of climate change messages framed as either self- or social-focused, adapted from leading Chinese news outlets. The main study, a longitudinal between-subjects experiment, consisted of six separate exposures spaced three days apart. Chinese residents over 18 were randomly assigned to one of three conditions for six exposures: self-framing messages, social-framing messages, or a mix of both framing messages. The primary findings suggest that repeated exposures to framed messages generally increase climate change beliefs, attitudes, and pro-environmental behavioral intentions, with the mixed-framing condition showing the most promising results. Additionally, individuals' situational activity on climate change predicts their communicative behaviors and climate change outcomes, regardless of the framing condition. Also, repeated messages can change the types of publics over time.

This chapter first synthesizes and interprets the dissertation's key findings, including drawing connections to prior research on climate change communication and STOPS literature. Then, this chapter illustrates the dissertation's theoretical and practical implications for climate change communication and public relations. This chapter concludes with a discussion of the dissertation's limitations and recommendations for future research to understand further repeated message strategies to combat climate change in China. Figure 3 is again presented on the next page to reference all research questions, hypotheses, and findings.

Figure 3

Summary of Hypotheses and Research Questions and Findings

H or RQ	Content	Supported or not	Summary
Research Question 1	Is the interaction between time and group significant in affecting climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	Repeated exposures do not exhibit significant interaction effects between time and condition on climate change outcomes.
Research Question 2	After how many exposures do the self- and social-framing conditions respectively reach their maximum impact on climate change outcomes, including climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	Both framing conditions tend to reach their peak on climate change outcomes after six exposures, while the only exception is public pro-environmental intentions in the self-framing condition, which reached the highest values after the first exposure.

Hypothesis 1	As the number of repeated exposure increases, there will first be an increase and then a decrease in climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions for all three conditions.	Not Supported	Most climate change outcomes show a consistent increase after repeated exposures rather than an initial increase followed by a decrease.
Research Question 3	When individuals in each framing condition reach their highest levels of belief in climate change, their most positive attitudes, and their strongest intentions for both private and public pro-environmental behaviors, which messaging frame—self-framing or social-framing climate change messaging—leads to stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	The self-framing and social-framing conditions show no significant differences in strengthening climate change beliefs, attitudes, and pro-environmental behavioral intentions at peak response levels (i.e., after six exposures).

Research Question 4	After six repeated exposures, individuals in which frame condition—self-framing or social-framing climate change messaging—result in stronger climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions?	N/A	The self-framing and social-framing conditions show no significant differences in terms of strengthening climate change beliefs, attitudes, and pro-environmental behavioral intentions after six exposures.
Research Question 5	After six exposures, are there significant differences in message fatigue between participants exposed to mixed-framing messages compared to only self-framing and social-framing messages?	N/A	Although message fatigue in the mixed-framing condition was slightly lower than in the self-framing and social-framing conditions, there were no significant differences after six exposures.
Hypothesis 2	Compared to conditions exposed to only one type of frame repeatedly, the mixed-use of both self- and	Partially Supported	After six exposures, mixed-framing messages lead to significantly higher

	social-framing messages will result in higher values for climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures.		values for climate change outcomes. However, the statistical analysis was only significant for comparing mixed-framing and self-framing conditions.
Research Question 6	How does pro-environmental self-identity moderate the relationship between repeated exposure to different framing messages and climate change outcomes, specifically in relation to climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions after six exposures?	N/A	Pro-environmental self-identity does not significantly interact with different framing strategies to affect climate change outcomes after six exposures, although it independently influences the climate change outcomes.
Hypothesis 3	The more situationally active individuals are on climate change, the more information forefending (a),	Supported	The level of situational activity on climate change significantly influences

	information permitting (b), information forwarding (c), information sharing (d), information seeking (e), information attending (f) they will engage in about climate change. Specifically, these information behaviors will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.		communicative behaviors, with higher activity levels correlating with more positive information behaviors.
Hypothesis 4	The more situationally active individuals are on climate change, the less information avoidance (a) and information omission (b) they will engage in about climate change. Specifically, these information behaviors will be the lowest in members of an active public, second in an aware public, third in a latent	Supported	The level of situational activity on climate change significantly influences passive communicative behaviors, with higher activity levels correlating with less information avoidance and omission.

	public, and last in a nonpublic, before the first exposure in all conditions.		
Hypothesis 5	The more situationally active individuals are on climate change, the higher climate change beliefs (a), climate change attitudes (b), and private (c) and public (d) pro-environmental behavioral intentions they will have about climate change. Specifically, these outcomes will be the highest in members of an active public, second in an aware public, third in a latent public, and last in a nonpublic, before the first exposure in all conditions.	Supported	The level of situational activity on climate change significantly influences climate change outcomes, with higher activity levels correlating with more positive climate change outcomes.
Research Question 7	How do the effects of repeated exposures to self- and social-framing messages on all outcomes, including climate change beliefs (a), climate change attitudes	N/A	Different framing conditions do not interact significantly with the type of publics to influence climate change

	(b), and private (c) and public (d) pro-environmental behavioral intentions, in three different framing conditions differ among various publics after six exposures?		outcomes after six exposures; individuals' type of publics predict outcomes independently of framing.
Research Question 8	To what extent, if any, will the overall proportion of each public change for each condition after six repeated exposures in each condition?	N/A	Six repeated exposures to climate change messaging significantly shift the overall proportion of each public in each condition, particularly increasing the proportion of the Active public.

Section 5.1 Discussion of Findings

This dissertation makes significant theoretical and practical contributions to climate change communication and public relations. Theoretically, this dissertation challenges the inverted U-shaped model, extends message convergence theory and the STOPS model, and addresses research gaps in climate change communication, such as the effectiveness of framing combinations. Practically, this dissertation demonstrates the potential of repeated exposure and mixed-framing strategies to enhance the impact of climate change communication and support current practices in risk communication. Also, the findings of this dissertation offer insights for developing targeted communication strategies based on public segmentation and suggest the potential for repeated message strategies to change public segment types actively. The following sections further discuss these primary contributions to theory and practice, grouped by seven primary findings. The following subsections discuss seven primary findings grouped by the relevancy of all research questions and hypotheses.

Section 5.1.1 Cumulative Effects of Repeated Exposures

This section explores the cumulative effects of repeated exposure to self- and social-framing messages on climate change outcomes in China. This section discusses the overall increasing trend in climate change outcomes, which does not support the inverted U-shaped model, along with potential explanations and implications for future research.

Hypothesis one examines whether the effects follow the curve suggested by the inverted U-shaped model with an initial increase in the impact on climate change outcomes followed by a decrease in both framing conditions (Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017). Research question two asks after how many exposures the self- and social-framing conditions, respectively, reach their maximum impact on climate change

outcomes. The findings reveal that contrary to prior research on the U-shaped model (Montoya & Horton, 2014; Montoya et al., 2017), each exposure significantly increases climate change outcomes in all three conditions, including climate change beliefs ($F = 16.06$, $p < .0001$), climate change attitudes ($F = 37.93$, $p < .0001$), private pro-environmental intentions ($F = 5.29$, $p < .0001$), and public pro-environmental intentions ($F = 8.7$, $p < .0001$), reaching their peak after six exposures, except for the public pro-environmental intentions in the self-framing condition, which peaks after the first exposure. Three potential explanations of an overall increasing curve and suggestions and implications for future research are discussed below in subsections.

Familiarity with Climate Change Issues. The first explanation for the overall increasing trends is the inherent nature of the climate change issue itself. In previous repeated exposure studies involving advertisements or other stimuli, it was commonly found that after three to four exposures, negative factors (i.e., redundancy or boredom) would outweigh positive factors (i.e., habituation and learning), leading to an initial increase followed by a decrease in positive attitudes and outcomes (Berlyne, 1970; Cacioppo & Petty, 1979; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017; Stang, 1975).

However, in contrast to these advertisements or other stimuli, people are generally quite familiar with the climate change issue, particularly in China (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). This familiarity may have made people accustomed to regularly encountering similar climate change information. The dissertation and previous research have also found that the frequency of people's exposure to climate change information is typically weekly or even daily in China (Duan & Miller, 2021; Han et al., 2017; Xie, 2015). In contrast, the stimuli used in previous advertising or psychological experiments might have had little relevance to people's lives, quickly causing negative factors to outweigh positive factors (Lu et

al., 2015; Montoya & Horton, 2014; Montoya et al., 2017). However, regarding the climate change issue, most people agree that it is a matter worthy of attention, regardless of their belief in the reality of climate change or the need for action to address it (Pan et al., 2021, 2023; Wang & Zhou, 2020). Therefore, the inherent nature of the climate change issue may be one of the main reasons for the lack of support for the inverted U-shaped model. Other risk topics, such as diseases that people are less familiar with, may yield different results (Lu et al., 2015; Kievik et al., 2020; Shi & Smith, 2016).

Experimental Design. Second, the dissertation's experimental design may have contributed to this overall increasing pattern, including the number of repetitions, the time intervals between repetitions, and the use of similar rather than identical messages. Using completely identical messages and shorter repetition intervals has been found to reduce the effectiveness of stimuli quickly (Montoya & Horton, 2014; Montoya et al., 2017; Shi & Smith, 2016). In this dissertation, the messages were similar and involved diverse message characteristics, such as statistical data, storytelling, and celebrity endorsements. The inclusion of diverse original message characteristics was to increase the external validity of stimuli while having strong interval validity by only manipulating self- and other-framing. This approach may have caused the accumulation of negative factors that did not reach the critical point necessary to reduce the impacts on climate change outcomes.

Suppose identical messages were used, with each framing strategy involving an identical self- or social-framing message and shorter time intervals, such as the 24-hour intervals used by Skurka et al. (2023). In that case, the effects might have been markedly different and potentially supportive of the inverted U-shaped model. Skurka et al. (2023) found small but significant effects through seven days of daily exposure to threatening messaging for a US adult sample,

with fear and intentions exhibiting curvilinear relationships with repeated exposure (i.e., increasing initially but plateauing around six exposures). The differences between their results and this dissertation may be attributed to the differences in population and experimental design, as Skurka et al.'s study design of daily exposures accelerated the emergence of negative factors. The differences in the messages should also be acknowledged, as Skurka et al. tested high and low levels of threatening messaging. Another possibility related to the experimental design is that a turning point might have been observed if more exposures were tested in this dissertation. For example, future research including ten exposures with a three-day time interval or six exposures spaced over 24 hours may lead to different patterns of repeated exposure effects on climate change outcomes in China.

Unique Characteristics of the Chinese Population. Third, the unique characteristics of the Chinese population may lead to an overall increase in repeated exposure to most climate change outcomes. First, previous research generally has found high levels of belief regarding climate change, and China has a culture that traditionally emphasizes respect for nature (Hou, 1997; Pan et al., 2021, 2022, 2023; Xu et al., 2022; Zeng, 2022). These findings are consistent with the various climate change outcomes observed in this study and may lead to a higher tolerance for repeated climate change information among Chinese participants (Hou, 1997; Pan et al., 2021, 2022; Xu et al., 2022). Consequently, no turning point in the communication effects was observed during the six exposures, and more exposures may surpass the tolerance. However, this tolerance may not extend to other types of messages or a greater number of exposures for other risk topics.

Therefore, the turning point likely depends on the nature of the issue, cultural contexts, population characteristics, and the study design (e.g., time intervals, message characteristics, and

the number of repetitions). Future research could further analyze these determinants to identify the optimal number of exposures, message strategies, characteristics, and time intervals for communicating climate change or other risk issues among different populations.

An Exception with Public Pro-environmental Intentions. Furthermore, this study found that while most outcomes gradually increased with exposure frequency, the only exception was public pro-environmental intentions in the self-framing condition, which reached the highest values after the first exposure. A possible reason for this exception could be that multiple exposures to information with only self-framing (i.e., information that emphasizes individual responsibility and the impact of climate change) may not contribute to participants' involvement in collective initiatives to confront environmental issues. These collective initiatives include active environmental citizenship activities, such as petitioning about environmental matters, joining, and contributing to environmental organizations, and endorsing or accepting public policies (Bergquist et al., 2023; Hornsey et al., 2016; Steg, 2023; Stern, 2000). Sections 5.1.2 and 5.1.3 discuss the effects of different framing strategies in more detail.

Conclusion. This section discusses the effects of self- and social-framing on climate change outcomes over repeated exposures in China. The findings do not support the inverted U-shaped model, showing a general increase in most outcomes, including climate change attitudes, beliefs, and private and public pro-environmental intentions, possibly due to the familiarity with the issue, the study design, and the unique characteristics of the Chinese population. Overall, repeated exposure significantly enhances framing impacts on most climate change outcomes. The following section discusses the lack of significant differences across framing conditions after each exposure.

Section 5.1.2 The Lack of Significant Differences After Each Exposure

Research question one assesses whether each exposure's effect is significant (i.e., time effects) and whether there is a difference in the extent of impact among each condition with each exposure (i.e., interaction effects). Results suggest repeated exposures do not exhibit significant interaction effects between time and condition on climate change outcomes. Moreover, each exposure significantly increases climate change outcomes, but the degree of increase does not differ between the conditions (i.e., self-framing and social-framing).

The Difference between Self-social Framing and Self-other Framing. Before comparing the current dissertation with previous single-exposure experiments, it is important to note that in the fields of climate change communication and environmentally sustainable behaviors, although many studies claim to investigate self-framing and other-framing, they often conceptualize these two framing conditions as the same as self- and social-framing conditions. As mentioned in a systematic review, these studies "often described an issue, outcome or object from a personal versus societal or environmental perspective or from an ingroup versus outgroup perspective" (Florence et al., 2022, p. 636). In essence, these studies examine self- and social-framing (e.g., Chen, 2019, 2020; De Dominicis et al., 2017; Florence et al., 2022; Green & Peloza, 2014; Kareklas et al., 2014; Schill & Shaw, 2016; Yocco et al., 2015). This study uses the exact definition of self- and social-framing as those of self-framing and other-framing climate change communication studies. Self-framing is defined as a strong emphasis on individual impacts, responsibilities, and actions, while social-framing denotes a strong emphasis on impacts, responsibilities, and actions relevant to groups, the environment, and society (Chen, 2019, 2020; De Dominicis et al., 2017; Florence et al., 2022).

True self-framing and other-framing studies (i.e., contrasting oneself with specifically other individuals, not including oneself) in climate change are rare and more commonly found in health communication contexts (Chen & Chen, 2023; Gillman et al., 2023; Huang & Li, 2023). Therefore, the self-other framing studies in the environmental communication field are essentially evaluating self- and social-framing approaches, making them comparable to the results of the current dissertation. In the future, these fields could benefit from more precise conceptualization, as self-social and self-other framing have inherently different conceptualizations. Moreover, future research could explore the potential differences between self-social and self-other framing in climate change communication, examining whether the effects observed in health communication contexts extend to environmental issues.

Three Possible Explanations. The finding in this dissertation that there are no significant differences between the two framing approaches at each exposure is unique compared to the findings of previous single-exposure experiments. This may be due to three possible reasons. First, most studies that found significant differences between the two framing approaches were not conducted in the Chinese context. As discussed earlier, the Chinese population has high levels of climate change beliefs, attitudes, and intentions (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). As a result, ceiling effects may occur (i.e., a measurement problem that limits the maximum level an individual can achieve on a test, resulting in a discrepancy between a person's test score and their true score or reality) (Chyung et al., 2020; Fries et al., 2011). This could lead to both self-framing and social-framing being highly effective at each exposure but without significant differences in their effectiveness. Suppose the individual's climate change beliefs, attitudes, and intentions were not initially high.

In that case, it is possible that the two different framing conditions could bring about significantly different effects at each exposure.

Another possibility is publication bias. Some single-exposure experimental studies conducted in China that compare self- and social-framing with null differences may not have been published. These studies may not have the opportunity for publication if they do not find significant differences between different conditions (Coburn & Vevea, 2015; Kepes et al., 2014) because most of the value of an experiment lies in comparing whether there are significant differences between different conditions, thereby generating contributions (Levy & Ellis, 2011; Sherman, 2003).

The third possibility is that the effects of these two framing approaches may differ, but a single exposure may not make a significant difference. The different effects may require more than one exposure to become statistically significant. This possibility is further discussed in the next section, along with the findings related to the subsequent research questions and hypotheses.

Comparison with Previous Research. The finding that each new exposure does not show a significant difference in persuasiveness across framing conditions compared to the last is unfavorable evidence for the distinctive effects of different framing conditions, meaning that a single exposure to different framing cannot make a difference. This finding differs from previous research that found significant differences in the impacts of self- and social-framing after a single exposure, not supporting the suggestion of construal level theory that different framing leads to various social distances, which in turn influences people's perceptions and intentions (Chang et al., 2015; Florence et al., 2022; Green & Peloza, 2014; Spence et al., 2012; Trope & Liberman, 2010). Similarly, Skurka et al. (2023) also found no significant interaction effect between

condition (i.e., high threatening and low threatening) and time in a longitudinal experiment on fear and intentions with repeated exposures to threatening messaging.

Most relevant single-exposure experimental studies that compared self- and social-framing approaches were not conducted in the Chinese context. However, regardless of the country in which the research was conducted, most of these studies found significant differences between the two framing approaches despite inconsistencies in their results. Some studies found that self-framing is more effective than social-framing on mitigation intentions (Bai et al., 2018; Bigsby et al., 2021; Chen et al., 2020; De Dominicis et al., 2017; Schill & Shaw, 2016; Singh et al., 2017), while others found that other-framing (i.e., social-framing) yields better results than self-framing (Chen, 2016; Florence et al., 2022; Geng et al., 2019; Jaeger & Weber, 2020; Ma et al., 2023; Yocco et al., 2015; Yu et al., 2017).

Only three climate change communication studies in China found no significant difference on mitigation intentions between these two framing conditions (Chen, 2019, 2020; Tan et al., 2023). However, two of these studies (Chen, 2019, 2020) did not manipulate the framing approaches; instead, both studies used self-reported survey results to measure the self-other frame, which might contribute to their lack of significant results. Tan et al. (2022) discovered that neither self nor social framing conditions could significantly predict donation behaviors with a Chinese adult sample in an experiment. The donation behavior was measured by giving participants 200 tokens (i.e., payment) and asking them the number of tokens they would like to donate to this foundation. They explained that one possible reason for this outcome is that donating may require a higher level of commitment than other pro-environmental behaviors, such as information seeking, sharing, and personal mitigation intentions.

Overall, these findings suggest that both self-framing and social-framing may be effective in the Chinese population for each exposure, and repeated exposure can significantly increase their impact. However, it may be unreasonable to expect that simply changing a few words (i.e., in this study, changing "you" to "our society" to create different framing conditions) and exposing these messages to individuals one time can result in significant differences in the effects on climate change outcomes. This expectation sometimes seems unreasonable and excessive, as individuals' views on complex matters such as climate change are inherently very complicated and involve numerous factors (Hornsey et al., 2016; Rode et al., 2021; Wang & Zhou, 2020).

Conclusion. While no significant differences were found between the two framing conditions at each exposure, possibly due to ceiling effects, publication bias, or the need for more exposures, the results suggest that both framing approaches can be effective in China. However, expecting significant differences from a single exposure to slightly modified messages may be unreasonable, given the complexity of factors influencing views on climate change. The following section discusses the findings on the effectiveness of the different framing approaches after six exposures.

Section 5.1.3 Comparing Different Framing' Effectiveness at the Peak Values

This section compares the effectiveness of different framing conditions at their peak values after six exposures. It reveals that mixed-framing, defined as using both self- and social-framing messages in a random sequence for six exposures in this dissertation, leads to significantly higher climate change outcomes than self-framing but not social-framing. Then, this section discusses potential explanations for these findings, including message convergence

theory and the construal level theory of psychological distance, along with implications for future research and practice.

Research questions three and four and hypothesis two collectively examine whether the outcomes of different framing conditions significantly differ after six exposures. The results reveal that the maximum values are attained after six exposures for most climate change outcomes. Specifically, after six exposures, mixed-framing messages lead to significantly higher values for climate change outcomes than self-framing but not social-framing.

Possible Explanations and Implications for Message Convergence Theory. These findings suggest that combining self- and social-framing elements in climate change communication through repeated exposure over time may be more effective than relying solely on self-framing. The superiority of mixed-framing over self-framing could be attributed to several factors. First, by incorporating personal and societal perspectives, mixed-framing messages may appeal to a broader range of motivations and values, resonating with a larger audience. Second, combining self- and social-framing elements may create a more comprehensive and persuasive argument, as it addresses the climate change issue's individual and collective aspects (Bergquist et al., 2023; Florence et al., 2022; Hornsey et al., 2016; Steg, 2023).

Third, message convergence theory may also help explain this finding. The theory posits that people make decisions on risks while being exposed to arguments from multiple sources on the same topic, and convergence occurs when messages from these sources overlap in ways recognized by observers, creating perceptions of credibility and influencing their risk decisions (Anthon & Sellnow, 2016; Anthony et al., 2013, 2017; Liu et al., 2020). Therefore, journalists

should emphasize or build convergence among reputable sources and introduce divergence when misunderstanding or lack of evidence has led to an unproductive perception of convergence.

The finding from this dissertation also suggests that convergence may be created by different sources and message framing through repeated exposures from the same source, contributing to message convergence theory. In this case, information about the personal impact and responsibility of climate change may converge with information about the societal impact and responsibility of climate change to enhance communication effectiveness, as different aspects of climate change's impact and responsibility lead to the same conclusion – the importance of protecting the environment. Future research could consider exploring the differential effects of messages with various characteristics, such as different narrative perspectives and types of evidence, and whether multiple exposures to these diverse messages from the same source and/or different sources may enhance credibility due to convergence, thereby influencing people's perceptions and intentions. This finding effectively extends message convergence theory in a new way (i.e., through the repeated combined use of different framing).

The Lack of Significant Difference between Mixed-framing and Social-framing. However, it is important to note that the lack of significant differences between the mixed-framing and social-framing conditions suggests that the effectiveness of these two approaches may be more similar than initially expected. This finding raises questions about the relative contributions of self- and social-framing elements in the mixed-framing condition and whether including self-framing content provides additional benefits over pure social-framing. Future research could further investigate the mechanisms underlying the effectiveness of mixed-framing messages and the optimal balance between self- and social-framing elements in these repeated

messages. Researchers can develop more targeted and efficient communication strategies for promoting climate change awareness and action by examining the specific components of mixed-framing that contribute to its persuasive power.

Although the mixed-framing condition did not significantly differ from the social-framing condition, results (see Figures 4 through 7 from pages 170 to 172) clearly show that for each climate change outcome, the values in the mixed-framing condition are consistently higher than those in the social-framing condition, albeit not to a statistically significant degree. In contrast, the values in the mixed-framing condition are significantly higher than those in the self-framing condition. As discussed in a previous section, it is possible that the gradually accumulating differences in effects could become significant after more exposures or with a larger sample size.

Practical Implications. The finding that mixed-framing is the most effective approach also echoes the finding from the previous section, where public pro-environmental intentions in the self-framing condition reached the highest values after the first exposure. Together, these findings suggest that information emphasizing both the societal and personal impacts and responsibilities of climate change is more suitable for combined use, which has implications for Journalists. It is encouraging to see that many current practices, such as those in risk communication, already employ a mixed approach by using diverse sources, different types of evidence, and non-identical information in China and beyond (Anthony et al., 2013, 2017; Guo et al., 2019; Liu et al., 2020; Xie, 2015).

The dissertation results offer empirical support for these existing practices, indicating that messages that complement each other in framing are effective. In the future, it will be necessary to continue using and finding more diverse message strategies and characteristics to create

convergence in climate change communication since this convergence is likely to create perceptions of credibility and influence individuals' risk decisions (Anthon & Sellnow, 2016; Duan & Miller, 2021; Han et al., 2017; Liu et al., 2020; Xie, 2015). However, as argued in the previous section and the last paragraph, we should not have overly high expectations for a single exposure. The effects of different framing messages should be examined more sustainably (e.g., through more exposures and combinations with other frames and strategies). The optimal number of exposures may also depend on factors such as the source, the event itself, and the cultural context.

Implications for Construal Level Theory of Psychological Distance. Combining the discussion from the previous section, the differences that various framing approaches can bring for each exposure may be relatively limited, but significant differences may emerge after multiple exposures. This finding represents a complement to, rather than a rejection of, the construal level theory of psychological distance (Florence et al., 2022; Green & Peloza, 2014; Liberman & Trope, 2008; Trope & Liberman, 2010). The findings from this dissertation effectively supplement the construal level theory of psychological distance by considering the repeated effects of framing. The lack of significant differences in the effects of different framing after a single exposure does not necessarily imply no differences in their effects. Their differences may likely be too small to detect after one exposure. Although the research findings did not reveal significant differences between self- and social-framing, observations from Figures 2 to 5 clearly show that after the sixth exposure, social-framing consistently results in higher climate change outcomes for each outcome compared to the self-framing condition. Therefore, more exposures or a larger sample size may be necessary for statistically significant differences to emerge between these two framing approaches after multiple exposures.

Future framing research based on the construal level theory of psychological distance should consider the dimension of repetition and its impact on the effects of different framing approaches. In the real world, most of the information we encounter is similar, and we do not encounter certain types of information only once (Diamond & Urbanski, 2022; Hassan & Barber, 2021; Lee, 2001; Lu et al., 2015; Lu, 2022; Montoya & Horton, 2014; Montoya et al., 2017; Schmidt, 2015). Investigating the framing effects of repeated messages on individuals' perceptions, beliefs, and intentions would be a fruitful direction for future research and practices (Diamond & Urbanski, 2022; Lu, 2022; So & Song, 2023).

Implication for the Combined Use of Opposing Framing Strategies. Moreover, the mixed-framing approach employed in this dissertation has significant implications for climate change framing research, addressing the lack of examination of the effects of the combined use of opposing framing strategies in the climate change messaging literature. Previous studies that investigated the mixing of different framing approaches did so by examining congruent combinations (e.g., negative paired with abstract-focused in one message; concrete paired with social-focused in one message) without the ability to test the mixed use of opposing message frames over time (Chen et al., 2020; Grazzini et al., 2018; Outcault et al., 2018; van den Broek et al., 2017; Wang et al., 2019; White et al., 2011; Wolske et al., 2018; Yang et al., 2015). This dissertation is the first to respond to the call from previous research (Diamond & Urbanski, 2022) by examining the mixing of framing approaches in a temporal sequence and discovering the significantly different effects of this approach. This type of mixing can complement real-world practice, where different framing approaches may be present within the same message, but messages with different framing approaches may also be seen over time.

Conclusion. This section examines the effectiveness of different framing conditions at their peak values. The superiority of mixed-framing over self-framing is attributed to its ability to appeal to a broader range of motivations and create a more comprehensive argument. Message convergence theory helps explain this finding and can be enriched by the evidence that convergence can be created by messages from different sources and message framing approaches from the same source. Although the mixed-framing approach did not significantly outperform the social-framing approach, the consistently higher values across all outcomes suggest that the mixed-framing approach may have unique advantages. The findings highlight the importance of considering the cumulative impact of repeated message exposures. This section also emphasizes the need for future research to consider the dimension of repetition in framing effects to extend the construal level theory of psychological distance. Lastly, the mixed-framing approach employed in this dissertation addresses a critical gap in climate change framing research by examining the combined use of opposing framing strategies over time, complementing real-world communication practices. The following section discusses the findings regarding message fatigue.

Section 5.1.4 Increase of Message Fatigue for All Framing Conditions

This section explores the differences in message fatigue between the mixed-framing, self-framing, and social-framing conditions after six exposures. It reveals that, although message fatigue was slightly lower in the mixed-framing condition, there were no significant differences across conditions. Then, potential explanations for these findings, including the context-dependent nature of fatigue and the unique characteristics of the Chinese population's attitudes toward climate change, along with implications for future research, are discussed.

Research question three investigates whether there are significant differences in message fatigue between participants exposed to mixed-framing messages compared to those exposed to only self-framing or social-framing messages after six exposures. The results reveal that, although message fatigue in the mixed-framing condition was slightly lower than in the self-framing and social-framing conditions, there were no significant differences after six exposures.

Comparison with Previous Research. The finding of an increase in message fatigue in all three conditions shares similarities and differences with previous related research (Gurr & Metag, 2022; So & Song, 2023). While some studies suggest that repeated exposure to the same issue increases message fatigue (Gurr & Metag, 2022; So et al., 2017), others propose that the relationship between exposure and fatigue is more complex and influenced by factors such as motivation, context, and previous chronic message fatigue levels (Lu, 2022; So & Song, 2023). This dissertation contributes to the literature by demonstrating that message fatigue can increase over repeated exposure in China to the climate change issue, highlighting the context-dependent nature of message fatigue in climate change communication.

For example, a qualitative longitudinal study by Gurr and Metag (2022) analyzed data obtained from semi-structured diaries and interviews with the same participants regarding their repeated exposure to the same news issue in the US. The study discovered that, as news users were repeatedly exposed to the issue, they increasingly developed a sense of redundancy regarding the issue and its media coverage.

Another study conducted by So and Song (2023) exposed a US adult sample to five different climate change messages with a time interval of 24 hours and discovered that repeated exposure resulted in lower message fatigue for those with a positive attitude toward the climate change issue. In contrast, message fatigue increased for those with a negative attitude as the

number of exposures grew. The researchers proposed that fatigue may depend more on motivation and context than previously suggested in the literature. Although message fatigue has often been viewed as a straightforward and relatively automatic result of accumulated exposure (So et al., 2017), So et al.'s findings imply that message fatigue may not have a simple linear relationship with exposure but instead be more motivational. Being motivational means that an individual's motivation to process and engage with the message content plays a significant role in determining how message fatigue would develop.

In contrast, this dissertation revealed that message fatigue generally increased over repeated exposures despite no significant differences across conditions. The difference in these findings may be related to fatigue's context-dependent nature, as So and Song's (2023) study suggested. Americans have become accustomed to climate change being a politicized, controversial issue that requires collective discussion (Bergquist et al., 2023; Hornsey et al., 2016; Rode et al., 2021; Steg, 2023). As a result, when repeatedly exposed to different messages that support climate change mitigation efforts, those who initially held unsupportive attitudes may experience significant cognitive dissonance (Bem, 1967; McGrath, 2017; Yang et al., 2023), leading to a noticeable increase in message fatigue towards climate change information. On the other hand, those who already support climate change mitigation might find their beliefs reinforced and feel more content as they receive additional support for their convictions.

In China, the climate change issue appears to be less debatable, with a consensus about the severity and causes of climate change issues among most of the population, although their awareness and intentions to address climate change vary (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). This may cause the climate change information in this experiment to be perceived as somewhat redundant, leading to a slight increase in message fatigue. This increase

in fatigue even happens among climate change supporters, rather than a decrease in fatigue due to repeated exposure to information that aligns with their stance.

Future research should conduct more empirical explorations of the mechanisms underlying the generation and effects of message fatigue in China and other countries. As the global community faces the urgent need to address climate change, it is essential to identify and overcome potential barriers to sustained public support and action (Steg, 2023; Stern, 2020). Understanding message fatigue as an essential possible barrier is crucial for developing effective climate change communication strategies that maintain public engagement and minimize fatigue over time.

Possible Explanations for Non-significant Differences among Conditions. The finding that message fatigue gradually increased without significant differences across conditions, when considered alongside the previous finding that the mixed-framing condition was more effective on climate change outcomes, deviates from the initial expectations. It was hypothesized that due to the more diverse information in the mixed-framing condition, participants' fatigue accumulation might be slower or lower than in the self-framing and other-framing conditions, resulting in significantly lower message fatigue among participants in the mixed-framing condition, which could lead to higher climate change outcomes.

The lack of significant differences in message fatigue across the three conditions may be due to two reasons. First, the number or frequency of exposures may not be sufficient to produce significant differences. More frequent or a greater number of exposures might result in the accumulation of significant differences across conditions in message fatigue (So et al., 2017; So & Song, 2023). Second, using similar information that only shared a common frame but employed different narrative styles and evidence in this dissertation may have led participants in

the mixed-framing condition to perceive the six messages they encountered as not significantly more diverse than the information in the other two conditions. Suppose the self- and social-framing conditions used identical information for each exposure, while the mixed-framing condition repeated two types of identical information. In that case, the message fatigue in the mixed-framing condition might be significantly lower than in the other two conditions.

Moreover, the non-significant difference in message fatigue among the three conditions cannot explain why mixed-framing is the best strategy for enhancing most climate change outcomes among the three conditions, as discussed in the previous section. Following the inverted U-shaped model, as a type of negative factor, message fatigue in the mixed-framing condition would need to be significantly lower than in the other two conditions to account for why mixed-framing is the best strategy (Montoya & Horton, 2014; Montoya et al., 2017; Lu et al., 2015; Schmidt, 2015; Stang, 1975). This may be because message fatigue was not exceptionally high (i.e., mean = 3.47 for all conditions after six exposures, ranging from 1-7) and may not have reached the threshold to influence the climate change outcomes.

This finding is not entirely different from what the inverted U-shaped model suggested, as the model also posits that positive and negative factors are always present, and negative factors may only outweigh positive factors when accumulation reaches a certain level (e.g., enough exposures), thereby affecting the results (Montoya & Horton, 2014; Montoya et al., 2017). In this case, as discussed in the previous section, convergence theory may better explain this finding within the current study design, suggesting that the diverse message framing approaches in the mixed-framing condition may lead to convergence among individuals, thereby enhancing persuasiveness on climate change outcomes.

Conclusion. This section explores the differences in message fatigue between the mixed-framing, self-framing, and social-framing conditions after six exposures. Although message fatigue was slightly lower in the mixed-framing condition, there were no significant differences across conditions. This finding differs from previous studies, possibly due to the context-dependent nature of fatigue and the unique characteristics of the Chinese population's attitudes toward climate change. The lack of significant differences in message fatigue cannot fully explain the effectiveness of mixed-framing. Still, convergence theory may provide a better explanation, suggesting that diverse framing approaches lead to convergence and enhanced persuasiveness. Future research should investigate the mechanisms underlying message fatigue and its effects further. The following section discusses the segmentation findings using STOPS in this dissertation.

Section 5.1.5 Distinct Communicative Actions and Climate Change Outcomes for Different Publics

This section confirms the effectiveness of the situational theory of problem solving (STOPS) in segmenting climate change publics based on their situational activeness, demonstrating significant differences in communicative actions and climate change outcomes among various publics. STOPS is a dominant public relations segmentation theory that explains publics' communicative actions in problematic life situations through situational antecedents (Grunig, 1997; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014). Specifically, STOPS theorizes that when publics accept a situation as problematic, do not have many obstacles to obtaining information about how to address the problem, and believe that the problem is highly related to themselves, they will likely work to solve the problem through engaging in

communicative actions in problem solving (Grunig, 1997; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014).

Hypotheses three, four, and five collectively explore the idea that when segmenting participants based on STOPS, the more situationally active individuals are on climate change, the higher their willingness to engage in positive communicative actions and climate change outcomes, and the lower their willingness to engage in negative communicative actions after six exposures. The results confirm these three hypotheses, showing that different publics' communicative actions and climate change outcomes differ significantly, confirming the effectiveness of STOPS segmentation and extending this approach to climate change outcomes. This section discusses the contributions of these findings, including being the first study to apply STOPS to climate change segmentation, segmenting communicative actions and climate change outcomes, and extending the model's applicability beyond public relations research, along with implications for future research and practice.

Enriching the Theoretical Choices in Climate Change Segmentation. This study is the first to directly apply the STOPS model to segment climate change publics and confirm its effectiveness. This finding enriches the existing theoretical choices in the climate change segmentation literature (Hine et al., 2014; Metag & Schäfer, 2018; Neumann et al., 2022). As discussed in section 2.3.2, the Six Americas segmentation approach, the dominant public segmentation approach in the climate change communication literature, may not be suitable for the Chinese context, given the generally high levels of belief regarding climate change and the traditional Chinese culture that emphasizes respect for nature (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). This dissertation confirms that STOPS may be a good alternative since STOPS does not use climate change beliefs for segmentation. Therefore, this dissertation

borrowed the STOPS segmentation approach from the public relations literature and made important implications for future studies. However, although this study confirms the effectiveness of the STOPS model in segmenting climate change publics in the Chinese context, future research could explore the model's segmentation applicability in other cultural backgrounds for other risk topics. Also, comparing STOPS segmentation with the Six Americas segmentation approach in the US context may also be a fruitful direction for future research.

The Segmentation of Communicative Actions in Climate Change Communication Research. The second significant contribution of this finding is that previous climate change segmentation literature has never segmented communicative actions (Hine et al., 2014; Metag & Schäfer, 2018; Neumann et al., 2022). These communicative actions include information acquisition (i.e., information seeking and attending), information selection (i.e., information forefending and permitting), information transmission (i.e., information forwarding and information sharing), information avoidance, and information omission (Chon et al., 2023; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014; Tao et al., 2020). This dissertation finds that more situationally active individuals have higher engagement in positive communicative behaviors and lower engagement in information avoidance and omission.

The successful segmentation of communicative actions and climate change outcomes using the STOPS model in this dissertation has important implications for future research on other sociopolitical issues, as communicative action is integral to civil discourse (Mittelstadt, 2016) and civil society (Yang & Taylor, 2013) and plays a crucial role in acquiring and interpreting climate change information, which could later influence individuals' perceptions, beliefs, attitudes, and behaviors (Jiang et al., 2019; Tao et al., 2020).

The segmentation of communicative actions also addresses the call for focusing on fundamental changes in the climate change communication literature. Hine et al. (2014) advocated moving beyond superficial behavioral changes and focusing on approaches that can fundamentally transform how individuals perceive and respond to climate change. The perceptual variables and communicative actions outlined in the STOPS model can exemplify these fundamental changes. STOPS's focus on communicative actions represents a shift from simply promoting one-time mitigation intention change to encouraging ongoing, active engagement with climate change information. By nurturing these communicative actions, climate change journalists can help create more informed and engaged publics to take actions that contribute to long-term, systemic changes in addressing the climate crisis. In this way, the STOPS model provides a framework for understanding and promoting the fundamental changes necessary for effective climate change communication and action (Jiang et al., 2019; Tao et al., 2020).

Contribution to STOPS Literature on Segmenting Climate Change Outcomes. Finally, very few previous public relations research has segmented outcomes other than communicative actions with the STOPS model (Chon et al., 2023; Dam et al., 2021; Grunig, 1997; Jiang et al., 2019; Kim, 2006; Kim & Grunig, 2011; Kim & Krishna, 2014; Liu et al., 2019). Therefore, the successful segmentation of climate change outcomes, including climate change attitudes, beliefs, and private and public pro-environmental intentions, has significant implications for future public relations and crisis communication research. Future studies in these fields can attempt to employ STOPS to segment other important perceptions and intentions in other risk issues, further understanding different types of publics and contributing to practices.

With segmentation, future research could investigate how to develop targeted communication strategies for each segmented group based on the differences in communicative behaviors and climate change outcomes among various publics. For example, for active publics, communicators could emphasize their crucial role in addressing climate change and encourage them to continue engaging in relevant actions. In contrast, for nonpublics, more basic strategies may be required, such as raising awareness and attention to climate change issues. By tailoring communication approaches to each segment's specific characteristics and needs, journalists can optimize the effectiveness of their messages and foster more meaningful engagement with different publics.

Conclusion. This section confirms the effectiveness of the STOPS model in segmenting climate change publics based on their situational activeness. This study is the first to apply the STOPS model to climate change segmentation, enriching the existing literature and offering a suitable approach for the Chinese context. The successful segmentation of communicative actions and climate change outcomes addresses the call for focusing on fundamental changes in climate change communication and extends STOPS's segmentation applicability beyond public relations research. Future studies should explore the model's segmentation applicability in other cultural backgrounds and social issues and investigate targeted communication strategies for each segmented group to optimize message effectiveness and foster meaningful engagement with different publics. The following section discusses the lack of interaction effects on self-identity and types of publics with different framing approaches.

Section 5.1.6 No Interaction between Self-identity Levels and Types of Publics with All Framing Conditions

This section examines the moderating effects of pro-environmental self-identity and public types on the relationship between repeated exposure to different message framing and climate change outcomes. This section reveals that although pro-environmental self-identity and types of publics independently influence climate change outcomes, they do not significantly interact with different framing conditions. Then, this section discusses potential explanations for these findings, including the mixed nature of climate change and the unique characteristics of the Chinese context, along with implications for future research and practice.

Research question six investigates how pro-environmental self-identity moderates the relationship between repeated exposure to different frames and climate change outcomes. Similarly, research question seven examines how the effects of repeated exposures to self-framing and social-framing messages on various outcomes differ among various publics after six exposures in three different framing conditions. The results indicate that, although pro-environmental self-identity and the types of publics independently influence climate change outcomes, they do not significantly interact with the different framing conditions. These two research questions and their findings are relatively similar; thus, they are discussed in one section.

Differences between Pro-environmental Self-identity and STOPS Publics. Measuring pro-environmental self-identity specifically involves asking participants whether they consider themselves environmentally-friendly consumers, are very concerned with environmental issues, and would feel embarrassed if others perceived them as environmentally friendly or very concerned with environmental issues (Dermody et al., 2015; Whitmarsh & O'Neill, 2010). This

differs from the STOPS's segmentation of publics, which is based on varying levels of constraint recognition, involvement recognition, and problem recognition regarding the climate change issue (Kim & Grunig, 2011; Kim & Krishna, 2014). However, despite these two approaches being different, the results are the same: neither pro-environmental self-identity nor types of publics interact with different framing.

Non-significant Interaction Effects of Pro-environmental Self-identity and Different Framing Approaches. The significant main effects of pro-environmental self-identity are consistent with most previous research (Carfora et al., 2017; Lavuri et al., 2023; Tarinc et al., 2023), indicating that an individual's pro-environmental self-identity is an essential factor that significantly influences their perceptions and intentions regarding climate change, even after the six repeated message exposures in this dissertation. However, the results show that the effects of different framing messages do not significantly differ between individuals with higher or lower pro-environmental self-identity.

One possible explanation for this finding is that the self- and social-framing used in the study highlight different aspects of the climate change issue that are relevant and compelling to individuals with varying levels of pro-environmental self-identity (Carmi & Kimhi, 2015; de Dominicis et al., 2017; Florence et al., 2022; Jaeger & Weber, 2020; Ma et al., 2023). For example, self-framing, which emphasizes personal responsibility and the impact of individual actions on climate change, may resonate with those with a strong pro-environmental self-identity by reinforcing their sense of obligation to address environmental issues. At the same time, self-framing may also be effective for individuals with lower pro-environmental self-identity by making the issue more personally relevant and encouraging them to consider their own role in contributing to climate change mitigation.

Similarly, social-framing, which focuses on the societal implications of climate change and the need for collective action, may appeal to individuals with high pro-environmental self-identity by highlighting the broader impact of their actions and the importance of working together to address the issue (Florence et al., 2022; Schill & Shaw, 2016; Yocco et al., 2015). For those with lower pro-environmental self-identity, social-framing may be persuasive by emphasizing the social norms and expectations surrounding climate change mitigation, encouraging them to align their attitudes and behaviors with those of their peers and society.

The overall effectiveness of both framing approaches across different levels of pro-environmental self-identity suggests that self-framing and social-framing may not be suitable message strategies explicitly tailored to an individual's self-identity to be persuasive. However, this dissertation's findings on the effects of lack of interaction may be specific to the framing approaches and outcomes investigated in this context and population. Future research could examine whether pro-environmental self-identity interacts with other types of message framing and strategies or influences different aspects of climate change engagement, such as emotional responses and memory in other populations over repeated exposures (Feldman & Hart, 2016; Marlon et al., 2019). Another specific example is to investigate the interaction between pro-environmental self-identity and gain-loss framing (Cheng et al., 2011; Spence & Pidgeon, 2010) and temporal framing (Schuldt et al., 2018; Trudel et al., 2022) over repeated exposures in shaping climate change attitudes and behaviors.

Non-significant Interaction Effects of Types of Publics and Different Framing Approaches. Furthermore, similar results were found for the interaction between public types and the framing approach. The previous idea was that, for instance, in the scenario where self-framing is employed, it was hypothesized that upon viewing self-framing messages six times, the

outcomes for the aware public in this condition might significantly surpass those of the aware public in the social-framing condition. This hypothesized finding could be due to the cumulative impact of repeated exposure to self-framed messages fostering a more profound sense of personal relevance and engagement with the issue of climate change. However, the findings did not align with this initial expectation. While framing was effective, there was no interaction with public types.

One possible explanation for this result is that individuals, regardless of what publics they belong to, recognize the importance of both personal and collective action in mitigating climate change. Therefore, both self-framing and social-framing are equally relevant and compelling to different publics. For example, even those in the aware public, who are more likely to be engaged with the issue and have a stronger sense of personal relevance, may also acknowledge the need for societal-level changes and the role of collective action in addressing climate change. Similarly, those in the latent or active publics may be receptive to both self-framing and social-framing, as they understand that the issue requires a multi-faceted approach involving individual behavior change and broader societal shifts.

Furthermore, the lack of interaction effects between framing and public types may be influenced by the specific characteristics of the Chinese context, where there is generally a high level of awareness and consensus regarding climate change (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). This shared understanding of the importance of addressing climate change may lead to a more uniform response to different framing approaches, regardless of what publics they belong to.

Therefore, these findings of a lack of interaction between self-identity levels and types of publics with different framing implies that, in practice, no different framing effects were found

after six exposures, even for people identifying as supporters or active publics. Self-framing and social-framing may not be directions for tailoring messages for people with different pro-environmental self-identities or different publics. However, this conclusion should be verified in other designs, topics, and populations.

Conclusion. The results of research questions six and seven indicate that although pro-environmental self-identity and public types independently influence climate change outcomes, they do not significantly interact with different framing conditions. This lack of interaction effects suggests that the impact of self-framing and social-framing on climate change outcomes does not vary significantly across different levels of environmental self-identity or situational activeness with the issue. However, it is important to note that the results do not necessarily imply that both framing approaches are equally effective. The mixed nature of climate change, which requires both individual and collective action, may contribute to the uniform effectiveness of these framing approaches. Further research is needed to identify additional factors that may moderate the effectiveness of different framing approaches in various contexts and populations. The following section discusses the proportional changes in the types of publics after repeated exposure.

Section 5.1.7 Proportional Changes of Types of Publics After Six Exposures

This section investigates the extent to which the overall proportion of different publics changes for each condition after six repeated exposures. This section reveals that six repeated exposures to climate change messaging significantly shift the proportions of different publics, particularly increasing the proportion of the active public. Then, the uniqueness and contributions of these findings, including confirming that types of publics can be changed

through repeated exposure and providing new directions for future research and practice, are discussed, along with suggestions for further exploration.

Research question eight addresses the extent to which the overall proportion of different publics will change for each condition after six repeated exposures in each condition. The findings reveal that six repeated exposures to climate change messaging significantly shift the overall proportion of different publics in each condition, particularly increasing the proportion of active publics.

At first glance, this result may seem to conflict with the findings discussed in the previous section on the moderating effects of pro-environmental self-identity and types of publics. However, they are not contradictory. The previous section discusses whether exposure to different framing approaches would affect the climate change outcomes of various publics and individuals with different self-identities after repeated exposure. In contrast, research question eight seeks to answer whether the overall proportion of each public would significantly change after repeatedly viewing different framing approaches. In other words, this dissertation examines the impact of repeated exposure to different framing approaches on participants' constraint recognition, involvement recognition, and problem recognition rather than the influence on the climate change outcomes discussed in the previous section.

Unique Contribution to Segmentation Research. These proportional changes are unique, as no studies have attempted to understand the longitudinal effects of tailored messages on segment membership. Most previous public segmentation research has been cross-sectional (Bain et al., 2012; Bayes et al., 2023; Hine et al., 2014, 2016; Metag & Schäfer, 2018; Moser, 2010, 2016). Even longitudinal studies, such as the Six Americas annual national surveys (Leiserowitz et al., 2021; Metag & Schäfer, 2018; Roser-Renouf et al., 2016), cannot be directly

compared to the results presented here due to differences in focus. Rather than tracking the same group of individuals over time, these studies employed multiple cross-sectional national surveys to examine the distribution of the American publics over several years (Leiserowitz et al., 2021; Metag & Schäfer, 2018; Roser-Renouf et al., 2016). While they use representative samples to accurately capture changes in the proportions of different public segments, the survey methodology does not allow for a specific investigation of how targeted climate change messages may contribute to these shifts longitudinally in the same individuals.

Practical Suggestions. In contrast, this dissertation research tracked the same individuals over time and attempted to employ framing strategies to determine whether these messages could change participants' constraint recognition, involvement recognition, and problem recognition, thus providing unique insights. This approach makes the dissertation a distinctive piece of segmentation research that focuses on examining how messages might impact individuals' activeness with issues over time, such as moving from latent to aware publics according to the STOPS model (Hine et al., 2014; Leiserowitz et al., 2021; Martel-Morin & Lachapelle, 2022; Metag & Schäfer, 2018; Moser, 2016).

The longitudinal data collection in this dissertation offers an innovative approach to understanding the dynamic responses of publics to climate change messaging over time, enabling journalists to design effective public relations campaigns and better navigate the complex landscape of climate change communication. For instance, journalists can utilize the finding that repeated exposure to climate change messages significantly increases the proportion of the active public to develop campaigns that focus on sustained, long-term engagement for specific publics. By providing a steady stream of informative and engaging content, journalists can cultivate a

more active and involved audience, which is crucial for promoting meaningful action on climate change.

Future Research Directions. Therefore, the main contribution of this result is the confirmation that types of publics can be changed and that repeated exposure is one way to achieve this, answering the call for segmentation to emphasize fundamental changes, as discussed in section 5.1.5 (Hine et al., 2014; Metag & Schäfer, 2018). While the changes observed in this study may not be considered fundamental in the sense of long-term, deep-rooted shifts in beliefs and behaviors due to the relatively short duration of the data collection, the findings at least demonstrate the potential for targeted communication strategies over repeated exposure to influence public segmentation over time.

This finding provides new directions for future public relations and climate change segmentation research. In addition to investigating how to segment publics (Bain et al., 2012; Hine et al., 2014, 2016; Martel-Morin & Lachapelle, 2022; Roser-Renouf et al., 2015) and tailor effective message strategies for different publics (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2010, 2016), researchers can also attempt to actively change segment types through effective message strategies, thereby influencing other perceptions and subsequent intentions. For example, based on the finding that repeated exposure to climate change messages significantly increases the proportion of the active public, researchers can investigate the optimal frequency, duration, and content of messages needed to shift individuals from less engaged segments (e.g., latent, or aware publics) to more active ones. By identifying effective strategies for promoting these transitions, researchers can contribute to developing communication approaches that target existing segments and actively work to create more engaged and action-oriented publics over time.

Finally, the findings highlight the importance of considering the impact of repeated exposure on audience segmentation and engagement over time in future research and practice. Journalists can incorporate these insights into their existing media coverage of climate change to further enhance their effectiveness. For instance, they can integrate the repeated exposure approach with other current proven tactics, such as influencer partnerships, community outreach, and multi-platform content distribution, to amplify the impact of their climate change communication efforts. By leveraging the power of repeated exposure alongside other best practices, journalists can create even more engaging and effective campaigns that drive meaningful change in public perceptions and behaviors related to complex issues like climate change.

While this study demonstrated the impact of six repeated exposures, future research could explore the optimal number of exposures required to effectively shift the proportions of publics in the long term instead of three weeks' shifts in the dissertation. Also, future studies could investigate how the source and channel of climate change messages interact with repeated exposure to influence audience segmentation and engagement. For example, researchers could compare the effects of repeated exposure to messages from different sources (e.g., government, NGOs, or scientists) or through various channels (e.g., social media, traditional media, or interpersonal communication), as suggested by the message convergence theory (Anthon & Sellnow, 2016; Liu et al., 2020).

However, it is essential to note that while the proportional changes found in this dissertation are significant, it is unclear whether they are long-term or how long they will persist. Future research could attempt to continue tracking publics after repeated exposure has caused

proportional changes to further evaluate the practical value of this approach in diverse contexts and populations.

No Apparent Proportional Differences for Different Framing. Moreover, all study conditions effectively produced proportional changes, but the final proportions of different publics did not appear to differ greatly. For example, the final proportion of active publics was around 80% in all three conditions (i.e., 79% in social-framing, 81% in self-framing, and 84% in mixed-framing). This indicates that repeated exposure seemed to matter most in this dissertation, with less impact from different framing approaches. These different framing approaches did not produce substantial differences in changing the proportions of publics. However, as this study only tested self-framing and social-framing, it does not mean that other framing approaches would not produce significant differences after repeated exposure.

Therefore, future studies could design message strategies that effectively change types of publics by targeting constraint recognition, involvement recognition, and problem recognition. For instance, to target constraint recognition, studies could design repeated messages that provide actionable solutions and resources, empowering individuals to overcome perceived barriers to engagement. Furthermore, to enhance problem recognition, researchers could create messages that present compelling evidence of the urgency and severity of climate change, using vivid imagery, emotional appeals, or expert testimonials. This recommendation could also be applied to the Six Americas segmentation (Hine et al., 2014; Leiserowitz et al., 2008, 2021, 2023), where future research could draw on the approach of this study to design effective information characteristics and strategies aimed at its segmenting variables (i.e., climate change beliefs, concerns, and motivations).

Conclusion. This section discusses the finding that repeated exposure to climate change messaging can significantly shift the proportions of different publics, particularly increasing the proportion of the active public. This finding is unique, as previous segmentation research has primarily been cross-sectional or has not specifically investigated the impact of targeted messages on segment membership over time. This longitudinal approach offers valuable insights into how messages can influence publics' engagement with climate change issues, providing new directions for public relations and climate change communication research and practice. After thoroughly discussing the findings for all research questions and hypotheses, the following section summarizes the theoretical implications drawn from the discussion of all the previous sections.

Section 5.2 Summary of Theoretical Implications

This dissertation makes several important theoretical contributions to climate change communication and public relations research. First, this dissertation challenges the inverted U-shaped model in the context of climate change communication and highlights the importance of considering the longitudinal effects of framing. Additionally, this dissertation extends message convergence theory and addresses gaps in climate change framing research on framing combinations. Furthermore, this dissertation confirms the effectiveness of the STOPS model for climate change public segmentation and extends the model to segment climate change outcomes, including climate change attitudes, beliefs, and private and public pro-environmental intentions. Finally, this dissertation demonstrates the potential for targeted messages to change public segment membership over time.

The first theoretical implication of this dissertation is challenging the inverted U-shaped model in climate change communication (Lu et al., 2015; Montoya & Horton, 2014; Montoya et

al., 2017; Schmidt, 2015; Stang, 1975). The findings do not support the inverted U-shaped model, showing a general increase in most climate change outcomes after repeated exposures to self- and social-framing messages. This may be due to the familiarity with the issue, the study design, and the unique characteristics of the Chinese population (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022), inconsistent with one study in the US context found support for the model in climate change communication (Skurka et al., 2023). This contribution suggests that the inverted U-shaped model may not apply to all contexts and highlights the need for further research on the factors influencing the effectiveness of repeated messaging in climate change communication.

This dissertation's second important theoretical implication is emphasizing the importance of considering the repeated effects of framing strategies, complementing the previous longitudinal framing effects research examining the repeated negative and positive framing strategy in the US context for climate change issues (Diamond & Urbanski, 2022). Despite the effectiveness of both self-framed and social-framed messages in enhancing most climate change outcomes after each exposure (i.e., the time effect), the lack of significant differences between the two approaches at each exposure underscores the importance of examining framing effects over multiple exposures since previous research only compared their different impacts on climate change outcomes with a single-exposure design and found mixed results (De Dominicis et al., 2017; Florence et al., 2022; Geng et al., 2019; Jaeger & Weber, 2020; Ma et al., 2023; Schill & Shaw, 2016; Singh et al., 2017; Yocco et al., 2015). This finding complements the construal level theory of psychological distance, which posits that individuals' responses to stimuli at varying distances are influenced by perceived proximity to an object, event, or issue (Florence et al., 2022; Green & Peloza, 2014; Liberman & Trope, 2008; Trope & Liberman, 2010), by

suggesting future research to consider the dimension of repetition when investigating framing effects.

Next, the dissertation theoretically contributes to message convergence theory. The superiority of mixed-framing over self-framing after six exposures can be explained by message convergence theory. This theory proposes that people make decisions on risks while being exposed to arguments from multiple sources on the same topic, and convergence occurs when messages from these sources overlap in ways recognized by observers, creating perceptions of credibility and influencing their risk decisions (Anthon & Sellnow, 2016; Anthony et al., 2013, 2017; Liu et al., 2020). This finding extends the theory by suggesting that convergence can be created by different sources and message framing approaches from the same source, providing a new avenue for future research on the mechanisms underlying the effectiveness of mixed-framing strategies.

This dissertation also addresses gaps in climate change research on combining framing approaches. The mixed-framing approach employed in this dissertation addresses a critical gap in climate change framing research by examining the combined use of opposing framing strategies over time, answering the call from previous research (Diamond & Urbanski, 2022; Florence et al., 2022). This novel approach complements real-world communication practices. Specifically, individuals are often exposed to a mix of different message frames over time rather than a single consistent frame (Pan et al., 2021, 2023; Wang & Zhou, 2020). By sequentially combining self-framing and social-framing messages, this dissertation closely mimics the diverse range of climate change information individuals encounter daily. Researchers can build upon this work by investigating the effectiveness of mixed-framing approaches in different cultural,

political, and social contexts and examining the potential mixed-use of other framing strategies beyond self- and social-framing.

This dissertation's fifth theoretical implication confirms STOPS's effectiveness for climate change public segmentation. Individuals with higher levels of situational activeness on climate change (i.e., active publics) exhibited greater willingness to engage in positive communicative actions and had stronger climate change beliefs, attitudes, and behavioral intentions compared to less situationally active publics (i.e., aware, latent, and nonpublics). Previous climate change segmentation approaches, such as the Six Americas segmentation, have primarily focused on variables like climate change beliefs, concerns, and motivations (Hine et al., 2014; Leiserowitz et al., 2008, 2021, 2023), which may not be as suitable for the Chinese context due to the generally high level of belief in climate change and the cultural emphasis on respect for nature (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). This dissertation is the first to directly apply the STOPS model to segment climate change publics and confirm its effectiveness, enriching the existing climate change segmentation literature (Hine et al., 2014; Metag & Schäfer, 2018; Neumann et al., 2022), demonstrating that the STOPS is a suitable approach for the Chinese context.

Also, this dissertation extends the STOPS model's segmenting of communicative actions to include other climate change outcomes. Individuals with higher levels of situational activeness on climate change (i.e., active publics) exhibited stronger climate change beliefs, attitudes, and behavioral intentions compared to less situationally active publics. The successful segmentation of communicative actions and climate change outcomes using the STOPS model extends the model's applicability to other outcomes, such as emotional responses, in public relations research. This contribution opens new avenues for future research on climate change and public

relations segmentation. For example, researchers can explore how the different publics in STOPS would have distinct emotional responses to climate change, such as hope, fear, or anger (Lim et al., 2019). Furthermore, future studies can examine the potential of using the STOPS model to segment publics in other contexts. By extending the STOPS model to a wider range of outcomes and contexts, researchers can develop a comprehensive understanding of how public segmentation can inform the design of effective climate change messaging.

Finally, this dissertation demonstrates the potential for targeted messages to change public segment membership over time. Six repeated exposures to climate change messaging significantly shift the overall proportion of different publics in each condition, particularly increasing the proportion of active publics. The significant shifts in the proportions of different publics after six repeated exposures to climate change messaging provide unique insights into how targeted messages can influence public segment membership over time (Bayes et al., 2023; Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018). This finding highlights the importance of considering the impact of repeated exposure on audience segmentation and engagement in future research and practice, offering new directions for researching and designing news coverage for sustained engagement and perceptional changes.

Conclusion. This dissertation makes several valuable theoretical contributions to climate change communication, message framing, public relations, and public segmentation. These contributions challenge existing models, extend current theories, address research gaps, and provide new insights into the effectiveness of repeated communication strategies. The findings offer multiple avenues for future research and have important implications for designing and implementing effective climate change messaging. Therefore, the following section illustrates explicitly this dissertation's important practical implications.

Section 5.3 Summary of Practical Implications

This dissertation offers critical practical contributions to climate change communication and public relations. First, this dissertation highlights the effectiveness of repeated exposure to climate change messages in enhancing communication effects and demonstrates the potential of mixed-framing strategies for increasing the impact of climate change messaging. Additionally, this dissertation supports current risk communication practices that employ a mixed approach and offers insights for developing targeted communication strategies based on public segmentation. Furthermore, this dissertation emphasizes the importance of considering the impact of repeated exposure on audience segmentation and engagement in designing longitudinal climate change messaging. Finally, it suggests the potential for repeated message strategies to change public segment types actively and influence perceptions and intentions.

First, this dissertation highlights the effectiveness of repeated exposure to climate change messages. The findings suggest that repeated exposure to climate change messages can significantly enhance communication effects, particularly in the Chinese context, where there is generally high familiarity with the issue and a strong consensus regarding its importance (Pan et al., 2021, 2023; Wang & Zhou, 2020; Xu et al., 2022). Although single-exposure campaigns and news coverage are less common in practice, previous researchers and journalists may not have systematically designed and analyzed the ongoing, continuous news reports (Hornsey et al., 2016; Rode et al., 2021; Wang & Zhou, 2020). This dissertation's findings suggest that conceptualizing and evaluating climate change communication as a series of repeated exposures rather than isolated instances can lead to a better understanding of its cumulative impact on individuals' perceptions and intentions. By adopting this perspective, journalists can develop

effective long-term communication strategies that capitalize on the power of repeated messaging to drive meaningful change in the face of the climate crisis.

Second, this dissertation demonstrates the potential of mixed-framing strategies. The superiority of mixed-framing over self-framing after six exposures highlights the possibility of combining personal and societal perspectives in climate change communication over time. Journalists can apply this finding by developing messages that incorporate both self- and social-framing elements, as this approach may appeal to a broader range of motivations, create more comprehensive arguments, and enhance the overall impact of climate change news coverage.

Third, this dissertation provides support for current practices in risk communication. The effectiveness of mixed-framing aligns with current practices in risk communication that already employ a mixed approach by using diverse sources, different types of evidence, and non-identical information (Anthony et al., 2013, 2017; Guo et al., 2019; Liu et al., 2020; Xie, 2015). The findings offer empirical support for these existing practices, encouraging journalists to continue using diverse message strategies and characteristics to create convergence and enhance the impact of climate change communication (Anthon & Sellnow, 2016; Duan & Miller, 2021; Han et al., 2017; Liu et al., 2020; Xie, 2015).

Next, this dissertation offers insights for developing targeted communication strategies based on public segmentation. The successful application of the STOPS in segmenting climate change publics and demonstrating significant differences in communicative actions and climate change outcomes among various publics provides valuable insights for journalists (Hine et al., 2014; Metag & Schäfer, 2018; Neumann et al., 2022). It is recommended to develop targeted strategies for each segmented group, such as emphasizing the crucial role of active publics in addressing climate change and encouraging their continued engagement while employing more

basic strategies for nonpublics to raise awareness and attention to the issue (Jiang et al., 2019; Tao et al., 2020).

Also, this dissertation emphasizes the importance of considering repeated exposure to climate change news coverage in the future. The significant shifts in the proportions of different publics after six repeated exposures to climate change messaging highlight the importance of considering the impact of repeated exposure on audience segmentation and engagement over time. Journalists can use these insights to design climate change messaging that strategically employs repeated exposure to tailored messages to drive desired changes in the publics' perceptions and intentions related to climate change or other complex issues.

Finally, this dissertation suggests the potential for climate change messaging to change public segment types actively. The findings provide new directions for journalists to actively change types of publics through effective message strategies actively, thereby influencing other perceptions and subsequent intentions (Bain et al., 2012; Hine et al., 2014, 2016; Martel-Morin & Lachapelle, 2022; Roser-Renouf et al., 2015). For example, journalists could design media coverage that targets the specific variables used for segmentation, including constraint recognition, involvement recognition, and problem recognition in the STOPS model, or climate change beliefs, concerns, and motivations in the Six Americas segmentation, to effectively shift individuals across different segments (Hine et al., 2014; Leiserowitz et al., 2021; Metag & Schäfer, 2018; Moser, 2010, 2016).

Conclusion. This dissertation offers several important practical contributions to climate change communication and public relations. These contributions highlight the effectiveness of repeated exposure, demonstrate the potential of mixed-framing strategies, provide support for current practices in risk communication, offer insights for developing targeted communication

strategies based on public segmentation, emphasize the importance of considering repeated exposure in designing longitudinal campaigns, and suggest the potential for message strategies to change public segment types actively. By applying these findings, journalists can design effective and impactful climate change news coverage and messaging that drives meaningful changes in how individuals perceive and respond to this critical issue. After a thorough discussion of this dissertation's theoretical and practical implications, the next section acknowledges the limitations of this dissertation and offers revenue for future research to continue this line of efforts.

Section 5.4 Limitations

This section discusses the limitations of the dissertation, including sampling, study design, message type, contexts, social desirability, and measurements, as well as their possible impacts on interpreting the results and opportunities for future research.

Sampling. Although the dissertation employed a quota sampling method to ensure gender balance, the sampling was not random, and the final sample had significant differences in demographic characteristics compared to census data. Specifically, the final sample is significantly younger, more educated, and more concentrated in lower-middle and middle-income ranges than the national population (National Bureau of Statistics of China, 2022). The high educational attainment of the sample is particularly noteworthy, as previous studies have consistently found that education level is the strongest predictor of climate change attitudes and behaviors in China (Fu et al., 2023; Wang & Zhou, 2020; Wang et al., 2022). Consequently, the highly educated nature of the dissertation sample may lead to higher pro-environmental attitudes and behaviors, and caution should be exercised when interpreting the results. However, it is worth noting that the highly educated nature of the sample also represents the primary readers of

news information in China, who are more likely to have opportunities to read about climate change (China Internet Network Information Center, 2021). Therefore, while the sample may not represent the general population, it may still provide valuable insights into the attitudes and behaviors of a key target audience for climate change communication in China.

Future research could use more robust sampling methods to conduct representative longitudinal experiments. However, it is worth noting that previous studies have found that survey experiments performed with convenience samples (e.g., MTurk experiments) tend to yield the same pattern of statistical significance and direction in most experiments when directly compared with those performed with probability-based samples, although sample demographic characteristics and prevalence estimates are likely to be differed significantly (Coppock et al., 2018; Jeong et al., 2019).

Study Design and Context. The findings in this dissertation are bound to the study design and the samples recruited. Six repeated exposures at three-day intervals were applied in this dissertation. However, repetition at a greater frequency beyond six exposures or in more frequent or different intervals in other societies may show different effects (Lu, 2022; Skurka et al., 2023; So & Song, 2023). Future research exploring repeated exposure experiment designs would enrich theory and inform the most effective way of repeated climate change messaging in other contexts.

Message Type. The conclusions of this study are limited to supportive information on climate change due to the nature of the stimuli (i.e., messages revised from major news outlets in China). This dissertation only tested media messages rather than campaigns, and future research could also examine whether different effects depend upon whether messages come from the media versus other sources of climate change information to provide more specific evidence and

suggestions for climate change campaigns. Also, this dissertation only tested text messages without any visuals or video components, which is another avenue for future research.

Social Desirability. After repeated exposures, participants may have become aware that the study's primary purpose was to enhance their perceptions and behavioral intentions about climate change. This awareness could have influenced their responses, potentially leading to social desirability bias in the results and their interpretations in the discussion chapter (Krumpal, 2013; Larson, 2019).

Measurement Issue with Ceiling Effects. When studying issues like climate change in China or similar East Asian societies, future researchers should be mindful of ceiling effects (Chyung et al., 2020; Fries et al., 2011), as they may lead to distorted results. The findings in this study were likely influenced by this effect, which needs to be acknowledged. To address this issue, future research could focus on developing specific scales that increase an individual's maximum level on a Likert scale. Such efforts would be valuable in mitigating the impact of ceiling effects and improving the accuracy of measurements in similar contexts.

Different Conceptualization of Time and Exposure Frequency. Although this dissertation employed a longitudinal repeated exposure experiment to investigate the effects of message framing on climate change outcomes, it is important to note that time and exposure frequency are not entirely interchangeable or equivalent concepts. The use of the term *longitudinal* in this dissertation primarily serves to differentiate it from cross-sectional repeated exposure experiments (Lu, 2022; Lu et al., 2015), where participants are exposed to repeated messages within a single experimental session. However, the results of this dissertation are largely confined to the effects of exposure frequency rather than the passage of time itself because all outcomes were measured after each exposure without delay. While the study design

aimed to simulate the real-world experience of encountering climate change messages over time, the three-day intervals between exposures do not fully capture the complex temporal dynamics of message processing and attitude formation. Future research should further explore the potentially distinct roles of time and exposure frequency in shaping responses to climate change communication, employing designs that more clearly disentangle these factors and investigate their unique contributions to message effectiveness.

Longitudinal Drop-out and Potential Bias. The differences between the drop-out sample and the final sample on income, education, and age suggest that while attrition may be essentially random concerning most of the measured controls (i.e., gender, communitarianism worldview, egalitarianism worldview, and frequency of encountering climate change information), as presented in section 4.2.1 and Table 3, some demographics could have played a role in retaining participants. Attrition leads to a reduction in the number of participants and a loss of power and may also introduce bias in the findings. However, studies comparing different age groups of participants and research designs in longitudinal studies have found that, overall, if the attrition rate is not excessive or caused by severe design flaws due to carelessness, attrition does not appear to be as significant a problem as commonly believed (Deeg, 2002; Gustavson et al., 2012). Nonetheless, it is important to acknowledge that the final sample analyzed in this dissertation consists of relatively less economically well-off, younger, and more educated individuals than the drop-out sample.

Furthermore, there is a potential for biased responses from the final exposure and the possibility that participants experiencing high levels of message fatigue may have been more likely to quit during the study period. Those who completed all six exposures might have had a higher tolerance for and a lower level of message fatigue, which could have influenced the

study's findings. However, it is worth noting that the overall mean for message fatigue was relatively low (i.e., mean = 3.18 for all conditions before the first exposure and mean = 3.47 for all conditions after six exposures, ranging from 1 to 7), suggesting that most participants did not experience excessive fatigue both before the first exposure to the stimuli and after all six exposures.

To address these limitations, future research could consider including a post-study questionnaire to assess participants' reasons for completing or withdrawing from the study for the initial sample, which could provide valuable insights into the factors in participant retention. By understanding and mitigating these potential sources of bias, future studies can generate more robust and generalizable findings on the effects of repeated exposure to climate change messages over time.

Conclusion. While this dissertation provides valuable insights into the effects of repeated exposure to self- and social-framing messages on climate change outcomes and audience segmentation, it is crucial to consider the limitations related to sampling, study design, context, social desirability, different conceptualization of time and exposure frequency, longitudinal drop-out, and measurement. By acknowledging these limitations, researchers can better interpret the findings and design future studies that address these challenges.

Section 5.5 Conclusion

Climate change poses an unprecedented global challenge, with unequivocal evidence of its devastating impacts on our planet (Reuters, 2024; Wang et al., 2016; Xu et al., 2022). As the world's largest emitter of greenhouse gasses, China plays a crucial role in the global response to climate change. However, despite increased media coverage and public discussion on the issue, a significant knowledge gap exists in understanding how to engage Chinese individuals in the fight

against climate change effectively (Chan et al., 2023; Jia & Luo, 2023; Pan et al., 2022, 2023; Wang & Huan, 2024).

By conducting a longitudinal experiment with six repeated exposures, this dissertation provides valuable insights into the effects of repeated exposure to self- and social-framing messages on climate change communicative actions, other outcomes (i.e., climate change attitude, beliefs, and private and public pro-environmental intentions), and public segmentation in the Chinese context. The findings challenge the inverted U-shaped model in the overall trends for repeated exposure to climate change issues, demonstrate the effectiveness of mixed-framing strategies, and confirm the applicability of the STOPS model in segmenting climate change publics based on their situational activeness. The study also highlights the potential for targeted messages to change public segment membership through repeated exposure over time.

Theoretically, the dissertation contributes to the literature by extending current theories, addressing research gaps, and providing new insights into the effectiveness of repeated communication strategies in audience segmentation. Practically, the findings offer guidance for developing repeated communication strategies and suggest the potential for repeated message exposures to change public segment types actively. Despite limitations related to sampling, study design, context, social desirability, and measurement issues, this dissertation provides valuable avenues for future research to investigate further the complex interplay between message framing, repeated exposure, and public segmentation in climate change communication. By applying the insights from this study, climate change and public relations researchers and journalists can design effective and impactful repeated climate change messaging that drives changes in how individuals perceive and respond to this critical issue.

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Appendices

Appendix A Pilot Study Stimuli

Message 1 (selected for the main study):
Table A1
Climate Change Threatens Cultural and Natural Heritage

Base message	Self frame part	Social frame part
In recent years, various extreme weather events have occurred frequently under the influence of climate change. These extreme weather events have impacted a vast amount of cultural and natural heritage that has been preserved due to previously stable climatic conditions. As early as the heavy rains in Henan and Shanxi in 2021, many cultural relics and ancient buildings were damaged in the downpour.	The destruction of these relics will have a profound impact on **you**. **You** may lose the opportunity to view and tour these irreplaceable cultural heritage sites, affecting **your** historical understanding and cultural experience. **You** should recognize the seriousness of climate change and take action in daily life to reduce its impact on the cultural heritage **you** cherish.	The destruction of these relics will have a profound impact on **society**. **All of us** may lose the opportunity to view and tour these irreplaceable cultural heritage sites, affecting **our** historical understanding and cultural experience. **All of us** should recognize the seriousness of climate change and take action to reduce its impact on the cultural heritage **we** cherish.

Message 1 in Chinese:
气候变化危害文化和自然遗产
近年来，在气候变化影响下，各种极端天气频繁发生，大量由于过去相对稳定气候条件保存下来的文化和自然遗产受到了很大的影响。早在 2021 年河南和山西暴雨发生时，很多文物和古建筑就在大雨中受损。

Self frame part:
这些遗物的损坏会对你产生深刻影响。你很可能失去观赏和游览这些不可替代的文化遗产的机会，影响你的历史认知和文化体验。你应该认识到气候变化的严重性，并在日常生活中采取行动，减少其对你所珍爱的文化遗产的影响。
Word count: 191

Social frame part:
这些遗物的损坏会对社会产生深刻影响。所有人都很可能失去观赏和游览这些不可替代的文化遗产的机会，影响大家的历史认知和文化体验。所有人都应该认识到气候变化的严重性，并采取行动，减少其对大家珍爱的文化遗产的影响。
Word count: 193
Source: The Paper News https://html.thepaper.cn/collection/xwnxoong

Message 2:
Table A2
Climate Change Leads to Increased Forest Fires

Base message	Self frame part	Social frame part
The forest and grassland fire prevention expert group recently stated that climatic factors are the main reason for the increased incidence of forest fires this year. Forest fires are closely related to hot and dry conditions. High temperatures and drought decrease the moisture content of surface combustibles and also directly affect the combustibles' temperature, reducing the heat required for ignition.	"The forest fires caused by high temperatures and droughts directly threaten **your** safety. These impacts include **your** respiratory health, property security, and life. Hence, **you** should recognize the seriousness of climate change, take fire prevention measures, reduce the risk of fires, and protect **yourself and your family**," said the expert group.	"The forest fires caused by high temperatures and droughts directly threaten **our society's** safety. These impacts include **our** respiratory health, property security, and lives. Hence, **all of us** should recognize the seriousness of climate change, take fire prevention measures, reduce the risk of fires, and protect **ourselves**," said the expert group.

Message 2 in Chinese:
气候变化导致森林火灾多发
近日，森林草原防火专家组称，气候因素是造成今年森林火灾多发的主要原因。森林火灾的发生与高温干旱密切相关。高温干旱会降低地表可燃物的含水量，也直接影响可燃物本身的温度，降低使其达到燃点时所需的热。

Self frame part:
"高温干旱导致的森林火灾对你安全构成了直接的威胁，这些影响包括你的呼吸健康，财产安全，甚至生命安全。因此每一个人应该认识到气候变化的严重性，采取防火措施，减少火灾风险，保护自己和家人。"专家组称。
Word count: 195

Social frame part:
"高温干旱导致的森林火灾对我们社会的安全构成了直接的威胁，这些影响包括我们的呼吸健康，财产安全，甚至生命安全。因此所有人都应该认识到气候变化的严重性，采取防火措施，减少火灾风险，保护我们自己。"专家组称。
Word count: 199
Source: The Paper News https://www.thepaper.cn/newsDetail_forward_24511230

Message 3:
Table A3
International Figures Praise Actions in Adapting to Climate Change

Base message	Self frame part	Social frame part
Patrick Verkooijen, CEO of the Center on Adaptation,	These adaptation strategies have brought tangible	These adaptation strategies have brought tangible

remarked that the recently released "Adaptation Strategy 2035" showcases remarkable foresight and innovation. The strategy addresses current issues while also looking to the future. Adapting to climate change is the beginning of new opportunities. He believes these adaptation strategies can provide invaluable experiences.	benefits to **you**. For instance, the adaptation strategies have improved food security, thereby protecting **your** health and enhancing **your** quality of life. At the same time, they have also strengthened economic stability and growth, providing **you** with new possible job opportunities and development prospects.	benefits to **China**. For instance, the adaptation strategies have improved food security, thereby protecting **our** health and enhancing **our** quality of life. At the same time, they have also strengthened economic stability and growth, providing **us** with new possible job opportunities and development prospects.

Message 3 in Chinese:
国际人士积极评价适应气候变化行动
全球气候适应中心首席执行官帕特里克·费尔科表示，最近发布的《适应战略 2035》显示出罕见的前瞻和创新。该战略既关注当前问题，又展望未来。适应气候变化是新机遇的开始。他认为，这些适应策略提供了宝贵经验。

Self frame part:
这些适应策略也为你带来了实实在在的好处，比如，适应战略提高了食品安全，进而保护了你的健康，提升了你的生活质量。同时这些策略也增强了经济的稳定和增长，进而为你提供了新的可能的就业机会与发展机遇。
Word count: 193

Social frame part:
这些适应策略也为中国带来了实实在在的好处，比如，适应战略提高了食品安全，进而保护了我们的健康，提升了我们的生活质量。同时这些策略也增强了经济的稳定和增长，进而为我们提供了新的可能的就业机会与发展机遇。
Word count: 197
Source: Xinhua News Agency http://world.people.com.cn/n1/2022/1115/c1002-32566048.html

Message 4:
Table A4
Climate Change Leads to Increased Conflicts Between Humans and Wildlife

Base message	Self frame part	Social frame part
The latest study in *Nature Climate Change* found that climate change intensifies conflicts between humans and wildlife. This research found that animals are forced to change their habitats to adapt to the climate crisis and	Researchers warn, "This kind of conflict directly affects **your** life. For example, conflicts with animals might impact **your** property and livelihood, and **you** could face health and safety issues from contact	Researchers warn, "This kind of conflict directly affects **all of society**. For example, conflicts with animals might impact **our** property and livelihood, and **we** could face health and safety issues from

changes in resource distribution, leading to increased contact and conflicts with humans.	with wild animals. Therefore, **you** need to take measures to reduce conflicts with wildlife and protect **your** home and safety."	contact with wild animals. Therefore, **all of us** need to take measures to reduce conflicts with wildlife and protect **our** home and safety."

Message 4 in Chinese (selected for the main study):
气候变化导致人与野生动物间冲突增多
《自然气候变化》杂志的最新研究发现，气候变化正加剧人类与野生动物间的冲突。此研究发现动物为了适应气候危机和资源分布的变化，被迫改变其栖息地，从而与人类产生更多接触和冲突。

Self framed part:
科研人员警告，"这种冲突直接影响到每个人的生活。例如，动物的冲突可能会影响你的财产和生计，你也可能会面临由于与野生动物接触而导致的健康和安全问题。因此你有必要采取措施，减少与野生动物的冲突，保护自己的家园和安全。
Word count: 191

Social frame part:
科研人员警告，"这种冲突直接影响到整个社会。例如，动物的冲突可能会影响我们的财产和生计，我们也可能会面临由于与野生动物接触而导致的健康和安全问题。因此我们所有人有必要采取措施，减少与野生动物的冲突，保护我们的家园和安全。
Word count: 195
Source: The Paper News https://www.thepaper.cn/newsDetail_forward_22108139

Message 5 (selected for the main study):
Table A5
Overall Impact of Climate Change Exceeds Predictions

Base message	Self frame part	Social frame part
A new report has been released titled "Climate Change 2022: Impacts, Adaptation, and Vulnerability", warning that the destruction brought about by climate change has surpassed previous predictions. Extreme weather events, food and water crises, and diseases have increased. Living in vulnerable environments that are easily affected by climate change is dangerous.	These huge and quick changes will directly impact existing food and water resources, subsequently threatening **your** health, property, and safety. **You** must recognize the tangible impact of climate change on **you** and **your** family, as well as the imperative for **you** to take action to mitigate the effects of climate change and safeguard **your** future.	These huge and quick changes will directly impact existing food and water resources, subsequently threatening **our** safety. **All of us** must recognize the tangible impact of climate change on **us**, as well as the imperative for **us** to take action to mitigate the effects of climate change and safeguard **our** future.

Message 5 in Chinese:
气候变化造成的总体影响超出预测
一个新的标题为《气候变化 2022：影响、适应和脆弱性》的报告最近被发布。报告警告气候变化带来的破坏已超出以往预测。极端天气，粮食和饮水危机，以及疾病已经增加。生活在易受气候变化冲击的脆弱环境中是非常危险的。

Self frame part:
这些巨大且迅速的变化将直接影响现存的食物和水资源，进而威胁到你的健康和财产安全。你必须认识到气候变化对个人和家庭的实际影响，以及你采取行动的必要性，以减轻气候变化的影响，保护你自己的未来。
Word count: 194

Social frame part:
这些巨大且迅速的变化将直接影响现存的食物和水资源，进而威胁到我们的安全。所有社会成员都必须认识到气候变化对的实际影响，以及我们采取行动的必要性，以减轻气候变化的影响，保护我们的未来。
Word count: 191
Source: The Paper News https://www.thepaper.cn/newsDetail_forward_17315598

Message 6:
Table A6
Climate Change Will Exacerbate Over Half of Infectious Diseases

Base message	Self frame part	Social frame part
A study from *Nature Climate Change* has discovered that climate change renders humans more vulnerable to many diseases, intensifying health risks. Researchers linked 286 distinct human pathogenic diseases with ten types of climate disasters. Among them, 277 were exacerbated by at least one kind of climate disaster.	For **you**, this study serves as an alarm bell. Reducing greenhouse gas emissions is not just about environmental protection but also about safeguarding **your** health and safety. **You** must take action to mitigate the health threats exacerbated by climate change, ensuring **you** can live in a healthier and safer environment.	For **all of society**, this study serves as an alarm bell. Reducing greenhouse gas emissions is not just about environmental protection but also about safeguarding health and safety for **all of us**. **All of society** must take action to mitigate the health threats exacerbated by climate change, ensuring **we** can live in a healthier and safer environment.

Message 6 in Chinese:
气候变化会使半数以上传染病加剧
《自然·气候变化》的研究发现，气候变化会导致人类面对诸多疾病更加脆弱，加剧健康风险。研究人员将 286 种独有的人类病原体疾病与 10 种气候灾害联系起来。其中 277 种被至少一种气候灾害所加剧。

Self frame part:

对于你来说，这项研究是一个警钟。减少温室气体排放不仅是为了保护环境，也是为了保护我们自己的健康和安全。你必须采取行动，以降低被气候变化加剧的人类传染病对自己健康的威胁，确保你自己能在一个更健康、更安全的环境中生活。
Word count: 195

Social frame part:
对于整个社会来说，这项研究是一个警钟。减少温室气体排放不仅是为了保护环境，也是为了保护我们所有人的健康和安全。整个社会必须采取行动，以降低被气候变化加剧的人类传染病对健康的威胁，确保大家能在一个更健康、更安全的环境中生活。
Word count: 199
Source: Science and Technology Daily
http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2022-08/11/content_540008.htm?div=-1

Message 7 (selected for the main study):
Table A7
Climate Change Could Jeopardize One-Third of Global Food Production

Base message	Self frame part	Social frame part
Climate change can negatively impact agriculture and livestock. Research indicates that by the end of this century, one-third of food production may fall to zero yields. The sustained growth of greenhouse gas emissions may make it challenging for grain crops and livestock production to adapt, primarily because of precipitation, temperature, and drought.	This implies that food might become scarcer and more expensive for **you**. Food security directly affects **your** daily life through rising food prices and unstable supply. **You** should be aware of the threats that climate change poses to **you** to support sustainable agriculture and environmental policies to ensure **your** food security.	This implies that food might become scarcer and more expensive for **all of society**. Food security directly affects the normal operations of **society** through rising food prices and unstable supply. **All of society** should be aware of the threats that climate change poses to **us to** support sustainable agriculture and environmental policies to ensure **our** food security.

Message 7 in Chinese:
气候变化或危及全球三分之一粮食产量
气候变化会对农业和畜牧业产生负面影响。研究表明到本世纪末，三分之一的粮食将陷入零产量状态。温室气体排放的持续增长可能会使粮食作物和畜牧业生产无法适应，这主要由于降雨、温度和干旱这三个气候因素。

Self frame part:
对于你来说，这意味着食物可能会变得更为稀缺和昂贵。粮食安全会通过食物价格上涨和供应不稳定直接影响你的日常生活。你应该意识到气候变化对你的生活的威胁，支持可持续农业和环保政策，确保自己的食物安全。

Word count: 193

Social frame part:

对于整个社会来说，这意味着食物可能会变得更为稀缺和昂贵。粮食安全会通过食物价格上涨和供应不稳定直接影响社会的正常运转。整个社会都应该意识到气候变化对集体生活的威胁，支持可持续农业和环保政策，确保我们的食物安全。

Word count: 200

Source: Science and Technology Daily http://finance.people.com.cn/n1/2021/0518/c1004-32106149.html

Message 8 (selected for the main study):

Table A8

Climate Change Exacerbates Global Meteorological Disasters

Base message	Self frame part	Social frame part
Current research indicates that if greenhouse gas emissions are not controlled, extreme weather events, such as heavy rains, tsunamis, and typhoons, will become more frequent in the future, with increased intensity and duration. Extreme weather events, once described as 'once in a century' occurrences, are becoming increasingly common.	Climate change is not a distant concept but a tangible threat to **you**. For instance, wildfires and heat waves could affect **your** housing and daily life, damaging property and even life-threatening situations. **You** should realize that reducing energy consumption and greenhouse gas emissions and supporting environmental policies are essential to protecting **your** life and property.	Climate change is not a distant concept but a tangible threat to **all of society**. For instance, wildfires and heat waves could affect **our** housing and daily life, damaging property and even life-threatening situations. **All of us** should realize that reducing energy consumption and greenhouse gas emissions and supporting environmental policies are essential to protecting **our** life and property.

Message 8 in Chinese:

气候变化加重全球气象灾害

现有研究显示，如果不控制温室气体排放，未来极端天气，例如暴雨，海啸和台风，会越来越频繁，强度和持续时间都会增加。过去曾被成为百年一遇的极端天气将会越来越常见。

Self frame part:

对你来说，气候变化不是遥不可及的概念，而是切实的威胁。例如，山火和热浪可能会影响你的住房和日常生活，导致财产损失甚至是生命危险。你应当认识到，减少能源消耗，温室气体排放，和支持环保政策，是保护自己生命和财产安全的重要手段。

Word count: 190

Social frame part:

对整个社会来说，气候变化不是遥不可及的概念，而是切实的威胁。例如，山火和热浪可能会影响我们的住房和日常生活，导致财产损失甚至是生命危险。所有人都应当认识到，减少能源消耗，温室气体排放，和支持环保政策，是保护我们生命和财产安全的重要手段。
Word count: 197

Source: Xinhua News Agency http://www.xinhuanet.com/world/2020-12/29/c_1210951004.htm

Message 9:
Table A9
The Impact of the Food Industry on Climate Change

Base message	Self frame part	Social frame part
Apart from fossil fuels, the food industry has the most significant impact on climate change. This is mainly because cattle emit significant greenhouse gases while digesting food. Second, the efficiency of converting feed to food in livestock is very low. Lastly, rearing livestock requires vast amounts of water and land, leading to more deforestation.	**You** can take simple measures to reduce meat consumption. For instance, if **you** try to gradually reduce animal protein intake, even reducing it by half can help **you** largely decrease **your** daily carbon emissions. This directly cuts down on greenhouse gasses and helps **you** establish healthier and more sustainable eating habits.	**All of society** can take simple measures to reduce meat consumption. For instance, if **all of us** try to gradually reduce animal protein intake, even reducing it by half can help **us** largely decrease **society's** daily carbon emissions. This directly cuts down on greenhouse gasses and helps **us** establish healthier and more sustainable eating habits.

Message 9 in Chinese:
食品业对气候变化的影响
除化石能源之外，食品业对气候变化的影响最突出。这主要因为牛在消化食物时排放的气体中含有大量温室气体。其次，家畜的喂养对食物的利用率非常低。最后，喂养家畜要耗费大量的水和土地，导致更多森林被砍伐。

Self frame part:
其实，你可以采取一些简单措施来减少肉类的消耗。例如，如果你尝试逐渐减少动物蛋白摄入，哪怕减少一半，也能帮助你每天很大程度上减少碳排放。这不仅能直接减少温室气体，且能帮助你建立更健康、更可持续的饮食习惯。
Word count: 198

Social frame part:
其实，整个社会可以采取一些简单措施来减少肉类的消耗。例如，如果所有人都尝试逐渐减少动物蛋白摄入，哪怕减少一半，也能很大程度上减少碳排放。这不仅能直接减少温室气体，且能帮助我们建立更健康、更可持续的饮食习惯。
Word count: 200

Source: Sina.com https://tech.sina.com.cn/d/v/2018-12-26/doc-ihmutuee2711488.shtml

Message 10 (selected for the main study):
Table A10
Film Star Urges Us to Reduce Plastic Use to Protect Turtles

Base message	Self frame part	Social frame part
The increasing amount of floating garbage in the oceans severely threatens the survival and health of sea turtles. Accidentally consuming plastic can lead to blockages or perforations in the turtles' digestive systems. A false sense of fullness from ingesting plastic might lead to turtles starving to death, and the toxins continuously released from plastics can harm their health.	Film actor Eddie Peng said, "By simply reducing **your** use of plastic bags and bottles, **you** can decrease the amount of trash in the oceans. Protecting sea turtles and marine life requires the participation of **you**. **You** have the power to save sea turtles' lives and, in turn, protect **yourself**. If **you** are willing, **you** can protect the environment and mitigate climate change while saving sea turtles."	Film actor Eddie Peng said, "By simply reducing **our** use of plastic bags and bottles, **we** can greatly decrease the amount of trash in the oceans. Protecting sea turtles and marine life requires the participation of **all of us**. **We** have the power to save sea turtles' lives and, in turn, protect **ourselves**. If **we** are willing, **we** can protect the environment and mitigate climate change while saving sea turtles."

Message 10 in Chinese:
电影明星呼吁我们减少使用塑料，保护海龟
海洋中的流动垃圾数量的增加对海龟的生存和健康造成了严重威胁。误食塑料会导致海龟内脏堵塞或穿孔，虚假的饱腹感可能导致海龟饿死，塑料在体内持续释放的毒素也会对海龟的健康产生负面影响。

Self frame part:
电影演员彭于晏说，"只要你减少使用塑料袋和塑料瓶，就能减少流入海洋的垃圾。保护海龟和海洋生物，需要你的参与。你能拯救海龟的生命，进而保护你自己。只要你愿意，你有能力为保护环境，在拯救海龟的同时减缓气候变化。"
Word count: 193

Social frame part:
电影演员彭于晏说，"只要我们减少使用塑料袋和塑料瓶，就能减少流入海洋的垃圾。保护海龟和海洋生物，需要所有人的参与。我们能拯救海龟的生命，进而保护我们自己。只要我们愿意，我们有能力为保护环境，在拯救海龟的同时减缓气候变化。"
Word count: 200

Source: The Paper News https://www.thepaper.cn/newsDetail_forward_3059045

Message 11:
Table A11

Calculating Carbon Footprint Can Help Address Climate Change

Base message	Self frame part	Social frame part
Sharing a carbon footprint (the amount of greenhouse gas emissions an individual causes daily) is an effective strategy to make people realize the urgency of climate change. Various aspects of routine life can be translated into energy consumption figures. For instance, recycling one ton of discarded beverage bottles equates to reducing carbon dioxide emissions by three tons and planting 41 trees.	This underscores the importance of starting with **yourself** and the potential to reduce **your** carbon footprint through simple and practical methods. If **you** consciously participate in low-carbon lifestyle practices, starting with every small action, **you** can mitigate climate change and protect **yourself**.	This underscores the importance of starting with **society** and the potential to reduce **our** carbon footprint through simple and practical methods. If **we** consciously participate in low-carbon lifestyle practices, starting with every small action, **we** can mitigate climate change and protect **society**.

Message 11 in Chinese:
计算碳足迹将有助于解决气候变化
为了让人们意识到气候变化的紧迫，分享碳足迹（个人在日常导致的温室气体排放量）是一个有效的策略。日常生活的很多方面都可以用能源消耗量进行换算，例如，回收 1 吨废弃饮料瓶，相当于减排二氧化碳 3 吨，种植树木 41 棵。

Self frame part:
这体现了从自己做起的重要性，以及通过简单实用的方法减少你的碳足迹的可能性。只要每个人都能有意识地参与到低碳生活的实践中，从每一件小事做起，你就可以缓解气候变化，并且保护你自己。
Word count: 190

Social frame part:
这体现了从社会做起的重要性，以及通过简单实用的方法减少我们的碳足迹的可能性。只要我们能有意识地参与到低碳生活的实践中，从每一件小事做起，我们就可以缓解气候变化，并且保护整个社会。
Word count: 191
Source: The Paper News https://www.thepaper.cn/newsDetail_forward_20012320

Message 12:
Table A12
Climate Change Can Trigger Underlying Diseases

Base message	Self frame part	Social frame part
Research indicates that a third of all deaths are associated with climate change. Being in non-optimal temperatures (i.e., conditions higher or lower than	**Your** quality of life, health, and future are closely linked to the environment **you** live in. **You** cannot simply focus	**Our** quality of life, health, and future are closely linked to **our** environment. **We** cannot simply focus on personal needs and comfort

the twenty-something degrees most suitable for human survival) can increase the probability of contracting underlying diseases, leading to fatalities. Thus, the incidence of many diseases will increase with climate change.	on personal needs and comfort by wasting energy or littering, but **you** should care about the environmental health **you** live in. **You** can enjoy a healthy future when **you** become aware of and act against climate change.	by wasting energy or littering, but **we** should broaden our horizons and care about the environmental health of **society**. **We** can enjoy a healthy future when **all of us** become aware of and act against climate change.

Message 12 in Chinese:
气候变化会引发基础疾病
研究表明全部死亡人数的 1/3 与气候变化有关。处在非最适温（即高于或低于人类最适宜生存的二十几度的环境下）就有可能增加患基础疾病的概率，造成死亡。所以很多疾病的发病率，会随着气候变化上升。

Self frame part:
你的生活质量、健康和未来，都与你所处的环境紧密相连。你不能仅仅关注个人的需求和舒适而浪费能源或乱扔杂物，而应该也关心你自己所处环境的健康。只有当你意识到这点并采取行动应对气候变化，你才能保护好自己的健康。
Word count: 193

Social frame part:
我们的生活质量、健康和未来，都与我们所处的环境紧密相连。我们不能仅仅关注个人的需求和舒适而浪费能源或乱扔杂物，而应该扩展我们的视野，关心社会的环境健康。只有当我们都意识到并采取行动应对气候变化，我们才能保护我们的健康。
Word count: 200
Source: The People's Daily https://www.thepaper.cn/newsDetail_forward_1402301

Appendix B Full Item List and Instructions in Pilot Study

Participants will need first to review the IRB-approved consent form and decide whether to consent to participate.

Welcoming Instructions:

Thank you for your interest in participating in our climate change communication study and getting incentive compensation. This research aims to understand public attitudes toward climate change issues. Suppose you are eligible to participate and decide to participate in this survey. In that case, you will need to carefully read 12 messages about climate change and answer one question for each message you read. The survey will take approximately 30 minutes to complete.

This research is being conducted by researchers at the University of Maryland, College Park. If you have questions, concerns, or complaints or need to report an injury related to the research, please get in touch with the investigator, Xin Ma, at xinma@umd.edu.

Screener:

Before you get started, we ask that you complete two questions to determine your eligibility for participation. If you are eligible to participate, you will be taken to the study's website, where you will be provided with more information about the study and the consent form. If you are not eligible to participate, you will be excluded from the study, and the data you provide in the survey will be deleted.

Are you a resident of China?

1. Yes
2. No

How old are you?

1. Under 18
2. 18 and above

Consent Form

Study Introduction

This research is being conducted by researchers at the University of Maryland, College Park (PI: Xin Ma). We are inviting you to participate in this research dissertation because you are at least 18 years of age and a resident of China. The study will help researchers understand public attitudes toward the issue of climate change.

The procedures involve taking an approximately 30-minute survey. You will read 12 messages adapted from news outlets, which may or may not reflect actual events or facts about climate change, and respond to survey questions.

Question Wordings and Flow for Pilot Study

Demographics (internal explanation only):

Please answer the following questions asking your general demographic information such as age, gender, education, and income level.

[Gender] What is your gender?

(1) Male

(2) Female

(3) Non-binary/third gender

[Age] Please choose your birthday

[response in years in which a respondent was born]

[Education] Please select your highest education

(1) Primary school and below

(2) Junior middle school

(3) General high school / technical secondary school / technical school / vocational school

(4) Training school

(5) Bachelor degree

(6) Master degree

(7) Doctor degree

[insert the first message here]

Perceived Self-Framing and Social-Framing (internal explanation only):

Please answer the following question:

[PF#1] The message you just read describes the issue of climate change in what ways:

1. Strongly emphasizing individual responsibilities and actions
2. Emphasizing individual responsibilities and actions
3. Somewhat emphasizing individual responsibilities and actions
4. Neutrally or balanced, emphasizing individual and group impacts and actions
5. Somewhat emphasizing groups of people and society's responsibilities and actions
6. Emphasizing groups of people and society's responsibilities and actions
7. Strongly emphasizing groups of people and society's responsibilities and actions

[insert the second message here]

Perceived Self-Framing and Social-Framing (internal explanation only):

Please answer the following question:

[PF#2] The message you just read describes the issue of climate change in what ways:

1. Strongly emphasizing individual responsibilities and actions
2. Emphasizing individual responsibilities and actions

3. Somewhat emphasizing individual responsibilities and actions

4. Neutrally or balanced, emphasizing individual and group impacts and actions

5. Somewhat emphasizing groups of people and society's responsibilities and actions

6. Emphasizing groups of people and society's responsibilities and actions

7. Strongly emphasizing groups of people and society's responsibilities and actions

[insert the third message here]

Perceived Self-Framing and Social-Framing (internal explanation only):

Please answer the following question:

[PF#3] The message you just read describes the issue of climate change in what ways:

1. Strongly emphasizing individual responsibilities and actions

2. Emphasizing individual responsibilities and actions

3. Somewhat emphasizing individual responsibilities and actions

4. Neutrally or balanced, emphasizing individual and group impacts and actions

5. Somewhat emphasizing groups of people and society's responsibilities and actions

6. Emphasizing groups of people and society's responsibilities and actions

7. Strongly emphasizing groups of people and society's responsibilities and actions

… (repeating the process for the fourth to 12th messages for both groups)

[insert the final message here]

Perceived Self-Framing and Social-Framing (internal explanation only):

Please answer the following question:

[PF#12] The message you just read describes the issue of climate change in what ways:

1. Strongly emphasizing individual responsibilities and actions

2. Emphasizing individual responsibilities and actions

3. Somewhat emphasizing individual responsibilities and actions

4. Neutrally or balanced, emphasizing individual and group impacts and actions

5. Somewhat emphasizing groups of people and society's responsibilities and actions

6. Emphasizing groups of people and society's responsibilities and actions

7. Strongly emphasizing groups of people and society's responsibilities and actions

Thank You Letter at the End of the Survey (internal explanation only):

Thank you for completing this research! If you have any questions, please reach out to the researcher at xinma@umd.edu.

Appendix C Full Item List and Instructions in Main Study

Participants will need first to review the IRB-approved consent form and decide whether to consent to participate.

Session 1 Welcome Instructions:

Thank you for agreeing to participate in our study on climate change communication. This research aims to understand public attitudes toward climate change issues. Suppose you are eligible to participate and decide to participate in this survey. In that case, you will need to carefully read one message about climate change and answer some questions. The survey will take approximately 20 minutes to complete. Please note that this is a series of six surveys; each will notify you after three days. If you complete the session, you will receive separate compensation for each completed session and provide a good-quality response.

This research is being conducted by researchers at the University of Maryland, College Park. If you have questions, concerns, or complaints or need to report an injury related to the research, please get in touch with the investigator, Xin Ma, at xinma@umd.edu.

Screener:

Before you get started, we ask that you complete two questions to determine your eligibility for participation. If you are eligible to participate, you will be taken to the study's website, where you will be provided with more information about the study and the consent form. If you are not eligible to participate, you will be excluded from the study, and the data you provide in the survey will be deleted.

Are you a resident of China?

1. Yes

2. No

How old are you?

1. Under 18

2. 18 and above

Consent Form

Study Introduction

This research is being conducted by researchers at the University of Maryland, College Park (PI: Xin Ma). We are inviting you to participate in this research project because you are at least 18 years of age and a resident of China. The study will help researchers understand public attitudes toward the issue of climate change.

Session 1 Question Wordings and Flow for Main Study

* All responses will be based on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), unless otherwise noted:

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Neither agree nor disagree
5. Somewhat agree
6. Agree
7. Strongly agree

Demographics (internal explanation only):

Please answer the following questions asking your general demographic information such as age,

gender, education, and income level.

[Gender] What is your gender?

(1) Male

(2) Female

(3) Non-binary/third gender

[Age] Please choose your birthday

[response in years in which a respondent was born]

[Education] Please select your highest education

(1) Primary school and below

(2) Junior middle school

(3) General high school / technical secondary school / technical school / vocational school

(4) Training school

(5) Bachelor degree

(6) Master degree

(7) Doctor degree

[Household Income] How much total combined income do all members of your household earn before taxes? (This will be conveyed into ¥)

(1) Less than $5,000

(2) $5,000 to $14,999

(3) $15,000 to $24,999

(4) $25,000 to $34,999

(5) $35,000 to $44,999

(6) $45,000 to $54,999

(7) $55,000 to $64,999

(8) $65,000 to $74,999

(8) $75,000 to $84,999

(9) $85,000 to $94,999

(10) More than $95,000

Cultural Worldview of Individualism Versus Communitarianism (internal explanation only):

Please rate your agreement with the following statements:

[CW#1] The government should do more to advance society's goals.

[CW#2] The government should help those in need.

[CW#3] The government should tell people how to live their lives.

[CW#4] It's society's responsibility to make sure everyone's basic needs are met.

[CW#5] The government should guide individuals to make choices good for society.

[CW#6] Everyone in our country should enjoy equal rights.

[CW#7] Our society will be better if the distribution of wealth is equal.

[CW#8] We need to reduce the inequalities among different classes.

The Frequency of Exposure to Climate Change News (internal explanation only):

[Frequency] Considering all sources (e.g., television, radio, newspapers, online news websites, social media, and conversations), how often do you encounter news or information about climate change?

(1) Rarely

(2) Once a month

(3) A few times a month

(4) Once a week

(5) A few times a week

(6) Daily

(7) Multiple times a day

Constraint Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements):

[CR#1] I don't believe I could make a difference in climate change.

[CR#2] I don't believe that I could influence the way climate change is solved.

Involvement Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements:

[IR#1] In my mind, I see a close connection between myself and climate change.

[IR#2] I feel climate change affects or could affect me personally.

[IR#3] I believe climate change could involve me or someone close to me at some point.

Problem Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements:

[PR#1] I feel that something needs to be done to improve the situation for climate change.

[PR#2] The current state (or situation) is largely different from what I believe it should be regarding climate change.

[PR#3] I believe people need to pay more attention to climate change.

Information Seeking (internal explanation only):

Please rate your agreement with the following statements:

[IS#1] I regularly check to see if there is any new information about climate change online.

[IS#2] I regularly visit websites relevant to climate change.

[IS#3] I would search for information about climate change on social media.

Information Attending (internal explanation only):

Please rate your agreement with the following statements:

[IA#1] I pay attention to climate change when a news report appears.

[IA#2] I attend to news about climate change.

[IA#3] I take some time listening if someone tries to give information about climate change.

Information Permitting (internal explanation only):

Please rate your agreement with the following statements:

[IP#1] I am willing to look at things from a different viewpoint on the issue of climate change.

[IP#2] I listen to even contradicting opinions on climate change.

Information Sharing (internal explanation only):

Please rate your agreement with the following statements:

[ISh#1] Unless people ask me, I may not initiate a conversation about climate change.

[ISh#2] I talk about this problem only when others bring up the topic of climate change.

Information Forefending (internal explanation only):

Please rate your agreement with the following statements:

[IFo#1] I know where to go when I need updated information regarding climate change.

[IFo#2] I have learned enough about climate change to judge the value of updated information.

[IFo#3] I express my opinion confidently about what should be done to deal with climate change.

Information Forwarding (internal explanation only):

Please rate your agreement with the following statements:

[IFn#1] I have posted my opinion about and experience on climate change online.

[IFn#2] I make sure that my friends know about climate change.

[IFn#3] I bring the issue of climate change to the attention of people I know.

Information Omitting (internal explanation only):

Please rate your agreement with the following statements:

[IO#1] I avoid information about climate change.

[IO#2] When it comes to climate change, I don't want to know more.

[IO#3] I refuse to listen to information about climate change.

[IO#4] I tune out information about climate change.

[IO#5] I ignore information about climate change.

Information Avoiding (internal explanation only):

Please rate your agreement with the following statements:

[IAv#1] I would rather not know about climate change.

[IAv#2] I avoid learning about climate change.

[IAv#3] Even if it will upset me, I want to know about climate change (This will be reverse-scored).

[IAv#4] When it comes to climate change, sometimes ignorance is bliss.

[IAv#5] I want to know about climate change (This will be reverse-scored).

[IAv#6] I can think of situations in which I would rather not know about climate change.

[IAv#7] It is important to know about climate change (This will be reverse-scored).

[IAv#8] I want to know about climate change immediately (This will be reverse-scored).

Message Fatigue (internal explanation only):

Please rate your agreement with the following statements:

[MF#1] At this point, I've heard about problems related to climate change more than I ever needed to.

[MF#2] There are simply too many messages about climate change nowadays.

[MF#3] After hearing them for years, messages about climate change seem repetitive.

[MF#4] Messages about climate change are all beginning to sound the same to me.

[MF#5] I'm sick of hearing about problems associated with climate change.

[MF#6] I'm tired of hearing about the importance of climate change.

[MF#7] I find messages about climate change to be dull and monotonous.

[MF#8] Messages about climate change are tedious.

Pro-environmental Self-identity (internal explanation only):

Please rate your agreement with the following statements:

[PES#1] I think of myself as an environmentally-friendly consumer.

[PES#2] I think of myself as someone who is very concerned with environmental issues.

[PES#3] I would be embarrassed to be seen as having an environmentally friendly lifestyle. (This will be reverse-scored)

[PES#4] I would not want my family or friends to think of me as someone who is concerned about environmental issues. (This will be reverse-scored)

Climate Change Beliefs (internal explanation only):

Please rate your agreement with the following statements:

[CCB#1] The climate will always be changing and what we will observe is just a natural fluctuation. (This will be reverse-scored)

[CCB#2] The burning of fossil fuels over the next 50 years will cause serious damage to the

planet's climate.

[CCB#3] Human carbon dioxide emissions will cause climate change.

[CCB#4] Humans are too insignificant to have an appreciable impact on global temperatures. (This will be reverse-scored)

[CCB#5] Climate change is a process that is underway.

[CCB#6] Climate change will not happen. (This will be reverse-scored)

Climate Change Attitudes (internal explanation only):

Please rate your agreement with the following statements:

[CCA#1] I feel concerned about climate change.

[CCA#2] I worry about climate change.

[CCA#3] I feel that climate change is an important issue to address.

[CCA#4] Climate change is an important issue to me.

Private Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPEBI#1] Choose low-carbon commuting methods like public transportation, cycling, or walking to reduce carbon emissions.

[PPEBI#2] Opt for recyclable and reusable products when making purchases.

[PPEBI#3] Reduce your personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances.

Public Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPBI#1] Support policies that limit emissions from power plants.

[PPBI#2] Support increased government investment in renewable energy research.

[PPBI#3] Support implementing a carbon tax.

[PPBI#4] Volunteer for pro-environmental activities.

[PPBI#5] Participate in climate change campaigns.

[insert the first message here for three groups]

Climate Change Beliefs (internal explanation only):

Please rate your agreement with the following statements:

[CCB#1] The climate will always be changing and what we will observe is just a natural fluctuation. (This will be reverse-scored)

[CCB#2] The burning of fossil fuels over the next 50 years will cause serious damage to the planet's climate.

[CCB#3] Human carbon dioxide emissions will cause climate change.

[CCB#4] Humans are too insignificant to have an appreciable impact on global temperatures. (This will be reverse-scored)

[CCB#5] Climate change is a process that is underway.

[CCB#6] Climate change will not happen. (This will be reverse-scored)

Climate Change Attitudes (internal explanation only):

Please rate your agreement with the following statements:

[CCA#1] I feel concerned about climate change.

[CCA#2] I worry about climate change.

[CCA#3] I feel that climate change is an important issue to address.

[CCA#4] Climate change is an important issue to me.

Private Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPEBI#1] Choose low-carbon commuting methods like public transportation, cycling, or walking to reduce carbon emissions.

[PPEBI#2] Opt for recyclable and reusable products when making purchases.

[PPEBI#3] Reduce your personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances.

Public Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPBI#1] Support policies that limit emissions from power plants.

[PPBI#2] Support increased government investment in renewable energy research.

[PPBI#3] Support implementing a carbon tax.

[PPBI#4] Volunteer for pro-environmental activities.

[PPBI#5] Participate in climate change campaigns.

Session 1 Thank You Letter at the End of the Survey (internal explanation only):

Thank you for completing the first session of this research! If you have any questions, please reach out to the researcher at xinma@umd.edu

Session 2-5 Welcome Instructions:

Welcome back to our study on climate change communication. As a reminder, this research spans seven sessions, and you are now in follow-up session [insert the appropriate session number]. Your involvement is crucial, and we appreciate your time. You need to carefully read a message first, then answering some questions.

Session 2-5 Question Wordings and Flow for Main Study

* All responses will be based on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), unless otherwise noted:

1. Strongly agree
2. Agree
3. Somewhat agree
4. Neither agree nor disagree
5. Somewhat disagree
6. Disagree
7. Strongly disagree

[insert the second to fifth messages here for three groups for each session]

Message Fatigue (internal explanation only):

Please rate your agreement with the following statements:

[MF#1] At this point, I've heard about problems related to climate change more than I ever needed to.

[MF#2] There are simply too many messages about climate change nowadays.

[MF#3] After hearing them for years, messages about climate change seem repetitive.

[MF#4] Messages about climate change are all beginning to sound the same to me.

[MF#5] I'm sick of hearing about problems associated with climate change.

[MF#6] I'm tired of hearing about the importance of climate change.

[MF#7] I find messages about climate change to be dull and monotonous.

[MF#8] Messages about climate change are tedious.

Climate Change Beliefs (internal explanation only):

Please rate your agreement with the following statements:

[CCB#1] The climate will always be changing and what we will observe is just a natural fluctuation. (This will be reverse-scored)

[CCB#2] The burning of fossil fuels over the next 50 years will cause serious damage to the planet's climate.

[CCB#3] Human carbon dioxide emissions will cause climate change.

[CCB#4] Humans are too insignificant to have an appreciable impact on global temperatures. (This will be reverse-scored)

[CCB#5] Climate change is a process that is underway.

[CCB#6] Climate change will not happen. (This will be reverse-scored)

Climate Change Attitudes (internal explanation only):

Please rate your agreement with the following statements:

[CCA#1] I feel concerned about climate change.

[CCA#2] I worry about climate change.

[CCA#3] I feel that climate change is an important issue to address.

[CCA#4] Climate change is an important issue to me.

Private Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPEBI#1] Choose low-carbon commuting methods like public transportation, cycling, or walking to reduce carbon emissions.

[PPEBI#2] Opt for recyclable and reusable products when making purchases.

[PPEBI#3] Reduce your personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances.

Public Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPBI#1] Support policies that limit emissions from power plants.

[PPBI#2] Support increased government investment in renewable energy research.

[PPBI#3] Support implementing a carbon tax.

[PPBI#4] Volunteer for pro-environmental activities.

[PPBI#5] Participate in climate change campaigns.

Session 2-5 Thank You Letter at the End of the Survey (internal explanation only):

Thank you for completing the [insert the appropriate session number] session of this research! If you have any questions, please reach out to the researcher at xinma@umd.edu

Session 6 Welcome Instructions:

Welcome to the final session of our study on climate change communication. We truly value the time and thought you have invested in this research. You need to carefully read a message first, then answering some questions.

Session 6 Question Wordings and Flow for Main Study

* All responses will be based on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree), unless otherwise noted:

1. Strongly agree
2. Agree
3. Somewhat agree
4. Neither agree nor disagree
5. Somewhat disagree
6. Disagree
7. Strongly disagree

[insert the sixth messages here for three groups]

Message Fatigue (internal explanation only):

Please rate your agreement with the following statements:

[MF#1] At this point, I've heard about problems related to climate change more than I ever needed to.

[MF#2] There are simply too many messages about climate change nowadays.

[MF#3] After hearing them for years, messages about climate change seem repetitive.

[MF#4] Messages about climate change are all beginning to sound the same to me.

[MF#5] I'm sick of hearing about problems associated with climate change.

[MF#6] I'm tired of hearing about the importance of climate change.

[MF#7] I find messages about climate change to be dull and monotonous.

[MF#8] Messages about climate change are tedious.

Climate Change Beliefs (internal explanation only):

Please rate your agreement with the following statements:

[CCB#1] The climate will always be changing and what we will observe is just a natural fluctuation. (This will be reverse-scored)

[CCB#2] The burning of fossil fuels over the next 50 years will cause serious damage to the planet's climate.

[CCB#3] Human carbon dioxide emissions will cause climate change.

[CCB#4] Humans are too insignificant to have an appreciable impact on global temperatures. (This will be reverse-scored)

[CCB#5] Climate change is a process that is underway.

[CCB#6] Climate change will not happen. (This will be reverse-scored)

Climate Change Attitudes (internal explanation only):

Please rate your agreement with the following statements:

[CCA#1] I feel concerned about climate change.

[CCA#2] I worry about climate change.

[CCA#3] I feel that climate change is an important issue to address.

[CCA#4] Climate change is an important issue to me.

Private Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPEBI#1] Choose low-carbon commuting methods like public transportation, cycling, or walking to reduce carbon emissions.

[PPEBI#2] Opt for recyclable and reusable products when making purchases.

[PPEBI#3] Reduce your personal energy consumption, such as turning off electrical appliances when not in use or minimizing the use of high-power appliances.

Public Pro-environmental Behavioral Intentions (internal explanation only):

Please indicate how likely you are to engage in the following behaviors within the next month:

[PPBI#1] Support policies that limit emissions from power plants.

[PPBI#2] Support increased government investment in renewable energy research.

[PPBI#3] Support implementing a carbon tax.

[PPBI#4] Volunteer for pro-environmental activities.

[PPBI#5] Participate in climate change campaigns.

Constraint Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements:

[CR#1] I don’t believe I could make a difference in climate change.

[CR#2] I don’t believe that I could influence the way climate change is solved.

Involvement Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements:

[IR#1] In my mind, I see a close connection between myself and climate change.

[IR#2] I feel climate change affects or could affect me personally.

[IR#3] I believe climate change could involve me or someone close to me at some point.

Problem Recognition (internal explanation only; using 6-point Likert scales, ranging from 1 (strongly disagree) to 6 (strongly agree)):

Please rate your agreement with the following statements:

[PR#1] I feel that something needs to be done to improve the situation for climate change.

[PR#2] The current state (or situation) is largely different from what I believe it should be regarding climate change.

[PR#3] I believe people need to pay more attention to climate change.

Session 6 Thank You Letter at the End of the Survey (internal explanation only):

Thank you for completing the last session of this research! If you have any questions, please reach out to the researcher at xinma@umd.edu.