AARHUS BSS
SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Can Stories Make Climate Change Communication More Effective?

Empirical Evidence

PhD dissertation

Brandi Shaw Morris

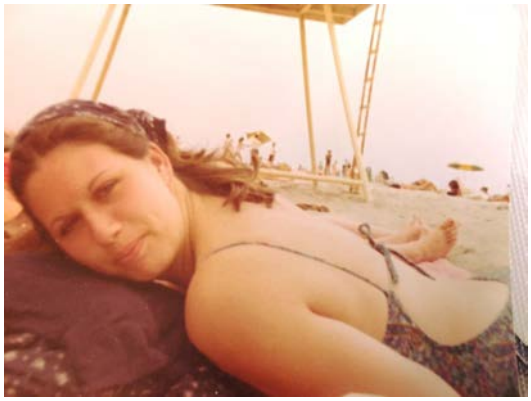
Aarhus BSS
Aarhus University
Department of Management
2018

For my mom. Brilliant, hilarious and creative.

Mad as any mad scientist.

This work is dedicated to her memory

and thanks to her sacrifice.



Acknowledgements

"The cure for everything is salt water – sweat, tears, or the sea."

– Karen Blixen

How true this is.

The past three years have been an incredible journey filled with all three.

Three whole years to learn, to teach, to go deep with a craft, and to be challenged beyond my wildest imagination. If you had told me that I would learn to code in R (or even know what R is, for that matter), report Bayesian Information Criterion, run conditional process analyses, or immerse myself in the topic of interoception -- all for the sake of improving engagement with climate change communication – I would not have believed you.

There are so many thanks to give, I am afraid this will not be short. Feel free to skip ahead but please indulge me a little. To me, this is the most important part of the entire book, which I realize that few will actually read.

First, thank you to my doctoral committee and advisors.

I am truly honored to have such inter-disciplinary titans evaluating my dissertation: Drs. Jessica Aschemann-Witzel, PhD, professor of marketing and consumer behavior, Lorraine Whitmarsh, PhD, professor of environmental psychology, and Irene Lorenzoni, PhD, senior lecturer in environmental science. A heartfelt thanks for the countless hours you have invested in constructively scrutinizing this work to improve it – and me. I have profound respect for the commitment that each of you shows to making the world a better place through the rigor and relevance of your research.

Jacob E., thank you for taking responsibility for me through this process. I am particularly grateful for the kindness that you and the department showed me during my mom's passing, one short year ago.

Pol and Panos – $P^{2:}$ where to start? You guys have been such faithful teachers and coaches. Words cannot express how grateful I am for your mentorship, support, patience, and encouragement. Thanks for the beers and the moussaka. For the hearty laughs and the comradery. Thanks for putting up with my real-world-impact-obsession and non-academic email prose. But most of all, for having the patience to let me wrestle with stats ;-) Είμαι μανούλα στη στατιστική!

Through my entire career, I have been extremely fortunate to have managers who are 'Multipliers': Scott H., Michael L., Michael M., Chip G.. Thank you for believing in and investing in me. Without your trust, I would not have gained the experience and expertise that allowed me to undertake and survive these past three years. I am more grateful than you can know.

To Jacobs Orquin and Christensen, Erik Lahm: again and again, you cheered me on (and up!) when I was in stats despair. Thank you, not only for your patient and brilliant mentorship but for your care and friendship.

During the past three years, I was so incredibly fortunate to have two separate research stays during which I not only had the privilege of collaborating on some fantastic work but also making dear new friends.

To my colleagues and friends at the Yale Program for Climate Change Communication: Tony L. thank you for so generously and proactively offering your mentorship and for taking an interest in my career. Lisa F., Jenn M., Xinran W., Erik F., Seth R, and John O., thank you for making me feel at home on

your team, for sharing your experience, wisdom, and findings. I have such abiding respect for your focus on both academic rigor and real-world impact. If Denmark hadn't been calling so strongly, you would not have been able to get rid of me.

To my collaborators and friends at the Center for Neuroeconomic Studies, Claremont Graduate University, I am grateful for your mentorship, partnership, and training. Thanks to Paul Z. for believing in the research idea from the get-go, and for inviting me to collaborate. To Jorge B. and Elisabeth T. who welcomed me with warmth and worked hard to train me in their lab. Holy cow those were ~~fun times~~ very serious and hardworking times. To all of my lab assistants – particularly Collin B., Dhruv K., Chelsey C., and Garrett T. Thank you for your hard work, for keeping me company and making me laugh during the wee hours.

To Andreas Roepstorff, not just brilliant, but a genuinely wonderful human being. Hero is not a word to be used lightly, but Andreas, you are. Being a part of the Interacting Minds Centre (IMC) has been a highlight of my experience at AU and certainly the brightest spark for my own creativity and enthusiasm these past three years. 1,000 thanks.

To Mary Helen Immordino-Yang, what the heck would I have done without your friendship, encouragement, advice, and brilliance? I seriously do not know. Sisters separated at birth.

To Lars Frederiksen and the PhD Selection Committee: thanks for giving me this opportunity despite my private sector background and the fact that I wasn't at the beginning of my career. I hope this will encourage you to take this chance on 'atypical' PhDs in the future. Lars, thank you for continually trying to make this a better place for doctoral students.

To Klaus Grunert – thank you for your fairness, generosity, and support as the leader of our research section. I respect you immensely and (given that we are, after all, in the Department of Management) your commitment to maximizing private sector impact. Thanks to Charlotte Rosholm, the world's most caring and helpful secretary (and a fantastic Latin dancer to boot)! John Thøgersen, thank you for believing in me throughout the application process and for inspiring me to care about sustainability.

A heartfelt thanks to the Danish taxpayers for valuing and investing in research and education for all. I did my level best to take this responsibility seriously and to generate something of use to society. It was a privilege. To the IMC and AUFF supplementary pool, a million thanks for the funding, without which this research would simply not have been possible.

To David Salvesen – thank you for sharing so generously from the great work you are doing at the University of North Carolina – Chapel Hill. Keep on telling impactful climate change stories! To Sue Campbell for her help in developing the stimuli for my very first study. Thanks for spending some of your literary talent on science!

To the hardworking research assistants here at COBE (Anna K.) and CGU who helped me with data collection. Thanks for all your help in the lab. I could not have done it without you.

Thank you to Mike M., Birgitte S., and Karin H. for your help in proofing this monster!! Xoxo

Finally, to beloved family, friends, and colleagues who have been so incredibly supportive to me and to our family in both tangible and intangible ways.

Helle, Franzi, Mai, and Eliane. Girls, your loyal friendship + great cocktails and tapas, have filled me with hope, inspired and kept me sane. Love you to the moon and back.

To my dear and faithful partners in crime: Cita, Katya, and Erik. For whiskey, belly laughs, practical advice, and moral support through good times and bad. Erik, you were the very best office mate a person can have (besides Darius of course ;-)). Can't wait to see you guys cross the finish line.

Natalie V.M., Darius F., Carsten B., Marija B., Pernille K., Charlotte, R., Lina J., Emma P., Susanne P., Tobias O., and to the many other wonderful friends & colleagues I have not mentioned by name, thank you.

To my oldest friend, darling Denise, thank you for a lifetime of friendship and for always seeing the best in me. Matt M., Dena and Rick V., Sonja B., Luc S., Jen P., Becca and Brian D., Jason and Heather D., Claudia and Rob M., for your faithful love, and support, even when it meant us moving halfway across the world.

To cherished and dear 'old' friends, our adopted family here in DK: Mic, Roberto, Gitte, Anders, Marian, Peter, Fatima, Torsten, Anders-Michael, Morten, Camilla, Bodil, Jens-Peder, Anni and Kenneth. I treasure every moment together and the chance to live side by side again.

To our families in the U.S.: thank you for your continual love and support, even from so many miles away. And for not kicking us out of the clan for leaving California. Remember how a bunch of our European ancestors sailed by ship to Ellis Island way back when? Well, a couple of hundred years later a few of us decided to come back to see how things are going ;-) So far, so good but we sure do love and miss you guys.

To my love, my husband, Michael. These years have been a wild ride, and you have been a rock. I would never have had the courage to take this leap or the fortitude to finish such a formidable undertaking, had it not been for your unwavering support and encouragement. Thank you for being so adventurous as to move our family halfway around the world. For leaving all that is familiar and culinarily right with the world, to embrace a land that is not your own. To say that this wasn't as simple as we expected is putting it mildly. Thank you for standing behind me, holding me, and reminding me of my value when this thing has brought me low. For the extra loads of laundry and pots and pots of spaghetti with meat sauce. What would I do without your continual sparring and feedback? I admire you in so many ways. Thank you, babe. We made it through, together – and stronger than ever. (And thank you, Stewart Mullin, for being so supportive when I was out of pocket!). To my precious and wonderful children, Audrey and Kellen. You guys are amazing. Ever since I started this "Ph-poop" (as Kellen calls it), you have been the sweetest cheerleaders. Your kisses and hugs are the best part of every day. I have done my best to keep work- and home life in balance, but this was not always enough. Even then, you were so supportive and loving. Thank you for letting me do this crazy thing, and for being proud of me no matter what. I am so honored and proud to be your mom. If a heart could burst with gratitude, mine definitely would. In the grand scheme of things, I hope these past few years will not have been *too traumatic* because nothing in this whole wide world comes close to being as important to me as the three of you.

With affection and gratitude,

Brandi S. Morris

Aarhus, October 12, 2018

Executive Summary

What good does it do to craft climate change communications that don't influence the public's beliefs, attitudes or behavior? Presenting empirical evidence from 11 experiments, this dissertation advances our understanding of how stories may be used to improve engagement with climate change. Building on prior research from the fields of psychology, neuroscience, narratology, and communication, my work fills lacunae in the literature by exploring the underlying mechanisms of how stories persuade. More specifically, I examine how climate change stories impact behavior, risk perception, and outcome efficacy via three mechanisms: narrative structure, affect and character identification.

Climate change is a psychologically distant and cognitively overwhelming threat with complex causes and solutions. Given low, current levels of public engagement among both skeptical and alarmed audiences, the legitimacy of the information deficit hypothesis must be called into question. Prior research demonstrates that motivated- and identity-protective cognition are formidable forces working against the rational assimilation of information on issues that represent viable threats to identity, worldviews, and social affiliation. The central proposition of this work is that stories have greater potential for overcoming these forces than analytical frames, primarily because they foster experiential processing and affective engagement, rather than cognitive elaboration. The findings of my research support this claim and demonstrate that stories predict behavior through emotional arousal, likely as the brain's way of optimizing scarce bodily resources. Further, I find evidence that climate change appeals ending with negative affective valence are more effective at heightening risk perception and outcome efficacy (i.e., the sense that one's own behavior actually makes a difference) than positive counterparts. This held true for nearly every audience segment, including those holding conservative, individualistic or hierarchical worldviews. Last, the findings of this research suggest that religious, individualistic and hierarchical audiences are less likely to

counterargue and more likely to perceive the threat of climate change after encountering story characters with whom they identify and perceive as sharing their own ideological commitments.

This research has implications for science communication scholars and practitioners alike. In a twist of irony, structuring narratives as factual presentations ignores what science tells us about the important role of affect and emotion for optimizing communication and engagement. To maximize risk perception, a sense of personal responsibility, and action on climate change, science communicators should consider enrobing the presentation of information in story structure with unhappy endings and characters who embody the values of the most disengaged audience segments.

The dissertation consists of three papers that are under review or prepared for publication in international scientific journals.

Dansk Resumé

Hvad godt gør det, hvis kommunikation om klimaforandringer ikke påvirker offentlighedens holdninger eller adfærd? Baseret på resultater fra 11 eksperimenter bidrager denne afhandling til vores forståelse af, hvordan historier kan bruges til at forbedre kommunikationen om klimaforandringer. Denne forståelse bygger på forskning inden for psykologi, neurovidenskab, narratologi og kommunikation, og dermed komplementerer afhandlingen litteraturen på området ved at undersøge underliggende mekanismer for, hvordan formuleringen af en historie eller et budskab overbeviser modtageren. Mere specifikt undersøger jeg, hvordan historier om klimaforandringer påvirker adfærd, risikoopfattelse og virkningsgraden ved hjælp af tre mekanismer: fortællestruktur, affektion og karakteridentifikation.

Klimaforandringer er en psykologisk fjern og kognitivt overvældende trussel med komplekse årsager og løsninger. I lyset af det nuværende lave niveau af offentligt engagement, både blandt klimaskeptikere og klimaforkæmpere, må der stilles spørgsmål ved legitimiteten af hypotesen om information deficit. Tidligere forskning har vist, at motiveret og identitetsbeskyttende kognition udgør stærke kræfter, der modarbejder rationel assimilering af information vedrørende forhold, som er en reel trussel mod en persons identitet, verdenssyn og sociale tilhørsforhold. Den centrale påstand i dette arbejde er, at historier har større potentiale til at overvinde disse styrker end analytiske rammer, primært fordi historierne fremmer en erkendelsesmæssig proces og et affektivt engagement snarere end en kognitiv bearbejdning. Resultaterne af min forskning støtter denne påstand og demonstrerer, at historier kan forklare adfærd via følelsesmæssig engagement. Dette kan skyldes, at hjernen optimerer kroppens begrænsede fysiske ressourcer.

Endvidere viser afhandlingen, at fortællinger om klimaændringer, der slutter negativt snarere end positivt, er mere effektive til at øge risikoopfattelsen og den faktiske indvirkning på individet (dvs. følelsen af, at ens egen adfærd rent faktisk gør en forskel). Dette var tilfældet

for næsten alle de undersøgte grupper, også dem med konservativ, individualistisk eller hierarkisk verdenssyn. Endelig tyder resultaterne af denne forskning på, at religiøse, individualistiske og hierarkisk-orienterede grupper er mindre tilbøjelige til at modargumentere og mere tilbøjelige til at opfatte truslen om klimaændringer efter at have læst/hørt om personer, som de kan identificere sig med, og som de ser som havende de samme overbevisninger som dem selv.

Denne forskning har både konsekvenser inden for det videnskabelige område og praksisområdet. Det viser sig, at videnskabens klassiske strukturerede og faktuelle tilgang, ignorer hvad videnskaben fortæller os om, hvordan affektivt og følelsesmæssigt engagement spiller en central rolle for kommunikationen og modtagernes engagement. For at maksimere risikoopfattelsen og en følelse af personligt ansvar samt for at øge handlingsparatheden vedrørende klimaforandringer bør videnskabsformidlere overveje at præsentere deres budskab på en måde, hvor tingene ender ulykkeligt, og hvor karakterernes personlige værdier ligner dem, som de mest uengagerede befolkningsgrupper har.

Afhandlingen består af tre artikler, som er under revision eller ved at blive forberedt til offentliggørelse i internationale, videnskabelige tidsskrifter.

Table of Contents

"The death of one man is a tragedy,
the death of millions is a statistic."

- Joseph Stalin

Preface

What good does it do to craft climate change communications that don't influence the public's beliefs, attitudes or behavior? A report or campaign may contain the findings of peer-reviewed research. It may even be aesthetically pleasing and well written. But if it does not influence how people think or act, what is the point?

In 2002, I was living in Los Angeles and working for an advertising agency specialized in serving some of the best-known charitable brands in the world. My job as an Account Supervisor was to interface with clients, understand their needs, and come up with a strategy with a team of agency specialists: designers, developers, media and production people. As we sat in the large glass boardroom, discussing how to <fill in the blank – raise money, raise awareness, etc.>, two things were sure: 1) we needed to influence some sort of behavior and 2) we were going to tell stories. And since our clients were non-profits, we were going to be accountable for each and every penny spent. This means that every single element of every marketing/advertising campaign would be A/B tested, weighed, and measured by its influence on one behavior or another.

Among the many steps to creating a campaign from start to finish, one of the most daunting was facing off with our Creative Director, Maggie. Tough and exacting, no campaign detail was spared her scrutiny. Maggie had a reputation for being a bit of a diva but not in the manner depicted in Madmen. Account people are usually strategists, but we are also in a sales role, wanting to dazzle our clients with originality. If we were frustrated by a lack of creativity or novelty in art, design or copy, our requests were always met by one single statement from Maggie, spoken with amusement in her eyes: "let's test it." And test it we would. Across hundreds of campaigns and audiences, using sophisticated segmentation strategies and every thinkable media. We tested headlines and photos, format sizes and color and often just a single word. Sometimes tests would confirm our intuitions and other times they would reveal our ignorance. But the *one thing* that high-performing campaigns always had in common was this:

they were emotionally compelling stories. Time after time, to my surprise, a poor-quality photo of a woman with a criminal past handily outperformed the well-executed and slick infographic. An account of a homeless guy who had beaten the odds (and whose story had been told a thousand times) would pummel a campaign that included intellectually compelling statistics and charts demonstrating profound societal impact. Over and over, stories were better at affecting actual behavior compared with even the most intellectually compelling information.

Now, if you ask people, they will tell you they like information, charts, and graphs. We are, after all, an evolved species! The problem seems to be that this kind of information doesn't have a strong track record of getting people out of their chairs to take action. There are many ways to tell a story; charts and graphs are one of them and not always a bad idea. The #1 rule of communication is to know your audience. Let me tell you: you'd be better off attending a scientific conference without pants than without charts, tables, and graphs with confidence intervals! But for most people walking through the noise of everyday life, these kinds of frames simply will not compel attention or engagement in the same way as a story about character X, struggling to overcome <fill in the blank> in order to <fill in the blank>. Though I didn't realize it at the time, Maggie was a scientist, listening not to her own creative whims or preferences, but to what the data told her about what actually influences behavior. And stories work. She knew the underlying mechanisms of what makes stories powerful and leveraged that understanding in every campaign she designed.

Fast forward to 2014. I had developed an obsession with the neuroscience and psychology of story at the same time as my concern about global warming was growing. It was hard to understand that nearly 30 percent of Americans didn't believe in a problem that 99 percent of scientists agree is real and influenced by human behavior[1]. In 1896, Swedish scientist

[1] IPCC. (2013). Summary for policymakers. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Svante Arrhenius was the first to warn that human activity such as fossil fuel combustion could eventually lead to a dangerous rise in global temperatures. Yet here we stood, 120+ years later, paralyzed by inaction. I was perplexed and dismayed by how, in spite of my own alarm, I could still reach for another plastic bag or tin foil instead of using a more sustainable and less convenient food storage option. This led me to the research of behavioral psychologist Dan Ariely. My portfolio of non-profit clients contained no environmental organizations, but I was starting to notice that few, if any, of these environmental groups, were telling stories, save for that of the occasional polar bear standing on a melting ice cap. 'Why,' I wondered, the ubiquitous absence of stories in these marketing communication campaigns?

Four years later, I think I know the answer. For the most part, climate change communicators are acting as the voice of scientists, sharing empirical research findings. Scientists are eminently cautious, they speak in probabilities, and avoid any appearance of certainty. As I would discover, scientists are highly suspicious of 'stories' hanging out in the world of science. Alas, scientists are humans with biases and blind spots too. It appears that in the realm of science communication, many scientists have forgotten to consider what empirical research tells us about the critical role of experiential processing and affective engagement – at least when it comes to lay audiences. It is here that my research questions were born. These questions are the basis of this dissertation and the three research papers it contains. It is my hope that this work contributes to a broader understanding of how climate change communicators might improve public engagement campaigns through the use of stories.

Chapter 1
Background and Theory

"The video about climate change was absolutely ridiculous. How can you answer questions about something that is political, masquerading as science…I hope you are planning to use it with uninformed people [because] I cannot imagine that an educated person would see any value in watching it."

- Nancy (online study participant)

1.0 Overview

The research presented in this dissertation draws on a valuable body of literature and a rich set of empirical data to explore the research questions and their corresponding conceptual models. This work builds on eleven experiments, conducted online and in laboratories, administered to people in the United States and Denmark. Great care was given to the selection and development of stimuli used in these experiments so as to maximize the external validity and generalizability of these findings. In this first chapter, I give a brief synopsis of the background, key concepts and theories upon which this work is founded. Chapter 2 provides an overview of the empirical work undertaken together with reflections on research design, methodology, and data collection. Chapter 3 is comprised of the three scientific articles themselves. Finally, Chapter 4 puts the major findings of the three papers into a broader context and discusses implications for practice and future research.

1.1 Background

"Climate change" describes both a public policy issue and set of physiologic phenomena. For more than 150 years, scientific understanding of climate change has progressed toward ever-increasing degrees of certainty about the phenomena (Weber & Stern, 2011) while the global consequences remain unclear. At the end of the nineteenth century, a Swedish Nobel laureate

was the first to warn that human activity such as fossil fuel combustion could eventually lead to a greenhouse effect causing a rise in global temperatures (Arrhenius, 1896), a prediction based on discoveries in geology, biology, physics, and chemistry dating back to the 1700s (Baum, 2016). In 1959, an observatory in Hawaii issued the first report of disturbingly high levels of atmospheric carbon dioxide (CO_2), compared with peak concentration levels observed in the 420,000 year-old ice-core record. In the United States, there was initially broad bipartisan concern and support for investigating the issue (Weber & Stern, 2011), which first emerged in public consciousness in the 1980s (Capstick, Whitmarsh, Poortinga, Pidgeon, & Upham, 2015). The U.S. Congress passed several important bills such as the Global Climate Protection Act of 1987 and the Global Change Research Act of 1990 to coordinate national policy on climate change and to study its' causes, effects, and proposed responses (Weber & Stern, 2011). Though limited in comprehension, global public awareness of the issue rapidly increased in the second half of the 1980s (Nisbet & Myers, 2007). Evidence presented by climate scientists was broadly accepted until the late 2000s, even as levels of concern fluctuated throughout those years (Capstick et al., 2015). Over time, people in the United States and the United Kingdom have consistently exhibited lower levels of belief than other countries. In 2007 and 2008, 49% of Americans and 48% of people in the UK believed that humans are causing climate change compared with, for example, 91% in Japan, 81% in Argentina, and 61% in Canada (Pelham, 2009).

Polarization and skepticism about the anthropogenic nature of climate change, and of climate science more broadly, experienced a sharp increase in the U.S. from 2008-2010, immediately following the financial crisis (Leiserowitz A, 2013). During this time, climate change imagery became increasingly associated with conspiracy theories and the belief that it is a naturally-occurring phenomenon (Smith & Leiserowitz, 2012). Similar findings from other countries confirmed a growing skepticism and belief that the threat of climate change was

grossly exaggerated (Capstick et al., 2015). The factors influencing these changes in public perception are myriad and complex. They include interactions between sociocultural, political, and physical phenomena (Capstick et al., 2015), an exhaustive discussion of which is beyond the scope of this dissertation. However, it is relevant to mention that one of these developments followed the election of Barack Obama, and the conservative Republican decision to espouse climate skeptical-views as a way of differentiating from the political platform of Democrats. Increasing political polarization and our evolutionary proclivity toward coalitional thinking have profound implications for the assimilation of information on this issue and our ability to converge on policy to effectively address the threat that climate change poses to all humans. Understanding these developments is critical in order to put this research into context.

Addressing climate change is one of the greatest challenges of our time yet only one in four Europeans believe that they bear personal responsibility for tackling anthropogenic effects (European Commission, 2014). In the U.S. 28 percent of the population are climate change skeptics', believing that global warming is due mostly to natural causes (Leiserowitz, 2017). While most mitigation strategies focus on long-term options, there is mounting evidence that actions by households could provide a behavioral 'wedge' to rapidly reduce carbon emissions with little or no reduction in well-being (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). How can science communicators influence the attitudes and behaviors of consumers in an environment characterized by uncertainty and foreboding complexity? Providing them with more information alone may not be the answer (Staats, Wit, & Midden, 1996). As illustrated by the 'green gap' (Black, 2010), even consumers with strong pro-environmental attitudes such as climate scientists and activists wrestle with reconciling competing goals and values (Waring, Teisl, Manandhar, & Anderson, 2014; Young, Hwang, McDonald, & Oates, 2010).

Climate change differs from many other threats in that it lacks a number of salient characteristics that elicit a sense of urgency and need for action. In many countries, an

individual's stance on climate change has also become a telling cue of values, identity and social belonging (Kahan, Jenkins-Smith, & Braman, 2011). The acknowledgement that climate change is real and influenced by human activity has implications that strike right to the heart of close-held values. These values inform individual views about how society should be ordered and exert significant influence on how individuals process risk. People may lack the motivation to accurately assimilate new information that threatens their values, identity or social belonging. A growing body of research suggests stories have the potential to overcome these tendencies. The following sections provide a brief layman's introduction to the key concepts and theories upon which the scientific papers themselves are founded.

1.2 Biased Assimilation of Information

Studies have shown that higher problem awareness is associated with stronger feelings of personal responsibility and higher outcome efficacy (de Groot & Steg, 2010; Gärling, Gärling, Fujii, & Jakobsson, 2003), but research also indicates that increasing knowledge and problem awareness are only minimally effective in producing behavioral change (Dolan et al., 2012; Rettie, Burchell, & Barnham, 2014). Even so, science communicators often employ information-based media campaigns (Pickett-Baker & Ozaki, 2008), exemplifying the information deficit hypothesis: the idea that giving people more information is the solution. However, a critical assumption underlying this hypothesis is that people strive for accuracy and automatically update their beliefs in the face of new information. This assumption conflicts with what extensive empirical research tells us about human nature.

We are highly skilled at discounting even well validated empirical information when it does not suit our purposes. This is particularly true for issues on which we hold very strong opinions or those which are closely tied to our identity and social affiliations (Kahan, Braman, Gastil, Slovic, & Mertz, 2007). The potential psychological and social costs may eclipse the

benefits of factual accuracy. Through the biased assimilation of information, we tend to accept confirming evidence at face value while rejecting disconfirming evidence - even after extensive scrutiny (Lord, Ross, & Lepper, 1979). In fact, in situations like these, empirical evidence tends to *increase* polarization rather than decreasing disagreement (Kahan, 2012a; Lord et al., 1979). Confirmation bias, motivated cognition, and identity-protective cognition are three of many cognitive biases which allow us to subconsciously process information in ways that protect us against threats to our identity, values, and social standing. These biases are also at the heart of much climate disengagement and denial.

Through numerous experiments, Dan Kahan and his team at Yale University have shown (see for example, (Kahan, 2012b; Kahan, 2013; Kahan et al., 2007) that when it comes to issues which have become "contaminated with social meaning" (e.g., climate change), scientific literacy and comprehension do not predict belief (Kahan, 2015, 2017). Kahan finds that people of all parties and persuasions calculate backwards to confirm conclusions they have already reached and which protect their closest social ties. No human is free from bias. In a cognitive bias known as moral licensing (Sachdeva, Iliev, & Medin, 2009), people who behave 'morally' (e.g., sustainably) in one area of their life may rationalize the areas where they are not (Bearzi, 2009). Motivated reasoning is a strategy for reducing cognitive dissonance, enabling people to arrive at their desired conclusions when new information conflicts with their directional goals and closely-held values (Kunda, 1990).

1.3 Values & Identity

Values are "(a) concepts or beliefs (b) about desirable end states or behaviors (c) that transcend specific situations (d) guide the selection of behavior and events, (e) are ordered by importance" (Douglas & Wildavsky, 1982, p. 551), and expressed in different motivational domains (Schwartz & Bilsky, 1987). They play a key role not only in forming our affiliations

but also in determining our receptivity to new information. When we perceive that another person shares our values, we are more likely to trust and be persuaded by them. This is particularly true for an issue like climate change because our values determine our worldviews and goals. The belief that climate change is anthropogenic (human-caused) has implications that constitute a greater threat to certain worldviews and goals than for others. For example, people holding an individualist worldview eschew government regulation and are therefore more likely to feel threatened by the implications of anthropogenic climate change than those holding communitarian worldviews (Kahan et al., 2011). Similarly, those who are religious are also more likely to experience cognitive dissonance when acknowledging that humans have responsibility for destroying the earth at the same time as believing in an all-powerful God. System justification theory (Jost, 2005) describes the finding that we are tempted and compelled to defend the systems that we support and which benefit us and our beliefs most.

Our values are closely tied to our identities, and according to Social Identity Theory, people derive a sense of "social and personal self-worth from the identities they hold" (Cohen et al., 2007). We will go to great lengths and are willing to pay a high price when it comes to factual accuracy in order to protect our identities and social standing. From an evolutionary perspective, motivated cognition is an adaptive strategy because belonging to a social in-group is critical for survival. However, disregard for factual accuracy is maladaptive when it leads us to make decisions which threaten our wellbeing and survival; such is the case of climate change. It appears that we might be able to mitigate these human vulnerabilities by framing information in a way that affirms rather than threatens, using messengers who share closely held values with their audience.

1.4 Risk Perception, Affect & Valence

Climate change is a unique type of threat because it lacks specific characteristics that typically cause us to worry and take action in the face of danger. Among other things, there is no clearly identifiable enemy or victim. Perhaps more accurately, the enemy and the victim is us. Our tin foil and plastic bags, our air travel, laziness and propensity towards convenience – we are becoming our own undoing. It is much easier to pin the blame on others…out there…the oil companies, the government, the factories. Who is buying these goods and services that are contributing to rising carbon dioxide levels? Who is electing these fickle governments who fail to take consistent and forceful action? We are, and this is difficult for us to face.

Climate change is a 'wicked problem' (Churchman, 1967) with complex causes and solutions. As a threat, its consequences seem distant, and this fosters a sense of numbness (Slovic, 2007) and optimism bias (Sharot, 2011). Humans have a "finite pool of worry" (Weber, 2006) and, according to recent public opinion research, climate change does not rank high on the list of top priorities for most Americans (Pew Research Center, 2018). Fatigued from constant warnings of impending apocalypse (Nordhaus & Shellenberger, 2009), it is easier for us to opine about the barrage of doom and gloom messages raining on our optimistic parade. Why can't they be more hopeful? Surely someone in the future will come along and fix this mess. In this way, we can allow ourselves to move on with life and business as usual. Unlike threats such as terrorism and Ebola, climate change does not spark strong affective engagement shown to be highly predictive of action taking (Loewenstein, Weber, Hsee, & Welch, 2001; Slovic, Finucane, Peters, & MacGregor, 2004).

A large body of research on the psychology of risk conveys a compelling and consistent message: humans have a propensity for unjustified optimism, laziness, and inaction for as long as we can convince ourselves that everything is going to be okay without our help. Affective engagement and emotion are necessary for motivating action in the face of a threat. Through

affective engagement, the brain constructs an instance of emotion which functions as an impetus for bodily action necessary to the optimization of bodily resources (Barrett, 2016). Affect has also been termed a 'heuristic' (Slovic, Finucane, Peters, & MacGregor, 2007): positive affect suggests that all is well in our surroundings and provides little impetus for change while negative affect enables more accurate probability calculation, the perception of risk, and the motivation to take action in the face of danger. Valence is the inherent (positive or negative) 'charge' of an emotion and thought to be a form of psychological valuation which exerts distinctive influence on judgment and decision making based on the perceived importance, desirability (Damasio, 2011) or expected consequence of a specific piece of information (Barrett, 2006). Negative affect has been shown to *increase* estimations of risk probability while positive affect *reduces* it (Finucane, Alhakami, Slovic, & Johnson, 2000; Ganzach, 2000).

1.5 Stories

The goal of all communication is to influence the target audience, yet information alone rarely changes attitudes, beliefs or behavior. Analytical information does not easily trigger affect, and this may be why climate change does not worry us (Loewenstein et al., 2001; Marx et al., 2007; Weber, 2006). Most people associate the word 'story' with fiction but as Haven (2007) puts it, "stories are a way of structuring information, the scaffolding upon which the content is hung, not the content itself." This idea of stories as fluffy personal accounts is a common misperception. For the purposes of this work, I define a story as "a detailed, character-based narration of a character's struggles to overcome obstacles and reach an important goal ... a framework and way of structuring information" (Haven, 2007, p. 79). It is not uncommon to hear the terms *narrative* and *story* used interchangeably, but in this work, I refer to them as distinctly different concepts. *Webster's Collegiate Dictionary* (2004) classifies 'narrative'

through a sequence of sub-definitions: (i) Narrate: to tell in writing or speech. To give an account of (ii) Narration: the act or process of narrating, and (iii) Narrative: of or having the nature of narration. By this definition, 'narratives' are a very general term, used to encompass all manner of different types of communication. Stories, however, are a specific subset within the category of narratives: all stories are narratives, but not all narratives are effective stories (Dalkir & Wiseman, 2004). In this work, I define *narrative structure* as the degree to which a narrative tells a story and contains essential features including an identifiable character, plot (temporal dimension, goal), and setting. The higher the narrative structure, the more story-like the narrative.

The core proposition of the research presented in this dissertation is that stories are a more effective way of presenting information than the analytical frames typically used in climate change communication. Stories are an effective way of communicating factual as well as tacit information and knowledge (Dalkir & Wiseman, 2004) and of providing the framework most conducive to long-term recall (Mandler, 2014), comprehension (Armbruster, Anderson, & Ostertag, 1987), retention, application, and learner enthusiasm (Coles, 1989). Clandinin and Connelly (2000) concluded that story structure facilitates all six levels of Bloom's Taxonomy (knowledge, comprehension, application, analysis, synthesis, and evaluation) by providing context and relevance as well as information. Stories activate unconscious parts of our brain (Pinker, 2015) and feed the output to the conscious mind for consideration (Edelman & Tononi, 2003). Stories have dominated human interaction for over 100,000 years, which may have rewired the human brain (Nelson, 2003; Pinker, 2015) to decode the world in story structure. Turner (1996) posited that the meaning from one story could be used to help make meaning of another through a form of psychological projection. Stories can function as a form of cognitive rehearsal and a form of observational learning (Hertwig, Barron, Weber, & Erev, 2004; Weber, Shafir, & Blais, 2004). They can function as proxies of personal experience (Cron, 2012)

shown to heighten perception of climate change risk (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013).

Narrative transportation describes the experience of being lost in a story (Nell, 1988) to the extent that all sense of time and space, as well as existing schema, are temporarily suspended (vanLaer, Ruyter, Visconti, & Wetzels, 2014). Through 'narrative transportation,' stories become vehicles of influence by conveying a desired way to feel, think, or act (Gerrig, 1993). In order for stories to influence attitudes and behaviors, they must contain elements of high emotional valence to capture attention and engage viewers in an empathic connection with the characters (Bagozzi & Moore, 1994; Fisher, Vandenbosch, & Antia, 2008; Lin, Grewal, Morin, Johnson, & Zak, 2013). The neuropeptide oxytocin (OT) has been associated with the subjective experience of empathy (Barraza, McCullough, Ahmadi, & Zak, 2011; Hurlemann et al., 2010) and has been identified as a biological basis for pro-social behavior in humans (Heinrichs, Fischbacher, Fehr, Zak, & Kosfeld, 2005), where OT receptors are distributed throughout regions of the brain associated with behavior (Huber, Veinante, & Stoop, 2005). In a study where subjects were exposed to an emotional narrative, Barraza, Alexander, Beavin, Terris, and Zak (2015) found that autonomic measures of sympathetic and parasympathetic reactivity derived from cardiac and electrodermal activity significantly predicted costly behavior.

In the language of dual process theory (Kahneman, 2003; Petty & Cacioppo, 1986), stories foster experiential, rather than analytical processing, reducing critical thoughts and counterargument, increasing the likelihood of narrative persuasion (Green, 1996; Green & Brock, 2000; Green & Clark, 2013). Experiential processing heightens affective processing in a way that analytical processing does not. Indeed, a growing body of research suggests that emotional stories (see for example Hoeken, Kolthoff, & José, 2016; Loewenstein, 2010) have

superior abilities to inspire pro-social behavior (Barraza et al., 2015; Lin et al., 2013; Small & Loewenstein, 2003) compared with informational narratives (Small & Loewenstein, 2003).

1.6 Defining Climate Change Engagement

The three articles contained in this dissertation build on theories discussed throughout this chapter. The primary aim of this research is to answer the overarching question as to whether structuring climate change narratives as stories will improve engagement with the issue. In line with Lorenzoni, Nicholson-Cole, and Whitmarsh (2007), I define climate change "engagement" as a personal state of connection, "an individual state of involvement…at cognitive, affective and behavioral levels" (p. 476), focusing primarily on the two latter aspects, emotional engagement and behavior.

1.7 Research Questions

Building on this valuable prior work, the studies outlined in this dissertation were driven by the following research questions:

- Are climate change narratives structured as stories better than analytical frames for promoting pro-environmental behavior and engagement with climate change?

- Do stories with negative affective end valence increase climate change risk perception and outcome efficacy more than those with positive affective end valence?

- Does perceived value congeniality between a story character and receiver heighten climate change risk perception?

References

Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. (2013). Do people "personally experience" global warming, and if so how, and does it matter? *Global Environmental Change, 23*(1), 81-91. doi:10.1016/j.gloenvcha.2012.07.006

Armbruster, B. B., Anderson, T. H., & Ostertag, J. (1987). Does text structure/summarization instruction facilitate learning from expository text? *Reading Research Quarterly*, 331-346.

Arrhenius, S. (1896). XXXI. On the influence of carbonic acid in the air upon the temperature of the ground. *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 41*(251), 237-276.

Bagozzi, R. P., & Moore, D. J. (1994). Public Service Advertisements: Emotions and Empathy Guide Prosocial Behavior. *Journal of Marketing, 58*(1), 56-70.

Barraza, J. A., Alexander, V., Beavin, L. E., Terris, E. T., & Zak, P. J. (2015). The heart of the story: peripheral physiology during narrative exposure predicts charitable giving. *Biol Psychol, 105*, 138-143. doi:10.1016/j.biopsycho.2015.01.008

Barraza, J. A., McCullough, M. E., Ahmadi, S., & Zak, P. J. (2011). Oxytocin infusion increases charitable donations regardless of monetary resources. *Hormones and Behavior, 60*(2), 148-151. doi:10.1016/j.yhbeh.2011.04.008

Barrett, L. F. (2006). Valence is a basic building block of emotional life. *Journal of Research in Personality, 40*(1), 35-55.

Barrett, L. F. (2016). The theory of constructed emotion: an active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, nsw154. doi:10.1093/scan/nsw154

Baum, R. (2016). Future Calculations: The First Climate Change Believer. *Distillations, 2*(2), 38-39. Retrieved from https://www.sciencehistory.org/distillations/magazine/future-calculations

Bearzi, G. (2009). When swordfish conservation biologists eat swordfish. *Conservation Biology, 23*(1), 1-2.

Black, I. (2010). Sustainability through anti-consumption. *Journal of Consumer Behaviour, 9*(6), 403-411.

Capstick, S., Whitmarsh, L., Poortinga, W., Pidgeon, N., & Upham, P. (2015). International trends in public perceptions of climate change over the past quarter century. *Wiley Interdisciplinary Reviews: Climate Change, 6*(1), 35-61.

Churchman, C. W. (1967, 12//). Wicked Problems, Editorial. *Management Science,* pp. B-141-B-142. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=7124291&site=ehost-live

Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry : experience and story in qualitative research* (1st ed. ed.). San Francisco :: Jossey-Bass Publishers.

Cohen, G. L., Sherman, D. K., Bastardi, A., Hsu, L., McGoey, M., & Ross, L. (2007). Bridging the Partisan Divide : Self-Affirmation Reduces Ideological Closed-Mindedness and Inflexibility in Negotiation. *Journal of Personality and Social Psychology, 93*(3), 415-430. doi:10.1037/0022-3514.93.3.415

Coles, R. (1989). *The call of stories: Teaching and the moral imagination*: Houghton Mifflin Harcourt.

Cron, L. (2012). *Wired for story: the writer's guide to using brain science to hook readers from the very first sentence*: Ten Speed Press.

Dalkir, K., & Wiseman, E. (2004). Organizational Storytelling and Knowledge Management: A Survey. *Storytelling, Self, Society, 1*, 57-73.

Damasio, A. (2011). Neural basis of emotions. *Scholarpedia, 6*(3), 1804. doi:10.4249/scholarpedia.1804
de Groot, J., & Steg, L. (2010). Explaining prosocial intentions: Testing causal relationships in the norm activation model. *British Journal of Social Psychology, 49*(4), 725-743. doi:10.1348/014466609X477745
Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proc Natl Acad Sci U S A, 106*(44), 18452-18456. doi:10.1073/pnas.0908738106
Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R., & Vlaev, I. (2012). Influencing behaviour: The mindspace way. *Journal of Economic Psychology, 33*(1), 264-277. doi:10.1016/j.joep.2011.10.009
Douglas, M., & Wildavsky, A. (1982). *Risk and culture : an essay on the selection of technical and environmental dangers*. Berkeley: University of California Press.
Edelman, G. M., & Tononi, G. (2003). A universe of consciousness: how matter becomes imagination. *Contemporary Psychology, 48*(1), 92.
European Commission. (2014). *Climate Change, Special Barometer* Retrieved from http://ec.europa.eu/public_opinion/archives/ebs/ebs_409_en.pdf.
Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of behavioral decision making, 13*(1), 1-17.
Fisher, R. J., Vandenbosch, M., & Antia, K. D. (2008). An Empathy-Helping Perspective on Consumers' Responses to Fund-Raising Appeals. *Journal of Consumer Research, 35*(3), 519-531.
Ganzach, Y. (2000). Judging risk and return of financial assets. *Organizational Behavior and Human Decision Processes, 83*(2), 353-370.
Gärling, A., Gärling, T., Fujii, S., & Jakobsson, C. (2003). Moderating effects of social value orientation on determinants of proenvironmental behavior intention. *Journal of Environmental Psychology, 23*(1), 1-9. doi:10.1016/S0272-4944(02)00081-6
Green, M. C. (1996). *Mechanisms of narrative-based belief change.* The Ohio State University. Retrieved from http://rave.ohiolink.edu/etdc/view?acc_num=osu1235579429
Green, M. C., & Brock, T. C. (2000). The Role of Transportation in the Persuasiveness of Public Narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. doi:10.1037/0022-3514.79.5.701
Green, M. C., & Clark, J. L. (2013). Transportation into narrative worlds: implications for entertainment media influences on tobacco use : Narrative transportation and tobacco use. *Addiction, 108*(3), 477-484. doi:10.1111/j.1360-0443.2012.04088.x
Haven, K. F. (2007). *Story Proof: the science behind the startling power of story*. Westport, CT: Libraries Unlimited.
Heinrichs, M., Fischbacher, U., Fehr, E., Zak, P. J., & Kosfeld, M. (2005). Oxytocin increases trust in humans. *Nature, 435*(7042), 673-676. doi:10.1038/nature03701
Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from Experience and the Effect of Rare Events in Risky Choice. *Psychological Science, 15*(8), 534-539. doi:10.1111/j.0956-7976.2004.00715.x
Hoeken, H., Kolthoff, M., & José, S. (2016). Story Perspective and Character Similarity as Drivers of Identification and Narrative Persuasion. *Human Communication Research, 42*(2), 292-311. doi:10.1111/hcre.12076
Huber, D., Veinante, P., & Stoop, R. (2005). Vasopressin and Oxytocin Excite Distinct Neuronal Populations in the Central Amygdala. *Science, 308*(5719), 245-248. doi:10.1126/science.1105636

Hurlemann, R., Patin, A., Onur, O. A., Cohen, M. X., Baumgartner, T., Metzler, S., . . . Kendrick, K. M. (2010). Oxytocin Enhances Amygdala-Dependent, Socially Reinforced Learning and Emotional Empathy in Humans. *Journal of Neuroscience, 30*(14), 4999-5007. doi:10.1523/JNEUROSCI.5538-09.2010

Inc., M.-W., & Merriam-Webster, I. (2004). *Merriam-Webster's collegiate dictionary*: Merriam-Webster.

Jost, J. T. (2005). Antecedents and Consequences of System-Justifying Ideologies. *Current directions in psychological science : a journal of the American Psychological Society, 14*(5), 260-265. doi:10.1111/j.0963-7214.2005.00377.x

Kahan, D. (2012a). Why we are poles apart on climate change. *Nature, 488*(7411), 255.

Kahan, D. M. (2012b). Cultural cognition as a conception of the cultural theory of risk *Handbook of risk theory* (pp. 725-759): Springer.

Kahan, D. M. (2013). Ideology, motivated reasoning, and cognitive reflection. *Judgment and Decision Making, 8*(4), 407-424.

Kahan, D. M. (2015). Climate-Science Communication and the Measurement Problem. *Political Psychology, 36*(S1), 1-43. doi:10.1111/pops.12244

Kahan, D. M. (2017). 'Ordinary science intelligence': a science-comprehension measure for study of risk and science communication, with notes on evolution and climate change. *Journal of Risk Research, 20*(8), 995-1016. doi:10.1080/13669877.2016.1148067

Kahan, D. M., Braman, D., Gastil, J., Slovic, P., & Mertz, C. (2007). Culture and identity-protective cognition: Explaining the white-male effect in risk perception. *Journal of Empirical Legal Studies, 4*(3), 465-505.

Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147-174. doi:10.1080/13669877.2010.511246

Kahneman, D. (2003). A Perspective on Judgment and Choice : Mapping Bounded Rationality. *American Psychologist, 58*(9), 697-720. doi:10.1037/0003-066X.58.9.697

Kunda, Z. (1990). The Case for Motivated Reasoning. *Psychological Bulletin, 108*(3), 480-498. doi:10.1037/0033-2909.108.3.480

Leiserowitz, A., Maibach, E., Roser-Renouf, C., Rosenthal, S., Cutler, M., & Kotcher, J. (2017). *Climate change in the American mind: October 2017*. Retrieved from New Haven, CT:

Leiserowitz A, M. E., Roser-Renouf C, Feinberg G, Rosenthal S, Marlon J. (2013). Climate Change in the American Mind.

Lin, P. Y., Grewal, N. S., Morin, C., Johnson, W. D., & Zak, P. J. (2013). Oxytocin increases the influence of public service advertisements. *PLoS One, 8*(2), e56934. doi:10.1371/journal.pone.0056934

Loewenstein, G. (2010). Insufficient Emotion: Soul-searching by a Former Indicter of Strong Emotions. *Emotion Review, 2*(3), 234-239. doi:10.1177/1754073910362598

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as Feelings. *Psychological Bulletin, 127*(2), 267-286. doi:10.1037/0033-2909.127.2.267

Lord, C. G., Ross, L., & Lepper, M. R. (1979). Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *Journal of Personality and Social Psychology, 37*(11), 2098.

Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change, 17*(3–4), 445-459. doi:http://dx.doi.org/10.1016/j.gloenvcha.2007.01.004

Mandler, J. M. (2014). *Stories, scripts, and scenes: Aspects of schema theory*: Psychology Press.

Marx, S. M., Weber, E. U., Orlove, B. S., Leiserowitz, A., Krantz, D. H., Roncoli, C., & Phillips, J. (2007). Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Global Environmental Change, 17*(1), 47-58. doi:http://dx.doi.org/10.1016/j.gloenvcha.2006.10.004

Nell, V. (1988). The Psychology of Reading for Pleasure: Needs and Gratifications. *Reading Research Quarterly, 23*(1), 6-50. doi:10.2307/747903

Nelson, K. (2003). Narratives and the Emergence of a Consciousness of Self. In G. D. M. Fireman, T.E.; Flanagan, O.J. (Ed.), *Narrative and Consciousness: Literature, Psychology and the Brain* (pp. 17-36). New York, NY: Oxford University Press.

Nisbet, M. C., & Myers, T. (2007). The polls—trends: Twenty years of public opinion about global warming. *Public Opinion Quarterly, 71*(3), 444-470.

Nordhaus, T., & Shellenberger, M. (2009). Apocalypse fatigue: Losing the public on climate change. *Yale environment, 360*, 16.

Pelham, B. W. (2009). Views on global warming relate to energy efficiency: Relationship exists regardless of national wealth, literacy. Retrieved from https://news.gallup.com/poll/117835/views-global-warming-relate-energy-efficiency.aspx

Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in experimental social psychology, 19*, 123-205.

Pew Research Center. (2018). Economic Issues Decline Among Public's Policy Priorities. Retrieved from http://www.people-press.org/2018/01/25/economic-issues-decline-among-publics-policy-priorities/

Pickett-Baker, J., & Ozaki, R. (2008). Pro-environmental products: marketing influence on consumer purchase decision. *Journal of Consumer Marketing, 25*(5), 281-293. doi:10.1108/07363760810890516

Pinker, S. (2015). *The language instinct : how the mind creates language*. London: Penguin Books.

Rettie, R., Burchell, K., & Barnham, C. (2014). Social normalisation: Using marketing to make green normal. *Journal of Consumer Behaviour, 13*(1), 9-17. doi:10.1002/cb.1439

Sachdeva, S., Iliev, R., & Medin, D. L. (2009). Sinning saints and saintly sinners: The paradox of moral self-regulation. *Psychological Science, 20*(4), 523-528.

Schwartz, S. H., & Bilsky, W. (1987). Toward a universal psychological structure of human values. *Journal of Personality and Social Psychology, 53*(3), 550.

Sharot, T. (2011). The optimism bias. *Current biology, 21*(23), R941-R945.

Slovic, P. (2007). "If I look at the mass I will never act": Psychic numbing and genocide. *Judgment and Decision Making, 2*(2), 79-95.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis, 24*(2), 311-322. doi:10.1111/j.0272-4332.2004.00433.x

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006

Small, D. A., & Loewenstein, G. (2003). Helping a Victim or Helping the Victim: Altruism and Identifiability. *Journal of Risk and Uncertainty, 26*(1), 5-16. doi:10.1023/A:1022299422219

Smith, N., & Leiserowitz, A. (2012). The Rise of Global Warming Skepticism: Exploring Affective Image Associations in the United States Over Time. *Risk Analysis, 32*(6), 1021-1032. doi:10.1111/j.1539-6924.2012.01801.x

Staats, H. J., Wit, A. P., & Midden, C. Y. H. (1996). Communicating the Greenhouse Effect to the Public: Evaluation of a Mass Media Campaign from a Social Dilemma Perspective. *Journal of Environmental Management, 46*(2), 189-203. doi:10.1006/jema.1996.0015

Turner, M. (1996). *The literary mind: The origins of thought and language*: Oxford University Press.

vanLaer, T., Ruyter, K. d., Visconti, L. M., & Wetzels, M. (2014). The Extended Transportation-Imagery Model: A Meta-Analysis of the Antecedents and Consequences of Consumers' Narrative Transportation. *Journal of Consumer Research, 40*(5), 797-817. doi:10.1086/673383

Waring, T., Teisl, M., Manandhar, E., & Anderson, M. (2014). On the Travel Emissions of Sustainability Science Research. *Sustainability, 6*(5), 2718-2735. doi:10.3390/su6052718

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change, 77*(1), 103-120.

Weber, E. U., Shafir, S., & Blais, A.-R. (2004). Predicting Risk Sensitivity in Humans and Lower Animals: Risk as Variance or Coefficient of Variation. *Psychological Review, 111*(2), 430-445. doi:10.1037/0033-295X.111.2.430

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist, 66*(4), 315.

Young, W., Hwang, K., McDonald, S., & Oates, C. J. (2010). Sustainable consumption: green consumer behaviour when purchasing products. *Sustainable Development, 18*(1), 20-31.

Chapter 2
Methodology & Data

In order to answer the research questions outlined at the end of Chapter 1, I conducted 11 experiments, the findings of which are presented in this dissertation. In this chapter, I explain why an experimental approach was deemed the most appropriate method for answering these questions and testing the conceptual models outlined in each paper. I also share my reflections on threats to validity and the measures taken to mitigate them when possible.

2.1 Ontology, Epistemology & Methodology

The research questions driving the work outlined in this dissertation emerged from the background and literature presented in Chapter 1. There is extensive inter-disciplinary work on public opinion and perception of climate change. My research questions relate to how these views, perceptions, and behavior are influenced by the structure and underlying mechanisms of the types of narratives we deploy. I was less interested in what people *say* and *say they do*, and more interested in *what they actually do and perceive,* after exposure to a narrative treatment. Studying these mechanisms necessitated the ability to not only observe, but also *measure* so as to make causal and statistical inferences from the data.

Based on my exclusive use of experimental methodology, one might surmise that I am positivist, but the perspective I take in this research is primarily that of a critical realist. On the one hand, I study a reality that can be observed and measured. On the other, I acknowledge that reality is co-constructed - even in highly controlled environments. There is no denying the potential for unintended influence, error, misinterpretation and inaccurate conclusions, despite detailed and consistent experimental protocols. Any researcher makes a plethora of decisions throughout the course of a study, most of which are (hopefully) well reflected and explicit. But to claim that this is always the case would be the height of hubris. In this sense, I am also a

constructivist. I acknowledge the fallibility of my decision-making, perceptions, and interpretations, which inevitably reflect my own culture, views, and biases. In an attempt to mitigate these flaws, I triangulate measures and/or replicate findings wherever possible. Where this has not been possible, I acknowledge it openly, communicating the limitations of the work and offering suggestions to improve future research. In reality, as research traditions, constructivism and critical realism both represent a spectrum rather than discrete paradigms. Finally, I would like to acknowledge from the outset that I subscribe to the current scientific consensus that 1) the climate is changing due, in large measure, to human activity, and 2) that this poses a real danger for humans and the natural world.

2.2 Research Approach & Threats to Validity

For all of these reasons, and because they make possible the drawing of conclusions about the causality of the 'treatment' (in this case, the manipulation of narrative structure, emotional end valence, and value congeniality), experimental research was deemed the most appropriate methodological option for answering my research questions. To address the inherent weaknesses of this approach and to mitigate threats to internal and external validity, myriad precautions were taken.

Every attempt was made to eliminate confounding variables that would pose threats to validity. One such threat is selection bias, particularly in online studies where a large portion of panel members are professional survey-takers (Stewart et al., 2015). To mitigate aptitude-treatment interactions, workers from previous studies were excluded, and naïve workers qualified whenever possible. Moreover, belief and concern about climate change are strongly associated with politically liberal values and ideology (Smith & Leiserowitz, 2012). To measure ideological variation in the main outcome variables (pro-environmental behavior and climate change risk perception), it was imperative that I sample from a broad spectrum of

society. Climate change deniers are not only adamant about their views but skeptical about the motives and values of scientists when it comes to this particular issue (Center, 2015; Vraga, Myers, Kotcher, Beall, & Maibach, 2018). As such, it would be difficult to get them to participate in a lab study on the subject. This led to a heavy reliance on digital survey experiments where it was actually possible (albeit still difficult) to reach, recruit, and study participants at all points on the ideological spectrum. Even with this concerted effort (e.g., making it convenient, providing competitive compensation), it was still often difficult to recruit these participants who make up almost 30 percent of the American population, but who are seriously underrepresented (Kahan, 2013a, 2013b) in panels claiming to be nationally representative. Studies where I attempted to achieve balance in the political orientation of the sample, for example, sometimes took twice as long to complete as studies where we took all comers.

To minimize the likelihood that the studies would be underpowered for the detection of medium-sized effects, power analyses were conducted to determine sample size, as recommended by Simmons, Nelson, and Simonsohn (2011). To counter potential order effects, treatments and measures were counterbalanced whenever possible with random selection and assignment.

Experimental research more efficiently enabled the collection of 'objective' data such as the assessment of perception, arousal, and behavior. Inevitably, someone will raise the (very fair) point that I did not make exclusive use of 'objective' measures. For example, sometimes I rely on self-report to gauge complex and largely sub-conscious phenomena. Every choice represents tradeoffs, and I was acutely aware of this fact. Most measures are operationalizations, or translations, of a theoretical construct. For example, I measure risk perception, character identification, counterarguing, and narrative transportation using self-reported scales developed by other researchers. When it comes to emotional arousal, in study

3 of Paper A, I employ objective measures of autonomic reactivity indicative of affective engagement and arousal while in others, I use self-reported measures shown in prior work to be strongly associated with objective measures. Each step of the way, I made every effort to select well-validated items deemed as having high construct validity so as to maximize the reliability of the instruments and the validity of the conclusions made on this basis. With all of this said, had it been feasible in terms of time, budget and sample variation, it would have been preferable to triangulate with psychophysiological measures in every study. In study A.3, for example, we find objective measures of emotional arousal via autonomic reactivity to be stronger predictors of post-stimuli persuasion than self-reported narrative transportation.

One of the chief strengths of experimental research turns out to be the source of one of its main disadvantages: the controlled environment. Laboratories and online panels enable us to control for many confounding factors, but they do not mimic real-life settings. There is every reason to be cautious when it comes to overgeneralizing the findings of survey and lab experiments. Human behavior is sensitive to the environment in which it occurs, and people behave differently in a laboratory than they do in the real world. Treatment effects can be lost or very small amidst the noise of real life, and may even disappear altogether (Barabas & Jerit, 2010).

Situational aspects of experiments pose threats to the external ecological validity of the research, and the best remedy would be to replicate the work in field studies. One of the main ways that I attempt to address this threat and enhance the ecological validity of the findings is through the selection and creation of stimulus material. Most of the studies employ either naturalistic stimuli or an adaptation thereof. These include YouTube videos developed by various climate change or scientific organizations working to engage the public as well as the development of an original video that mimics those developed by practitioners for such a

purpose. Written stimuli were either versions of the naturalistic stimuli or written with these in mind.

2.3 Protecting Human Research Participants

Finally, a word on ethics. As Principle Investigator, I made every effort to comply with the highest standards of research conduct and uphold all standards outlined in the two courses I completed on ethics and protecting human research participants. (*Social & Behavioral Research Best Practices for Clinical Research* course (CITI Program); *Protecting Human Research Participants* (National Institutes of Health)). Demonstrating the overarching principle of participant respect, all participants: 1) were thoroughly briefed regarding their rights, 2) gave informed consent, 3) were provided assurances regarding the protection of their data and privacy, and 4) received monetary compensation at or above an ethical minimum wage so as to signal fairness and a commitment to the highest ethical labor standards.

2.4 Overview of Studies & Research Designs

The following table presents an overview of each experiment in the context of papers, together with the main research question and information about the data, experimental treatment, and design, as well as the main dependent variable.

Table 1. Overview of Studies and Research Design

Paper	Study	Research Question(s)	Data / Participants	Experimental Treatment, Design	Main Dependent Variables
A	A.1	Does narrative structure predict pro-environmental behavior?	Randomized laboratory experiment employing (Danish & non-Danish) participants from an online recruiting pool (*N* = 158)	Written stimuli in either story (*N* = 53) or informational (*N* = 52) structure + control group (*N* = 53) about zero waste, marine pollution; single factor, between-subjects design	Pro-environmental behavior (e.g. (i) number of papers used in a task/whether both sides were used (ii) whether participants cleaned off their desk (as instructed in the survey), (iii) recycled, (iv) subscribed to the Greenpeace newsletter, (v) donated a portion of their participant compensation as a charitable gift, (vi*) turned off the light/computer, (vii*) used a plastic or glass cup if taking a drink (viii), and responded to a follow-up survey six weeks later. * Measures denoted with an '*' were poor or contained significant noise (e.g. had no variation or were culturally confounding), and therefore not included in the analysis.
A	A.2	Does narrative structure predict narrative transportation? Does narrative transportation predict pro-environmental behavior?	Randomized online experiment using U.S. based Mturk participants (*N* = 315)	Set of 22 (naturalistic) climate change videos independently coded & rated as having either high (story) (*N* =157) or low (information) (*N* = 158) narrative structure; single factor between-subjects design	Narrative transportation, time donation
A	A.3	Does narrative structure predict autonomic reactivity indicative of emotional arousal and narrative transportation? Do these predict pro-environmental behavior? Does this effect vary for positive vs. negative end valence?	Randomized laboratory experiment employing participants from an online recruitment pool of U.S. residents (*N* = 87)	Six (naturalistic) climate change videos independently coded & rated as having either high (story) or low (information) narrative structure; within-subjects, repeated measures design	Non-invasive measures of autonomic reactivity: RR-intervals, high-frequency HRV, electrodermal activity. Pro-environmental behavior (i.e. charitable donation)
B	B.1.	Does the end valence of a climate change story influence risk perception through emotional arousal?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 239)	A climate change story (based on naturalistic stimuli) with either positive (*N* = 101) or negative (*N* = 99) end valence; single factor, between-subjects design	Perception of climate change risk Emotional arousal Participant values (political ideology)
B	B.2.	Does the end valence of a climate change video influence risk perception through emotional arousal?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 299)	(Naturalistic) climate change video with either positive (*N* = 144) or negative (*N* = 147) end valence; single factor, between-subjects design.	Perception of climate change risk Emotional arousal Participant values (political ideology, cultural worldviews)
B	B.3.	Does the end valence of a climate change video influence risk perception through emotional arousal?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 450) (179 liberal; 114 moderate; 156 conservative)	(Naturalistic) climate change video with either positive (*N* = 228) or negative (*N* = 221) end valence; single factor, between-subjects design. Protocol identical to study B.2	Perception of climate change risk Emotional arousal Participant values (political ideology, cultural worldviews)

B	B.4.	Does the end valence of a climate change story influence outcome efficacy assessment through emotional arousal?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 1,115) (352 liberal; 392 moderate; 371 conservative)	A climate change story (based on naturalistic stimuli) with either positive (*N* =375), negative (*N* = 375), or doom (*N* = 365) end valence; single factor, between-subjects design	Outcome efficacy assessment Emotional arousal Participant values (political ideology, cultural worldviews)
C	C.1.	Is a political or scientific messenger more effective at heightening perception of climate change risk through reduced counterarguing and increased identification with the character?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 1,015)	(Naturalistic) climate change video where the messenger was either conservative international politicians (*N* = 511) or a climate scientist (*N* = 504); single factor between-subjects design	Climate change risk perception Counterarguing Character identification
C	C.2.	Does value congeniality in terms of religiosity/non-religiosity between messenger and story receiver predict perception of climate change risk through counterarguing and character identification?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 220)	(Controlled) climate change story (written stimuli) where the messenger was either religious (*N* =111) or non-religious (*N* =109); 2x2 between-subjects design	Climate change risk perception Counterarguing Character identification Participant values (religiosity)
C	C.3.	Does value congeniality in terms of cultural worldview (individualism/communitarianism) between messenger and story receiver predict perception of climate change risk through counterarguing and character identification?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 267); participants were pre-screened in order to ensure a balanced design	(Controlled) climate change story (written stimuli) where the messenger held either an individualist (*N* = 138) or communitarian worldview (*N* = 129); 2x2 between-subjects design	Climate change risk perception Counterarguing Character identification Participant values (GROUP cultural worldview)
C	C.4.	Does value congeniality in terms of cultural worldview (hierarchicalism/egalitariansm) between messenger and story receiver predict perception of climate change risk through counterarguing and character identification?	Randomized online survey experiment employing U.S. based Mturk participants (*N* = 240); participants were pre-screened in order to ensure a balanced design	(Controlled) climate change story (written stimuli) where the messenger held either a hierarchical (*N* = 125) or an egalitarian worldview (*N* = 116); 2x2 between-subjects design	Climate change risk perception Counterarguing Character identification Participant values (GRID cultural worldview)

References

Barabas, J., & Jerit, J. (2010). Are Survey Experiments Externally Valid? *American Political Science Review, 104*(2), 226-242.

Center, P. R. (2015). 2015 Public and Scientists' Views on Science and Society. Retrieved from doi:http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/

Kahan, D. (2013a). Fooled Twice, Shame on Who? Problems with Mechanical Turk Samples, Part 2.

Kahan, D. (2013b). What's a Valid Sample? Problems with Mechanical Turk Samples, Part 1.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-Positive Psychology: Undisclosed Flexibility in Data Collection and Analysis Allows Presenting Anything as Significant. *Psychological Science, 22*(11), 1359-1366.

Smith, N., & Leiserowitz, A. (2012). The Rise of Global Warming Skepticism: Exploring Affective Image Associations in the United States over Time. *Risk Analysis, 32*(6), 1021-1032. doi:10.1111/j.1539-6924.2012.01801.x

Stewart, N., Ungemach, C., Harris, A. J., Bartels, D. M., Newell, B. R., Paolacci, G., & Chandler, J. (2015). The Average Laboratory Samples a Population of 7,300 Amazon Mechanical Turk Workers. *Judgment and Decision Making, 10*(5), 479.

Vraga, E., Myers, T., Kotcher, J., Beall, L., & Maibach, E. (2018). Scientific Risk Communication About Controversial Issues Influences Public Perceptions of Scientists' Political Orientations and Credibility. *Royal Society Open Science, 5*(2). doi:10.1098/rsos.170505

Chapter 3:
The Empirical Work

3.0 Overview of the Papers

This chapter contains the three scientific articles that make up the backbone of the dissertation. Table 2 gives an overview of each paper and its current status. Every paper has its own research question, which builds upon, and is intertwined with, the others. Together they present a picture of how stories and their underlying mechanisms work to influence engagement with climate change.

Table 2

Overview of Papers in the Dissertation

Paper	Title	Status
A	Stories Trump Facts: Triggering Emotion & Action-Taking on Climate Change	Under review at Climatic Change
B	(Un)Happy Endings: in Climate Change Appeals: Risk Perception & Efficacy	Working paper
C	The Messenger IS the Message: Identification with Story Characters Influences Climate Change Risk Perception	Working paper

Paper A

Stories Trump Facts: Triggering Emotion & Action-Taking on Climate Change

Purpose: The purpose of this paper is to explore how the structure of narratives influences pro-environmental behavior. It aims to answer the research question 'Are climate change narratives structured as stories better than analytical frames for promoting pro-environmental behavior and engagement with climate change?'

Design/Methodology/Approach: I conducted three experimental studies (two laboratory, one online survey experiment) investigating how narrative structure influences pro-environmental behavior through its influence on emotional arousal. Using controlled written stimuli and naturalistic climate change videos, I explore the role of narrative transportation and autonomic reactivity, as well as emotional end valence using behavioral, self-report and psychophysiologic measures.

Findings: Narratives structured as stories influence autonomic reactivity (RR-intervals) indicative of emotional arousal, which serves as an impetus for pro-environmental behavior. Stories with negative affective end valence are particularly effective to this end.

Research limitations: Two of three studies utilized cross-sectional data. All were conducted in artificial settings. Inferences about psychophysiology should be made with caution. Cardiac activity is one of the more difficult measures to interpret because the heart is dually innervated and under both sympathetic and parasympathetic control. These factors limit the generalizability of the studies yet provide the opportunity to isolate effects in controlled environments.

Practical implications: To maximize the likelihood of engagement, communicators and policy makers should structure information about climate change as emotional stories.

Stories Trump Facts: Triggering Emotion and Action-Taking On Climate Change

*Brandi S. Morris[a,1], Polymeros Chrysochou[a,b], Jacob Christensen[a], Jacob L. Orquin[a], Jorge Barraza[c], Paul J. Zak[d], Panagiotis Mitkidis[a,e]

[a] Department of Management, Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V, Denmark;
[b] School of Marketing, University of South Australia, North Terrace 70, 5000, Adelaide, Australia; [c] Department of Psychology, University of Southern California, SGM 501, 3620 South McClintock Ave., Los Angeles, CA 90089-1061; [d] Center for Neuroeconomic Studies, Claremont Graduate University, 150 E. 10th Street, Claremont CA, 91711. [e] Center for Advanced Hindsight, Duke University, 334 Blackwekk St., Durham NC 27701

Abstract

Climate change is an issue that elicits low engagement, even among concerned segments of the public. While research suggests that the presentation of factual information (e.g. scientific consensus) can be persuasive to some audiences, there is also empirical evidence indicating that it may also increase resistance in others. In this research we investigate whether climate change narratives structured as stories are better than informational narratives at promoting pro-environmental behavior in diverse audiences. We propose that narratives structured as stories facilitate experiential processing, heightening affective engagement and emotional arousal, which serve as impetus for action taking. Across three studies, we manipulate the structure of climate change communications to investigate how this influences narrative transportation, measures of autonomic reactivity indicative of emotional arousal, and pro-environmental behavior. We find that stories are more effective than informational narratives at promoting pro-environmental behavior (studies 1 and 3) and self-reported narrative transportation (study 2), particularly those with negatively valenced endings (study 3). The results of study 3 indicate that embedding information in story structure influences cardiac activity, and subsequently, pro-environmental behavior. These findings connect work from the fields of psychology, neuroscience, narratology, and climate change communication, advancing our understanding of how narrative structure influences engagement with climate change through emotional arousal, which likely incites pro-environmental behavior as the brain's way of optimizing bodily budgets.

Keywords: Story, Emotion, Communication, Climate Change, Psychophysiology

Recent research finds a consistent ideological divide on belief and engagement with climate change across a range of countries, though none to the extent observed in the USA, Canada or Australia (Dryzek, Norgaard, & Schlosberg, 2011; Tranter & Booth, 2015). In the United States, approximately 28% of the population neither believes in anthropogenic climate change nor accepts the global scientific consensus. Of even greater concern, individual engagement with climate change is also low among those who profess to being concerned and alarmed by it (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013). The information deficit approach to climate change communications evinces the belief that giving people (more) peer-reviewed scientific evidence will persuade them to take action. Yet mounting evidence suggests that fact-based narratives are only minimally effective at motivating behavioral change (e.g.Whitmarsh, O'Neill, & Lorenzoni, 2013), and there is little to no relationship between public understanding of climate science and risk perception (Kahan, 2015). In this research we argue that the deficit approach to communication underestimates not only the critical role of affect and emotion in rationality (Peters & Slovic, 2000; Weber, 2006a), but also the formidable force of motivated cognition. In some countries, an individual's stance on the issue of climate change has become a marker of identity and a potential threat to social affiliation. As Kahan points out (Klein, 2014), although it may seem irrational to ignore scientific evidence, the high social and neurological cost of updating beliefs is likely to eclipse the benefits of cognitive flexibility and factual accuracy.

Effectively communicating climate change to diverse, non-scientific audiences requires alternative approaches and a few scholars have even suggested that stories might be part of this solution (e.g.Dahlstrom, 2014; Martinez-Conde & Macknik, 2017). A growing body of research suggests that engagement with emotional stories and their characters (i.e. Hoeken, Kolthoff, & José, 2016; Loewenstein, 2010) more effectively motivate pro-social behavior (Barraza, Alexander, Beavin, Terris, & Zak, 2015; Lin, Grewal, Morin, Johnson, & Zak, 2013;

Small & Loewenstein, 2003) than informational frameworks (Small & Loewenstein, 2003). Through a state known as narrative transportation, stories facilitate experiential rather than analytical processing (Green, 1996; Green & Brock, 2000), heightening emotional arousal (Zak, 2015), and reducing counter-arguing (Green & Brock, 2000). To our knowledge, there is little research about how narrative structure influences pro-environmental behavior in the context of climate change. In this article, we build on prior research investigating the persuasive powers of stories as well the underpinnings of affect, emotion, and end-valence to explicate how they influence behavior. Using three experiments, we investigate whether climate change messages structured as stories are better than analytical narratives at motivating pro-environmental behavior.

Homo Narrans: Humans and Stories

According to the Narrative Paradigm (Fisher, 1987), humans are 'homo narrans' – storytelling animals who are persuaded to make decisions based on the coherence and fidelity of stories. Coherence deals with the internal consistency of a story's characters and context, while fidelity relates to external consistency and 'fit' with the listener's values. Stories have dominated human interaction for millennia, and their efficacy as a form of communication seems to be related to how the human brain processes, imposes structure on, and interprets, information (Bransford, Brown, & Cocking, 2000; Pinker, 2003). Research from diverse fields suggests that story structure matches human neural maps and how we make sense of the world from birth (Donald, 1991; Nelson, 2003; Pinker, 2003; Plotkin, 1982): we process and communicate in story structure (Gopnik, Meltzoff, & Kuhl, 1999). Bruner (1986) posits that neural story maps are a form of heuristic used to process and decode narrative and experiential information. Schank (1990) goes so far as to assert that humans automatically select among accumulated story scripts rather than engaging in 'thinking.'

We adopt Haven's (2007) definition of story: "a detailed, character-based narration of a character's struggles to overcome obstacles and reach an important goal ... a framework and way of structuring information" (Haven, 2007, p. 79). The terms, *narrative* and *story* are often used interchangeably but our frame of reference is that stories are a specific subset within the category of narratives: all stories are narratives, but not all narratives are effective stories (Dalkir & Wiseman, 2004). Stories are often automatically associated with fiction but are actually a way of structuring information (Haven, 2007). Here, we define *narrative structure* as the degree to which a narrative tells a story and contains essential features including an identifiable character, plot (temporal dimension, goal), and setting. The higher the narrative structure, the more story-like the narrative.

How Stories Engage

The phenomenon of being 'lost in a story' (Nell, 1988) is known as 'narrative transportation' and can be defined as the degree to which a plot activates the story receiver's imagination through an empathic connection with the characters (Bagozzi & Moore, 1994; Fisher, Vandenbosch, & Antia, 2008; Lin et al., 2013), causing them to temporarily experience a sense of being suspended from reality (vanLaer, Ruyter, Visconti, & Wetzels, 2014). Narrative transportation is a convergent process (Green & Brock, 2000) involving experiential processing through *immersion into* a story. This is distinctly different from the divergent process of cognitive elaboration (Petty & Cacioppo, 1986), which entails analytical attention and *scrutiny to* major points of an argument. Under conditions of high cognitive elaboration, a person can still access pre-existing schemas, prior knowledge, experience and opinions. Instead, through the process of narrative transportation, the mind becomes focused on the events of the story, and the aforementioned aspects of 'reality' may fade into the background. Indeed, Green and Brock (2000) find reduced counter-arguing, resistance, and reactance in highly transported

story receivers compared with less transported receivers – irrespective of whether narratives were labeled as 'fact' or 'fiction'. Stories can become proxies for the vivid personal experience (Cron, 2012) shown to be an effective way of learning (Hertwig, Barron, Weber, & Erev, 2004; Weber, Shafir, & Blais, 2004).

These findings have important implications for the information deficit hypothesis because numerous experiments have shown only a weak association between public understanding of climate science and risk perception (Kahan, 2017; Kahan et al., 2012). Scientific literacy and numeracy can actually increase cultural polarization (Kahan et al., 2011). When confronted with the same scientific evidence about climate change, those already predisposed to believe become more concerned but those predisposed to be dismissive become even more dismissive (Kahan et al., 2011). In contrast, individuals who report being narratively transported into a story, experience higher empathy and are more likely to exhibit story-consistent beliefs and pro-social behavior in real life, even when controlling for individual dispositions toward empathy and transportability (Green & Brock, 2000) (Johnson, 2012). In the context of climate change, there is evidence that story "frames" influence cognition (Jones & Song, 2014) to the extent that they align with story receiver values and generate positive affect for "hero characters" (Jones, 2014b). However, in a study where participants were exposed to an emotional narrative, Barraza, Alexander, Beavin, Terris, and Zak (2015) found that changes in measures of autonomic reactivity and emotional arousal were associated with self-reported narrative transportation, empathic concern for characters in a story, and reliably predicted pro-social behavior. In order to understand how autonomic reactivity influences behavior, it is important to establish how emotion is constructed through affective engagement.

Emotion, the Impetus for Action Taking

The psychophysiological state of affect is a perpetual stream of information used by the body as evidence about the world (Barrett, 2017). Affect is a critical component of rationality, and analytical processing cannot be effective without it (Damasio, 2003). Valence, an important dimension of affect, influences attention allocation based on how the brain predicts external stimuli will impact bodily budgets (Barrett, 2017). Although people might prefer to experience the pleasure of positive emotional valence, it appears that emotions associated with negative valence, such as worry, drive risk management, and are better at actually getting us out of our proverbial chairs to do something about a problem (Peters & Slovic, 2000). In the context of climate change, negatively valenced emotions conceptualized as fear and anxiety, serve as early indicators, which compel urgency and action (Weber, 2006b). For the purposes of this research, we focus on how end valence influences behavior because the valence of most narratives naturally waxes and wanes throughout its duration.

Conceptual Model and Overview of Studies

The central proposition of this research is that climate change narratives structured as stories will facilitate higher levels of pro-environmental behavior than their analytical counterparts. Specifically, we seek to understand the psychological processes underlying the influence of narrative structure on pro-environmental behavior. We posit that, through narrative transportation, stories influence autonomic reactivity indicative of affective engagement, enabling the construction of emotion, which compels the brain to execute orders for action taking. Using three studies (two laboratory- and one online survey), we test the assumption that autonomic reactivity indicative of narrative transportation and emotional arousal will mediate the relationship between narrative structure and pro-environmental behavior, moderated by the

end valence of the stimuli. Figure 1 provides an overview of the conceptual model summarizing our propositions and studies.

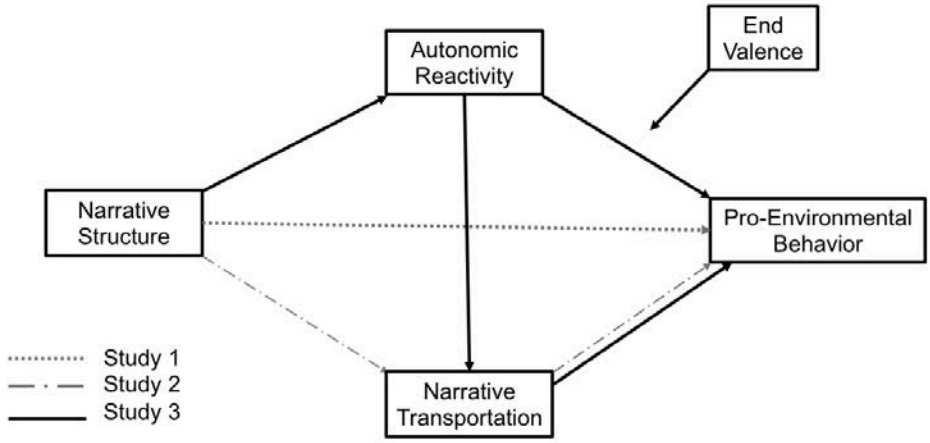


Figure 1. Conceptual Model with Overview of Studies

Study 1

In study 1, we examine whether narrative structure influences pro-environmental behavior using controlled, written stimuli in a lab setting.

Materials and Methods

In a single factor design, 158 participants (53% female) were recruited via email from a participant recruiting pool (ages 18-24 (51.9%), 25-34 (44.9%), 35-44 (1.9%), 55-64 (1.3%)). Sample size was determined with the goal of having at least 40 participants in each condition (Simmons, Nelson, & Simonsohn, 2011). All sessions were conducted at a lab in a Danish university, and participants were compensated with DKK 150 (approximately $28). An ethics advisory group approved this study.

After completing demographic questions, participants were randomly assigned to one of three conditions where they were asked to read a text containing identical pro-environmental content and number of words, structured either as a story (n=53) or informational narrative

(n=52) (Appendix A). The control group (n=53) was asked to read a neutral article about the construction of a university. Following the reading of the article, participants were asked to answer a series of questions assessing evaluations of the article and to complete a short task listing post-stimulus thoughts. In the second part of the study, participants were taken to a different lab room where they were offered a drink (with the option of choosing a glass or plastic cup) and snack, instructed thereafter to complete the final survey. Measures of pro-environmental behavior were recorded throughout the experiment and included: (i) number of papers used in a task/whether both sides were used (ii) whether participants cleaned off their desk (as instructed in the survey), (iii) recycled, (iv) subscribed to the Greenpeace newsletter, (v) donated a portion of their participant compensation as a charitable gift, (vi) turned off the light/computer, (vii*) used a plastic or glass cup if taking a drink (viii), and responded to a follow-up survey six weeks later (Appendix D). Measures denoted with an '*' were poor or contained significant noise (e.g. had no variation or were culturally confounding), and therefore not included in the analysis.

We computed the log odds ratio and Cohen's *d* between the independent variable (narrative structure) and the dependent variables (pro-environmental behaviors), using R Studio (Team, 2012). Effect sizes for continuous outcome variables were computed directly from the observed data, dividing the mean differences by the pooled standard deviation $\sqrt{\frac{(n_1-1)s_1^2+(n_2-1)\,s_2^2}{n_1+n_2-2}}$, where s_j and n_j refer to the standard deviation and sample size of conditions to be compared. Effect sizes for binary outcome variables were calculated using log odds ratios.

Results

Effect size calculations revealed that narrative structure influenced most of the post-stimuli pro-environmental behaviors we measured, with the exception of number of papers used, or

whether or not participants turned off the light or computer when exiting the lab room. Figure 2 shows the log odds ratios between the variables (as described above). A bar that represents 'story/control', for example, marks the difference in probabilities that a given pro-environmental behavior will occur in the story versus control conditions. Descriptives for continuous variables are shown in Appendix B.

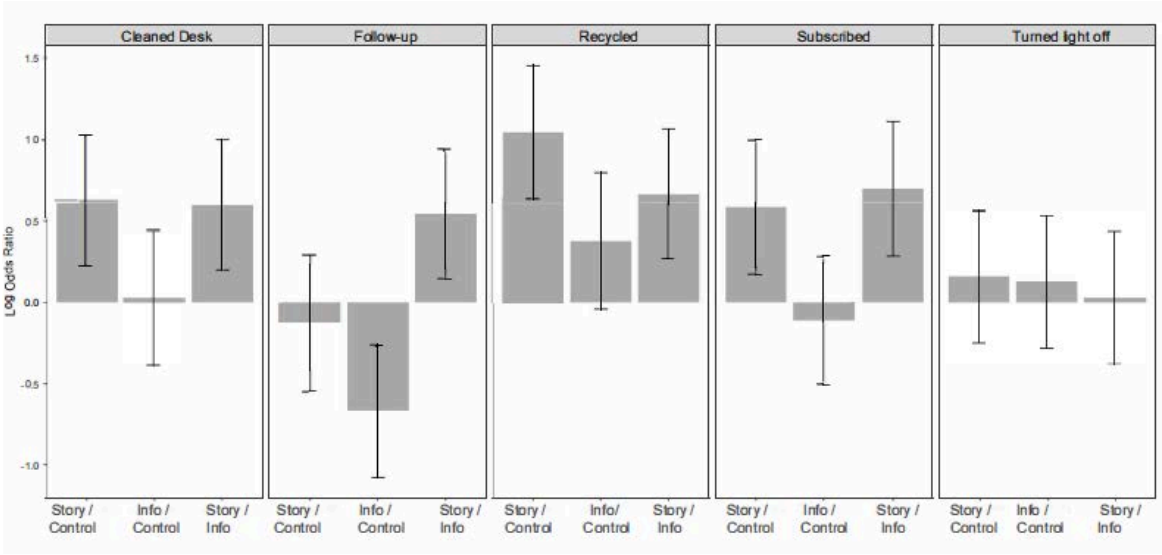


Figure 2. Log Odds Ratios for Behavioral Measures: Treatment and Control Groups. Bars indicate standard errors

The greatest observed difference in donation amount was between story and control groups, Cohen's $d = 0.26$ (95% CI [-0.13;0.64]), story and information groups $d = 0.21$ (95% CI [-0.18,0.59]), with the smallest observed difference between information and control group, $d = .08$ (95% CI [-0.31,0.46]) (Appendix C). Participants in the story condition were 2.00 times more likely to subscribe to the Greenpeace newsletter, and 1.72 times more likely to respond to the follow-up survey (with no additional payment or incentive) than those presented with information. Across all three conditions, the odds of a person recycling were 1.95 times higher in the story condition than in the information condition, and 2.83 times higher than in the control group. Participants in the story condition were 1.82 times more likely to clean off their

desk than those in the information condition, 1.88 times more likely than the control group, and approximately equal likelihood between information and control groups (see Appendix D for frequencies). No treatment effect was found for number of papers used or whether or not participants turned off the overhead light upon leaving.

Discussion

Results from this first study provide support for our expectations that narratives structured as stories are better vehicles of persuasion than informational narratives. We found that participants in the story condition were consistently more likely to exhibit pro-environmental behavior than those in the information condition. Moreover, it appears that this treatment effect persisted six weeks after the initial experiment: as can be seen from Figure 2, participants in the story condition were far more likely to respond to a follow-up survey, without additional remuneration.

Even more striking is the finding that participants treated with informational narratives *performed fewer pro-environmental behaviors* (e.g. response to a follow-up survey; willingness to subscribe to a newsletter) *compared with the control group*. Participants were, after all, being exposed to messaging with the not-so-subtle theme of environmental degradation. This result serves to further undermine the credibility of the information deficit hypothesis. For some measures no treatment difference was observed, such as whether or not participants turned off the overhead light when leaving the lab room or the number papers they used in a recall task. Turning off lights in a public office is not a common behavior, which may explain why no treatment effect was observed. With regard to number of papers used, the distraction task was a thought-listing exercise where most participants filled each sheet completely. As such, it is plausible that the connection to resource use was weak, thus diluting the treatment effect. While the results of this first study suggest an association between narrative structure and pro-

environmental behavior in the context of climate change, we had no evidence for the mechanisms underlying this relationship. Study 2, a survey experiment, builds on the findings of study 1 by investigating how narrative structure impacts self-reported narrative transportation and pro-environmental behavior, with added external validity derived from the use of naturalistic stimuli.

Study 2

Given the importance of public engagement with climate change, and the implications of our findings for practitioners, in this second study we employ videos produced by climate change communicators (e.g. the Royal Society, World Bank, NASA).

Methods and Materials

In a single factor between-subjects online experiment, 315 U.S. residents (53% female; ages 18-24 (7%), 25-34 (47%), 35-44 (22.2%), 45-54 (16.2%), 55-64 (6.7%), 65-74 (1%)) were recruited through Mturk. In accordance with guidelines by Simmons et al. (2011), sample size was determined beforehand with the goal of ensuring that each video was viewed by between 50-60 people.

As stimuli preparation for study 2, a set of 91 videos produced by numerous climate change communicators was compiled from YouTube (Appendix E), rated by trained, independent coders who assessed their narrative structure and residual emotional valence. Videos were given a narrative structure score based on whether or not they possessed essential story features such as an identifiable character, plot (temporal dimension, goal), and setting (Escalas, 1996, 2007). The higher (lower) the score, the more (less) story-like the narrative. For each narrative structure item, the mode was taken to create an index model of narrative structure for each video. Videos were also coded on end valence based on whether they ended

on an emotionally 'positive' or 'negative' note. To arrive at the final stimuli set, the following elimination criteria were used: 1) video duration should be no longer than 240 seconds, 2) no producer should have more than one video in the final set so as to preclude the possibility of repetition, and 3) no pop-up advertisements embedded in the video. Next, the 22 videos (Appendix F) with the highest/lowest narrative structure index scores ranging from 0.40 to 1.64 were selected. There was high consistency and inter-rater reliability with percentage of agreement ranging from 72.5% to 93.4%, calculated based on Krippendorff's Alpha (Appendix G).

All participants gave written informed consent and were compensated at fair market wages in the Mturk setting. Those accurately answering all attention checks were compensated with USD 4.90; participants who failed attention checks were paid USD 0.20, and their data was not analyzed. After answering demographic questions, participants were randomly assigned to view four of the 22 videos in either high (n = 157) or low-narrative structure condition (n = 158). After viewing each video, participants answered a 5-item self-reported measure of narrative transportation adopted by Appel et al (Appel, Gnambs, Richter, & Green, 2015) (Appendix H). Once all four videos were viewed, subjects were given the opportunity to donate between one and seven minutes of time to help further climate change research (e.g. testing an online carbon footprint calculator) when the survey was over. Following the time donation question, participants completed additional trait measures. Attention check accuracy was 98%.

In order to test the relationship between the independent variable, narrative structure, and the dependent variable, narrative transportation, we ran a series of models performing linear mixed effects analysis using R Studio (Team, 2012) and lme4 (Bates, Maechler, Bolker, & Walker, 2015). ΔBIC (Bayesian Information Criterion) scores were generated for all models, and the model with the lowest ΔBIC was selected as the most predictive.

Results

The model most predictive of narrative transportation included 'narrative structure' (story/info) with a fixed effect ($\beta = 4.30$; $SE = 0.69$), and the random intercept (participant ID), with a BIC score 26.91 points lower than the second most predictive model, which included the random intercept (participant ID) alone. Model coefficients are given in Appendix I. The model indicates that participants in the high narrative structure condition scored considerably higher on self-reported narrative transportation ($M = 26.548$; $SD = 6.461$), Cohen's $d = 0.64$, than those in the low narrative structure condition ($M = 22.191$; $SD = 7.205$), yet this had no observed effect on their willingness to donate time to furthering climate change research in a time donation task.

Discussion

The results of this study support our proposition that the narrative structure of climate change videos has a direct influence on the self-reported subjective experience of narrative transportation. However, these findings do not provide evidence for an association with subsequent pro-environmental behavior, as operationalized by the time donation task. One probable explanation is the online setting in which the study was conducted. A high percentage of Mturk workers are professional survey takers (Stewart et al., 2015) and likely to be cynical about requests for participation outside the Mturk environment. Moreover, we remain uncertain that an immersive psychological experience such as narrative transportation can be reliably measured via self-report. To explore these issues in greater depth, we designed a third study using autonomic measures of emotional arousal previously identified as indicative of narrative transportation.

Study 3

Study 3 investigates whether autonomic reactivity and self-reported narrative transportation mediate the effect of narrative structure on pro-environmental behavior as well as how this relationship might be moderated by the end valence of the stimuli.

In this study, we test the expectation that narrative structure impacts pro-environmental behavior by influencing autonomic reactivity and heightened emotional arousal associated with the subjective experience of narrative transportation. To strengthen the robustness of our findings we triangulate self-report measures of narrative transportation with measures of autonomic reactivity using a further reduced set of naturalistic stimuli from study 2. We predict that the influence of narrative structure on behavior is mediated by physiology, which is in turn moderated by the emotional valence of a video's ending and narrative transportation.

Methods and Materials

In a within-subjects, repeated-measures design, we pared down the stimuli list to six videos (Appendix J), selecting those with three highest and lowest mean narrative transportation scores as well as the following elimination criteria: 1) all videos should be produced by non-profit organizations 2) no producer should have more than one video in the final stimuli set so as to preclude the possibility of repetition 3) videos should not specifically mention localities outside of the U.S. 4) video duration was limited to a maximum 195 seconds so as to limit noise attributable to attentional variation between individual stimuli and to accommodate attentional constraints in an experimental setting. Valence was assessed during the independent coding procedure discussed in study 2, according to whether the video ended on a 'positive' or 'negative' emotional note.

Sessions were conducted at the lab of an American university and 87 participants were recruited (53% female) from the surrounding community through mass e-mails and an existing

online recruitment pool (ages 18-24 (55.8%), 25-34 (32.5%), 35-44 (7%), 45-54 (3.5%), 55-64 (1.2%)). Sample size was determined beforehand in line with recommendations by Simmons et al. (2011) and Quintana (Quintana, 2017). An Institutional Review Board approved this study. Immediately after consent, participants responded to a pre-treatment questionnaire containing demographic items and trait measures. Upon completion, participants were fitted with sensors, escorted to a private lab room, and seated in front of a laptop computer outfitted with headphones. All proceeding tasks, including the donation task, were presented in Psychopy (Peirce, 2009). A research assistant was seated on the opposite side of a privacy curtain throughout the duration of the study.

To gauge affective engagement and emotional arousal, we employ non-invasive measures of reactivity in the autonomic nervous system (ANS). Inter-beat (RR) intervals measure the number of milliseconds between R peaks in the QRS complex of the ECG wave. Closely associated with RR intervals, high frequency heart rate variability (HF-HRV) is calculated with the RR interval over a period of time using an algorithm known as fast Fourier transform. Because the heart is dully innervated, cardiac measures such as HF-HRV and RR intervals generally indicate both sympathetic and parasympathetic reactivity with HF-HRV reflecting greater parasympathetic control of the heart (Potter & Bolls, 2012a). Electrodermal activity (EDA) measures changes in skin conductance and tends to be a more 'pure' measure of SNS activation.

After a five-minute baseline acquisition period for ANS measures of cardiac activity and skin conductance (see Appendix K for further methodological detail), participants viewed all videos presented in random order. Autonomic activity was recorded continuously throughout the entire session. Participants were given a base compensation fee of USD 29 and the opportunity to earn an additional USD 1 per video. These additional dollars were our dependent variable in a donation task similar to that designed by Xygalatas et al. (Xygalatas et

al., 2016). Additional earnings were given to participants in the form of 100 pennies in a clear plastic container labeled 'earnings,' and placed next to an empty, but otherwise identical, container labeled 'donations.' Post-video stimulus, participants could voluntarily donate a portion of this dollar to the producer of the climate change video they had just viewed. Participants were instructed to pour the amount they wished to donate from the 'earnings' cup to the 'donations' cup without touching the coins or counting.

Upon completion of the task, participants notified the research assistant who removed both containers, privately weighing and recording donations out of the participant's purview. Participants were then asked to answer five items designed to assess self-reported narrative transportation (Appel et al., 2015), and two items to gauge narrative familiarity and attention. This process was repeated for each of the six stimuli, after which time all sensors were removed, and participants were escorted to another room where they completed a final questionnaire containing additional demographic, state and trait measures. After finishing the last survey, participants were privately paid their earnings, minus any donations, and dismissed. Donations were sent to the video producers at the conclusion of the study.

To examine the relationships between narrative structure and pro-environmental behavior, including mediators of autonomic reactivity (EDA, HF-HRV, and RR intervals), moderated by residual valence, and the unmoderated mediator of self-reported narrative transportation, we performed conditional process and linear mixed effects analyses, using R Studio (Team, 2012) and lme4 (Bates et al., 2015). Six participants were considered outliers or excluded from analysis for one or more of the following reasons: skin conductance levels $\geqslant$3 SD from the mean (Sokol-Hessner et al., 2009), cardiac activity $\geqslant$4 SD from the mean (Potter & Bolls, 2012a), or missing data, leaving a total of 81 participants for final analysis. ΔBIC scores were generated for all models, and the model with the lowest ΔBIC was selected as the

most predictive. In cases where the ΔBIC of models was ⩽ 2, the most parsimonious model was selected.

Results

As can be seen from Table 3, we observed a direct effect of narrative structure on one measure of cardiac activity, RR intervals (a_3 = 0.031). There was a conditional indirect effect of narrative structure on pro-environmental donation behavior, mediated by a 3.1% increase in inter-beat intervals (RR), compared with baseline, moderated by negative residual valence, Cohen's d = 0.021 (b_8 = -79.723). Our final model provides no evidence that narrative structure predicts behavior through self-reported narrative transportation or alterations in the other autonomic measures, electrodermal activity (EDA) or heart rate variability (HF-HRV).

Table 3

Main Results on the Effect of Narrative Structure on Pro-Environmental Behavior

		Consequent								
		M_1 (HF-HRV)		M_2 (EDA)		M_3 (RR)		M_4 (Narrative Transportation)		Y (Donation)
Antecedent		Coeff. (SE)		Coeff. (SE)		Coeff. (SE)		Coeff. (SE)		Coeff. (SE)
NarrativeStructure (X)	a_1	-------	a_2	------	a_3	0.031 (0.006) [0.019,0.43]	a_4	7.940 (0.515) [6.93,8.95]		----
HF-HRV (M_1)		-------		-------		-------		-------	b_1	-8.797 (23.478) [-54.508,36.923]
EDA (M_2)		-------		-------		-------		-------	b_2	-61.461 (36.501) [-132.657,9.950]
RR (M_3)		-------		-------		-------		-------	b_3	55.195 (43.945) [-30.420,140.756]
Narrative Transportation (M_4)		-------		-------		-------		-------	b_4	-------
End Valence (V)		-------		-------		-------		-------	b_5	-4.414 (4.282) [-12.752,3.925]
Interaction HF-HRVx End Valence (M_1 * V)		-------		-------		-------		-------	b_6	27.442 (34.880) [-40.744,95.356]
Interaction: EDA x End Valence (M_2 * V)		-------		-------		-------		-------	b_7	69.038 (45.927) [-20.476,158.669]
Interaction: RR (M_3 * V)		-------		-------		-------		-------	b_8	-80.251 (83.976) [-243.790,83.431]
Constant	i_1	- 0.209 (0.014) [-0.236,-0.182]	i_2	-0.002 (0.006) [-0.014,0.009]	i_3	- 0.004 (0.005) [-0.014,0.006]	i_4	17.41 (0.648) [16.14,18.68]	i_5	60.222 (8.008) [44.466,75.972]
		Variance (SD)		Variance (SD)		Variance (SD)		Variance (SD)		Variance (SD
ID/Random Intercept		0.011 (0.106)		0.00 (0.00)		0.000 (0.023)		22.84 (4.779)		4414.0 (66.44)
		R^2c/ R^2m		R^2c/ R^2m		R^2c/ R^2m		R^2c R^2m		R^2c /R^2m
		0.311/0.00		0.00/0.00		0.149/0.046		0.555/0.227		0.677/0.007

Although our primary aim with this study is not to investigate a direct relationship between narrative structure and donations, we include the path in our conditional process analyses, as recommended by Hayes (2013). Subsequent analysis revealed no direct effect between narrative structure and pro-environmental behavior, nor do we find self-reported

narrative transportation results to be predictive of donation behavior (see Appendices L-N for all models). The results of analysis using the pruned model following the Hayes (2013) method serve as a robustness check (see Appendices O and P).

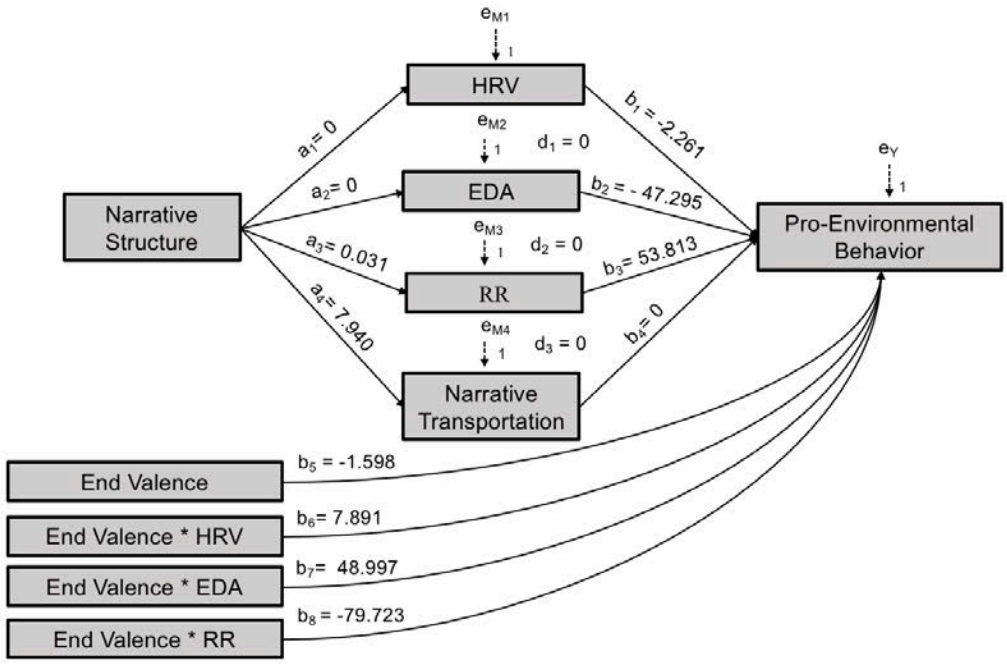


Figure 3. Statistical diagram with results

Discussion

Study 3 provides empirical support for our proposition that climate change narratives structured as stories stand a better chance than analytical narratives at influencing pro-environmental behavior through heightened emotional arousal. Indeed, climate change stories with negatively valenced endings influenced pro-environmental behavior by *increasing* inter-beat (RR) intervals. Inferences about psychophysiology should always be made with caution and RR intervals are one of the more difficult autonomic measures to interpret because cardiac activity is influenced by both the sympathetic (SNS) and parasympathetic (PNS) branches of the autonomic nervous system. These systems are comprised of motor neurons that control the organs and glands and can be coactive (Berntson, Cacioppo, & Quigley, 1993) or decoupled

(Potter & Bolls, 2012a). The SNS facilitates energy expenditure and, when activated, prepares the body for fight, fright and procreation. It prepares to mobilize the body to confront threats through physiologic changes such as an increase in heart rate and blood pressure. The PNS facilitates recovery and energy storage through rest, repair, and digestion. SNS and PNS reactivity can operate independently or orthogonally and both are indicative of attention and affective engagement (Barraza et al., 2015). Although our measure is likely under the influence of multiple patterns of ANS activity, it is clear that negatively valenced stories resulted in cardiac deceleration, which in turn predicted behavior.

Fluctuations in cardiac activity have been associated with attentional allocation (Potter & Bolls, 2012a) and emotional arousal (Mitkidis, McGraw, Roepstorff, & Wallot, 2015), key determinants of empathic and sympathetic responses (Dickert & Slovic, 2009). Stereotypical threat states and emotional arousal generally result in an acceleration in heart rate and decrease in RR intervals, as a result of SNS reactivity (Potter & Bolls, 2012a). Climate change, however, lacks a number of salient characteristics that typically trigger our cerebral alarms in the face of danger. Because the danger does not feel immediate or proximal, it provokes a different type of reactivity compared with threats that activate sympathetic arousal. Given that we observed no effect in the 'purer' measure of sympathetic activation (EDA), the finding that cardiac deceleration predicts behavior, suggests predominantly PNS reactivity. PNS activation has been associated with the orienting reflex (Graham & Clifton, 1966), increased allocation of cognitive resources in the form of attention and interest (Potter & Bolls, 2012b) as well as the encoding of information into working memory (Potter & Bolls, 2012a).

Our finding is in line with the information intake-rejection hypothesis, which posits that parasympathetic activation improves response effectiveness by enhancing ability to encode meaningful information from an individual's environment into working memory (Lacey & Lacey, 1974). These results may indicate a bodily state of 'vigilant readiness,' a preparatory

response pattern akin to a predator stalking its prey (Lang & Bradley, 2010) ; attentive and observant, weighing the options. This aligns with prior work proposing a relationship between negative emotional valence and heart rate deceleration (Bolls, Lang, & Potter, 2001; Lang, Newhagen, & Reeves, 1996) as well as increased autonomic arousal (Potter & Bolls, 2012a). Negative valence has been shown to have a more enduring effect on heart rate response compared with positive emotion (Brosschot & Thayer, 2003), which may help explain why participants who experienced cardiac deceleration also exhibited increased pro-environmental behavior.

Although it is difficult to disentangle emotional arousal and cognitive processing, our finding that heart rate deceleration leads to increased pro-environmental behavior likely reflects emotional arousal *in tandem with* cognitive processing, culminating in a calculated form of autonomic response to a distal threat. It is noteworthy that analytical narratives did not evoke this same autonomic response. We posit that, unlike stories, these informational narratives do not effectively aid the construction of emotion, which, in complement, signals the brain to take action to optimize bodily budgets.

Discussion

Based on the findings of this research, we echo the concerns of those who question the sufficiency of the information deficit approach to climate change communication. The primary goal of climate change communication campaigns is to persuade lay audiences as to the a) severity of the problem and b) need for action. While information and awareness are certainly not without value (van der Linden, Leiserowitz, Feinberg, & Maibach, 2014, 2015), our findings suggest that the structure in which information is embedded is of great consequence for eliciting pro-environmental behavior. It is always crucial to tailor messages to the needs of

a specific audience, but this is especially true for a psychologically distant threat and politically polarized issue.

It appears that climate change communications designed to motivate diverse audiences will benefit from being structured as stories. Across two of three experiments, we found that narratives framed as stories consistently outperformed factual narratives for encouraging action taking in all audiences. We suggest that this is because they more effectively trigger autonomic reactivity and emotional arousal. The results of this research also propose a key role for end valence as a moderator of the relationship between physiology and action. Studies by Bradley, Cuthbert, and Lang (1996) as well as Shoemaker (1996) provide evidence that humans allocate more attentional resources to negative messages as an adaptive survival response. In order to maintain 'allostasis', most of the brain's activity is dedicated to the intrinsic activity of prediction. Using past experience and Bayesian logic (Deneve, 2008) it continuously runs predictive models, and selects among, competing simulations, thereafter implementing an associated plan of action (Barrett, 2016). External stimuli do not easily interrupt this process (Barrett, 2017).

Interoceptive predictions about internal bodily sensations, produce affective feelings, which are the "brain's best guess about the state of [bodily] budgets" (Barrett, 2017). These interoceptive predictions monitor potential threats to allostasis, and determine the 'affective niche' - what an individual is affectively engaged with at a particular moment in time (Barrett, 2017). However, on its own, affect lacks meaning. For the brain to order action, it must perceive the need, and construct an instance of emotion, which is then expressed through involuntary changes in the autonomic nervous system (ANS) (Barrett, 2017). Our results suggest that negative end valence plays a key role in facilitating affective engagement and the perceived need for action. At the same time, having a sense of efficacy is extremely important for motivation to act in the face of a threat (Bandura, 1986). Feeling overwhelmed by the

enormity of a problem can cause paralysis. To what extent and under what conditions is negative valence more motivational than positive valence? These issues should be explored in greater depth.

Although we observed a clear association between narrative structure and self-reported narrative transportation, this did not translate into pro-environmental behavior in either of the studies where this was measured. Instead, we found autonomic reactivity to be a better indicator of emotional arousal and cognitive processing as well as predictor of pro-environmental behavior. Self-report has limitations when it comes to providing insights into a highly complex, immersive, largely sub-conscious, psychological process. Nevertheless, given the fact that our findings did not replicate prior work on this subject (vanLaer et al., 2014), future research should consider triangulating self-report with more objective measures of affective engagement and emotional arousal to gain a better understanding of how these correlate with the construct of narrative transportation. These findings do not align with research by Jones (2014a) which found no evidence that climate change 'stories' predict narrative transportation or support for climate change policy. However, the experimental stimuli of Jones' work would not qualify as a story in our paradigm.

To accommodate the variation inherent in naturalistic stimuli, an intentionally broad definition of narrative structure was applied in these studies. Future research could contribute to a greater understanding of how essential story elements such as character identification, goals, and motivations influence risk perception in climate change narratives. Given the important implications for practitioners, further studies could benefit by investigating all of these questions using controlled stimuli in a real-world setting.

Conclusion

This research advances our understanding of how narrative structure influences engagement with climate change through emotional arousal, which likely incites pro-environmental behavior as the brain's way of optimizing bodily budgets. These findings have important implications for science communication scholars and practitioners alike. In a twist of irony, structuring narratives as factual presentations ignores what science tells us about the important role of affective and emotional engagement for optimizing communication and decision-making. To maximize the likelihood of action taking, our results suggest that science communicators should consider enrobing the presentation of information in story structure instead.

Acknowledgements

We thank the entire lab team at the Center for Neuroeconomic Studies, especially Elizabeth Terris and Collin Binder for their diligence in the cleaning of physiologic data from study 3. Anne Koch, thank you for your help with data collection in study 1. For her help with stimuli development in study 1, we thank Sue Campbell, and John Thøgersen for his comments on this study's design. Finally, we thank Ekaterina Salnikova, Michael J. Morris, Iris Rittenhoffer, and Finn Frandsen for their comments. This research has been supported by seed funding from the Interacting Minds Centre, Aarhus University as well as the Aarhus University Research Foundation.

References

Appel, M., Gnambs, T., Richter, T., & Green, M. C. (2015). The Transportation Scale-Short Form (TS-SF). *Media Psychology, 18*(2), 243-266. doi:10.1080/15213269.2014.987400

Bagozzi, R. P., & Moore, D. J. (1994). Public Service Advertisements: Emotions and Empathy Guide Prosocial Behavior. *Journal of Marketing, 58*(1), 56-70.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*: Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Barraza, J. A., Alexander, V., Beavin, L. E., Terris, E. T., & Zak, P. J. (2015). The heart of the story: peripheral physiology during narrative exposure predicts charitable giving. *Biol Psychol, 105*, 138-143. doi:10.1016/j.biopsycho.2015.01.008

Barrett, L. F. (2016). The theory of constructed emotion: an active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, nsw154. doi:10.1093/scan/nsw154

Barrett, L. F. (2017). *How Emotions Are Made*. New York, NY: Houghton-Mifflin-Harcourt.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). lme4: Linear mixed-effects models using Eigen and S4. *Journal of Statistical Software, 67*(1), 1-48. doi:doi:10.18637/jss.v067.i01

Berntson, G. G., Cacioppo, J. T., & Quigley, K. S. (1993). Cardiac psychophysiology and autonomic space in humans: Empirical perspectives and conceptual implications. *Psychological Bulletin, 114*(2), 296-322.

Bolls, P. D., Lang, A., & Potter, R. F. (2001). The Effects of Message Valence and Listener Arousal on Attention, Memory, and Facial Muscular Responses to Radio Advertisements. *Communication Research, 28*(5), 627-651. doi:10.1177/009365001028005003

Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1996). Picture media and emotion: Effects of a sustained affective context. *Psychophysiology, 33*(6), 662-670.

Bransford, J. D., Brown, A., & Cocking, R. (2000). How people learn (Expanded ed.). *Washington, DC: National Academy*.

Brosschot, J. F., & Thayer, J. F. (2003). Heart rate response is longer after negative emotions than after positive emotions. *International Journal of Psychophysiology, 50*(3), 181-187. doi:10.1016/S0167-8760(03)00146-6

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, Mass.: Harvard University Press.

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of personality assessment, 48*(3), 306-307. doi:10.1207/s15327752jpa4803_13

Cin, S. D., Gibson, B., Zanna, M. P., Shumate, R., & Fong, G. T. (2007). Smoking in Movies, Implicit Associations of Smoking with the Self, and Intentions to Smoke. *Psychological Science, 18*(7), 559-563. doi:10.1111/j.1467-9280.2007.01939.x

Cron, L. (2012). *Wired for story: the writer's guide to using brain science to hook readers from the very first sentence*: Ten Speed Press.

Dahlstrom, M. F. (2014). Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences, 111*(Supplement 4), 13614-13620. doi:10.1073/pnas.1320645111

Dalkir, K., & Wiseman, E. (2004). Organizational Storytelling and Knowledge Management: A Survey. *Storytelling, Self, Society, 1*, 57-73.

Damasio, A. R. (2003). *Descartes' error : emotion, reason, and the human brain* (Repr. ed.). New York: Quill.

Deneve, S. (2008). Bayesian spiking neurons I: inference. *Neural computation, 20*(1), 91-117.
Dickert, S., & Slovic, P. (2009). Attentional mechanisms in the generation of sympathy. *Judgment and Decision Making, 4*(4), 297-306.
Donald, M. (1991). *Origins of the modern mind: Three stages in the evolution of culture and cognition*: Harvard University Press.
Dryzek, J. S., Norgaard, R. B., & Schlosberg, D. (2011). *The Oxford handbook of climate change and society*. Oxford: Oxford University Press.
Escalas, J. A. E. (1996). Narrative processing: Building connections between brands and the self: ProQuest Dissertations Publishing.
Escalas, J. A. E., and Barbara Stern. (2007). *"Narrative Structure: Plot and Emotional Responses"* Mahwah, N.J.: L. Erlbaum.
Fisher, R. J., Vandenbosch, M., & Antia, K. D. (2008). An Empathy-Helping Perspective on Consumers' Responses to Fund-Raising Appeals. *Journal of Consumer Research, 35*(3), 519-531.
Fisher, W. (1987). *Human Communication as Narration: Toward a Philosophy of Reason, Value, and Action*. Columbia, SC: University of South Carolina Press.
Gopnik, A., Meltzoff, A. N., & Kuhl, P. K. (1999). *The scientist in the crib: Minds, brains, and how children learn*: William Morrow & Co.
Gosling, S. D., Rentfrow, P. J., & Swann, W. B. (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality, 37*(6), 504-528. doi:10.1016/S0092-6566(03)00046-1
Graham, F. K., & Clifton, R. K. (1966). Heart-rate change as a component of the orienting response. *Psychological Bulletin, 65*(5), 305.
Green, M. C. (1996). *Mechanisms of narrative-based belief change.* The Ohio State University. Retrieved from http://rave.ohiolink.edu/etdc/view?acc_num=osu1235579429
Green, M. C., & Brock, T. C. (2000). The Role of Transportation in the Persuasiveness of Public Narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. doi:10.1037/0022-3514.79.5.701
Haven, K. F. (2007). *Story Proof: the science behind the startling power of story*. Westport, CT: Libraries Unlimited.
Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.
Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from Experience and the Effect of Rare Events in Risky Choice. *Psychological Science, 15*(8), 534-539. doi:10.1111/j.0956-7976.2004.00715.x
Hoeken, H., Kolthoff, M., & José, S. (2016). Story Perspective and Character Similarity as Drivers of Identification and Narrative Persuasion. *Human Communication Research, 42*(2), 292-311. doi:10.1111/hcre.12076
Johnson, D. R. (2012). Transportation into a story increases empathy, prosocial behavior, and perceptual bias toward fearful expressions. *Personality and Individual Differences, 52*(2), 150-156. doi:10.1016/j.paid.2011.10.005
Jones, M. D. (2014a). Communicating Climate Change: Are Stories Better than "Just the Facts"? *Policy Studies Journal, 42*(4), 644-673. doi:10.1111/psj.12072
Jones, M. D. (2014b). Cultural characters and climate change: How heroes shape our perception of climate science. *Social Science Quarterly, 95*(1), 1-39.
Jones, M. D., & Song, G. (2014). Making Sense of Climate Change: How Story Frames Shape Cognition. *Political Psychology, 35*(4), 447-476. doi:10.1111/pops.12057

Kahan, D. M. (2015). Climate‐Science Communication and the Measurement Problem. *Political Psychology, 36*(S1), 1-43. doi:10.1111/pops.12244
Kahan, D. M. (2017). 'Ordinary science intelligence': a science-comprehension measure for study of risk and science communication, with notes on evolution and climate change. *Journal of Risk Research, 20*(8), 995-1016. doi:10.1080/13669877.2016.1148067
Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*(10), 732-735.
Kahan, D. M., Wittlin, M., Peters, E., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. N. (2011). The Tragedy of the Risk-Perception Commons: Culture Conflict, Rationality Conflict, and Climate Change *Temple University Legal Studies Research Paper No. 2011-26; Cultural Cognition Project Working Paper No. 89; Yale Law & Economics Research Paper No. 435; Yale Law School, Public Law Working Paper No. 230.*
Klein, E. (2014). How Politics Make Us Stupid. *Vox*.
Lacey, J. I., & Lacey, B. C. (1974). On heart rate responses and behavior: A reply to Elliott. *Journal of Personality and Social Psychology, 30*(1), 1-18.
Lang, A., Newhagen, J., & Reeves, B. (1996). Negative video as structure: Emotion, attention, capacity, and memory. *Journal of Broadcasting & Electronic Media, 40*(4), 460-477.
Lang, P. J., & Bradley, M. M. (2010). Emotion and the motivational brain. *Biological psychology, 84*(3), 437-450. doi:10.1016/j.biopsycho.2009.10.007
Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Howe, P. (2013). Global warming's six Americas, September 2012. *Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication*.
Leiserowitz, A. A. (2005). American Risk Perceptions: Is Climate Change Dangerous? *Risk Analysis, 25*(6), 1433-1442. doi:10.1111/j.1540-6261.2005.00690.x
Lewis, G. F., Furman, S. A., McCool, M. F., & Porges, S. W. (2012). Statistical strategies to quantify respiratory sinus arrhythmia: Are commonly used metrics equivalent? *Biological psychology, 89*(2), 349-364. doi:10.1016/j.biopsycho.2011.11.009
Lin, P. Y., Grewal, N. S., Morin, C., Johnson, W. D., & Zak, P. J. (2013). Oxytocin increases the influence of public service advertisements. *PLoS One, 8*(2), e56934. doi:10.1371/journal.pone.0056934
Loewenstein, G. (2010). Insufficient Emotion: Soul-searching by a Former Indicter of Strong Emotions. *Emotion Review, 2*(3), 234-239. doi:10.1177/1754073910362598
Martinez-Conde, S., & Macknik, S. L. (2017). Opinion: Finding the plot in science storytelling in hopes of enhancing science communication. *Proceedings of the National Academy of Sciences, 114*(31), 8127-8129.
Meye, F. J., & Digirolamo, G. J. (2007). Handbook of Psychophysiology (3rd edn). *Psychological Medicine, 37*(12), 1818-1819. doi:10.1017/S0033291707001201
Mitkidis, P., McGraw, J. J., Roepstorff, A., & Wallot, S. (2015). Building trust: Heart rate synchrony and arousal during joint action increased by public goods game. *Physiology & behavior, 149*, 101-106. doi:10.1016/j.physbeh.2015.05.033
Nell, V. (1988). The Psychology of Reading for Pleasure: Needs and Gratifications. *Reading Research Quarterly, 23*(1), 6-50. doi:10.2307/747903
Nelson, K. (2003). Narratives and the Emergence of a Consciousness of Self. In G. D. M. Fireman, T.E.; Flanagan, O.J. (Ed.), *Narrative and Consciousness: Literature, Psychology and the Brain* (pp. 17-36). New York, NY: Oxford University Press.
Norris, C. J., Larsen, J. T., & Cacioppo, J. T. (2007). BRIEF REPORT : Neuroticism is associated with larger and more prolonged electrodermal responses to emotionally

evocative pictures. *Psychophysiology, 44*(5), 823-826. doi:10.1111/j.1469-8986.2007.00551.x
Peirce, J. W. (2009). Generating stimuli for neuroscience using PsychoPy. *Frontiers in neuroinformatics, 2*, 10.
Peters, E., & Slovic, P. (2000). The Springs of Action: Affective and Analytical Information Processing in Choice. *Personality and Social Psychology Bulletin, 26*(12), 1465-1475. doi:10.1177/01461672002612002
Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in experimental social psychology, 19*, 123-205.
Pinker, S. (2003). *The language instinct: How the mind creates language*: Penguin UK.
Plotkin, H. C. (1982). *Learning, development, and culture: essays in evolutionary epistemology*: John Wiley & Sons.
Potter, R. F., & Bolls, P. (2012a). *Psychophysiological measurement and meaning: Cognitive and emotional processing of media*: Routledge.
Potter, R. F., & Bolls, P. (2012b). Psychophysiological measurement and meaning: Cognitive and emotional processing of media: Routledge.
Quintana, D. S. (2017). Statistical considerations for reporting and planning heart rate variability case‐control studies. *Psychophysiology, 54*(3), 344-349.
Schank, R. C. (1990). *Tell me a story: A new look at real and artificial memory*: Scribner New York.
Schulte-Mecklenbeck, M., Kuehberger, A., & Ranyard, R. (2011). *A Handbook of Process Tracing Methods for Decision Research : A Critical Review and User's Guide* Retrieved from https://www.statsbiblioteket.dk/au/#/search?query=recordID%3A%22summon_FETCH-LOGICAL-a20025-d029a1c13c00ae9d8d8c935f3b0f38eb847ede670f65b69a3421a872f6173a003%22
Shoemaker, P. J. (1996). Hardwired for news: Using biological and cultural evolution to explain the surveillance function. *Journal of Communication, 46*(3), 32-47.
Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science, 22*(11), 1359-1366.
Small, D. A., & Loewenstein, G. (2003). Helping a Victim or Helping the Victim: Altruism and Identifiability. *Journal of Risk and Uncertainty, 26*(1), 5-16. doi:10.1023/A:1022299422219
Sokol-Hessner, P., Hsu, M., Curley, N. G., Delgado, M. R., Camerer, C. F., & Phelps, E. A. (2009). Thinking like a trader selectively reduces individuals' loss aversion. *Proceedings of the National Academy of Sciences, 106*(13), 5035-5040.
Spreng, R. N., McKinnon, M. C., Mar, R. A., & Levine, B. (2009). The Toronto Empathy Questionnaire: Scale Development and Initial Validation of a Factor-Analytic Solution to Multiple Empathy Measures. *Journal of personality assessment, 91*(1), 62-71. doi:10.1080/00223890802484381
Stewart, N., Ungemach, C., Harris, A. J., Bartels, D. M., Newell, B. R., Paolacci, G., & Chandler, J. (2015). The average laboratory samples a population of 7,300 Amazon Mechanical Turk workers. *Judgment and Decision Making, 10*(5), 479.
Team, R. S. (2012). RStudio: integrated development environment for R. *RStudio Inc, Boston, Massachusetts*.
Thøgersen, J., Haugaard, P., & Olesen, A. (2010). Consumer responses to ecolabels. *European Journal of Marketing, 44*(11/12), 1787-1810.
Tranter, B., & Booth, K. (2015). Scepticism in a changing climate: a cross-national study. *Global Environmental Change, 33*, 154-164.

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: plain facts, pie charts or metaphors? *An Interdisciplinary, International Journal Devoted to the Description, Causes and Implications of Climatic Change, 126*(1), 255-262. doi:10.1007/s10584-014-1190-4

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: experimental evidence. *PLoS One, 10*(2), e0118489.

vanLaer, T., Ruyter, K. d., Visconti, L. M., & Wetzels, M. (2014). The Extended Transportation-Imagery Model: A Meta-Analysis of the Antecedents and Consequences of Consumers' Narrative Transportation. *Journal of Consumer Research, 40*(5), 797-817. doi:10.1086/673383

Weber, E. U. (2006a). Experience-Based and Description-Based Perceptions of Long-Term Risk: Why Global Warming does not Scare us (Yet). *An Interdisciplinary, International Journal Devoted to the Description, Causes and Implications of Climatic Change, 77*(1), 103-120. doi:10.1007/s10584-006-9060-3

Weber, E. U. (2006b). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change, 77*(1), 103-120.

Weber, E. U., Shafir, S., & Blais, A.-R. (2004). Predicting Risk Sensitivity in Humans and Lower Animals: Risk as Variance or Coefficient of Variation. *Psychological Review, 111*(2), 430-445. doi:10.1037/0033-295X.111.2.430

Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2013). Public Engagement with Climate Change: What do we know and where do we go from here? *International Journal of Media and Cultural Politics, 9*(1), 7-25. doi:10.1386/macp.9.1.7_1

Xygalatas, D., Klocová, E. K., Cigán, J., Kundt, R., Maňo, P., Kotherová, S., . . . Kanovsky, M. (2016). Location, Location, Location: Effects of Cross-Religious Primes on Prosocial Behavior. *The International Journal for the Psychology of Religion, 26*(4), 304-319. doi:10.1080/10508619.2015.1097287

Zak, P. J. (2015). Why inspiring stories make us react: the neuroscience of narrative. *Cerebrum : the Dana forum on brain science, 2015*, 2.

Appendix A

Stimulus materials, Study 1

High Narrative Structure (Story)

A story

Anne wished this *was* all just a bad dream. She startled awake, heart pounding. In the nightmare, the vast ocean was filled with plastic of every kind: flimsy plastic bags, drinking straws, coffee cup lids, and millions of the small, colored bottle caps. There she stood in a tiny boat, rocked by waves and trying desperately not to fall into the debris.

As she splashed water on her face later that morning, feelings of hopelessness, guilt and worry overwhelmed her. The sad truth was that her nightmare *was* actually coming true. The ocean *was* being filled with plastic. And it didn't just fill the oceans, it was in landfills, littering the sides of roads, and even floating around in her own body.

In an attempt to distract herself, Anne opened her laptop and scanned through Facebook while sipping a cup of steaming hot coffee. The words, "Bea Johnson: zero waste" caught her eye. There was a video. She clicked. The camera showed a sleek, immaculate home. Anne stared at the kitchen pantry, stocked with glass jars full of rice, beans, flour and sugar. She watched as Bea Johnson walked through a supermarket with a shopping cart stocked with reusable glass jars and cloth bags. She saw Bea chatting with the man behind the deli counter as he stuffs cheese wedges into glass jars she brought from home. She watched, stunned, as Bea shook a liter sized glass jar containing all the trash generated by her family of four *in an entire year.* Bea talked about how her low waste lifestyle has created a simplified and more meaningful way of being in the world.

In that moment, Anne's life changed forever. *I could do that,* she thought. *I will try to make less trash.* That was more than a year ago and Anne has taken big steps towards her goal.

It was hard at first. Most of the things she usually bought – meats, fruits and vegetables -- were wrapped in plastic. There were very few stores that offered bulk items. Carrying clanking glass jars around on your bicycle made you sound like a drunk, or so her friends teased. And there were very few shop owners who understood what she was trying to accomplish. She laughs about the first time she tried to buy feta from a small cheese shop and tried to explain to the guy behind the counter that she wanted her cheese in her own glass jar. The exchange ended with him placing her jar full of cheese in a plastic bag and handing it to her. Red faced and embarrassed, she didn't bother trying to give the bag back.

What began as an experiment has now become a way of life. Little by little, Anne has changed her shopping habits to make less waste. Even the cheese guy knows how to package her feta these days. And although Anne does still sometimes worry about the future of the environment, she no longer feels guilty or hopeless because she has become part of the solution.

Low Narrative Structure (Information)

Factual Information

275 million metric tons of plastic waste is generated globally each year. 73.9 million tons of this plastic are spread throughout the world's oceans. The ocean is filled with plastic of every kind including bags, food wrappers, bottles, drinking straws, and bottle caps.

2 billion people within 48 kilometers of the coast create 100 metric tons of plastic waste. Plastic particles often contain pollutants that can enter into the food chain. Floating toxic micro-plastics are often toxic and ingested by marine life which in turn is consumed by humans. In the EU alone, 100 billion plastic bags are used every year. That is an average of 200 plastic bags used by every EU citizen. 89% of plastic bags are used only once.

The growing global population is faced with limited environmental resources. To relieve the pressures placed on finite resources, it has become even more important to prevent waste. Zero Waste is a philosophy that promotes not only reuse and recycling, but, more importantly, prevention and product designs that consider the entire product life cycle. Zero Waste designs strive for reduced materials use, use of recycled materials, use of more benign materials, longer product lives, reparability, and ease of disassembly at end of life. It supports sustainability by protecting the environment, reducing costs, and producing additional jobs in the management and handling of wastes back into the industrial cycle. As a strategy it may be applied to businesses, communities, industrial sectors, schools and homes.

At the individual level, Zero Waste is a growing movement of people who attempt to reduce the amount of waste they generate. Many people are joining this movement in an attempt to reduce and conserve materials. There are 5 steps to Zero Waste: refuse, reduce, re-use, recycle and rot (compost.)

Refuse means to buy only what you need and to buy things that last a long time. Reduce means to say 'no' to waste by not even letting trash enter into one's life. This includes excessive packaging, disposable and single-use items, or things that contain hazardous chemicals.

At first, reducing waste can be hard. Few stores offer items in bulk. Many foods such as meat, fruits and vegetables are heavily packaged and wrapped in plastic. Rather than buying packaged foods, people living a Zero Waste lifestyle take glass jars and cloth bags to the supermarket to be filled with various items. For example, glass jars taken to the store can be used to store items such as rice, beans, flour and sugar. Zero Waster's even request that foods such as cheese and meat be put into glass jars rather than in the usual plastic wrapping.

Re-use means finding new ways of re-purposing old things. Recycling helps preserve the value of the items that would be lost if they were thrown in the trash. Rot is composting biodegradable waste that cannot be re-used or recycled. There are so many ways to reduce waste and the results can be surprising. Many find the Zero Waste lifestyle to be a meaningful way of improving the environment.

Appendix B

Table 4
Descriptives for continuous variables, Study 1

	N	Donation (Mean)	Donation (SD)	# Papers Used (Mean)	# Papers Used (SD)
Control	53	11.340	2.609	5.774	6.311
Info	52	13.135	2.101	4.481	5.796
Story	53	18.208	2.742	4.019	4.766

Appendix C

Table 5

Cohen's d and Log Odds Ratios for Pro-Environmental Measures - Study 1

	Cohens d		
	Story/Control	Info/Control	Story/Info
	d	*d*	*d*
Donation	0.26 [-0.13,0.64]	0.08 [-0.31,0.46]	0.21 [-0.18,0.59]
Papers Used in total	-0.31 [-0.70,0.07]	-0.21[-0.60,0.17]	-0.09 [-0.47,0.30]

	Log Odds Ratio					
	Log(OR)	SE	Log(OR)	SE	Log(OR)	SE
Lights off	0.16	0.40	0.13	0.40	0.030	0.41
Cleaning desk	0.63	0.40	0.03	0.41	0.60	0.40
Recycle	1.04	0.41	0.38	0.42	0.67	0.40
Subscribers	0.59	0.41	-0.11	0.39	0.70	0.41
Follow-up	-0.13	0.42	-0.67	0.41	0.54	0.40

Appendix D

Table 6
Frequencies for Behavioural Measures – Study 1, Part 1

	Frequencies			
	No	Yes		Total
Computer to sleep*	156	2		158
Overhead light off	59	99		158
Wrote on both sides*	129	29		158
Recycled scratch paper	96	62		158
Desk cleaned off	96	62		158
Subscribe to Greenpeace newsletter	60	98		158
Decoy trash**	121	37		158
Snack eaten*	114	44		158
	Plastic	Glass	No Drink	Total
Drink*	75	54	29	158
	No	Yes	N/A	Total
Threw snack/drink away*	16	78	64	158

Note. * indicates measure was not analysed either because it contained no variation or was found to be a poor measure. ** Decoy trash was collapsed into the measure of whether or not desk was cleaned off.

Appendix E

Table 7

Narrative Structure Scores of Climate Change Videos (full set) - Study 2

Video ID	Producer	Title	Location	Residual Valence	Narrative Structure Score
1	NASA	NASA animation of temperature data from 1880-2011	https://www.youtube.com/watch?v=EoOrtvYTKeE	0	0.41
2	Climate Reality	For the love of guacamole	https://www.youtube.com/watch?v=kWiU9nVELBs	0	0.51
3	Greenpeace	Grow up, Cool Down	https://www.youtube.com/watch?v=E3YPBfO2Ys&list=PLC10611409349D4D	0	1.01
4	ON Gov	Kids talk climate change	https://www.youtube.com/watch?v=4igQKdjqIKU	1	0.66
5	Greenpeace	Global Warming Ad (Baby in bathtub)	https://www.youtube.com/watch?v=kOSsIIxQ_dE	0	1.16
6	Climate Reality	Heartland Department of Education	https://www.youtube.com/watch?v=9DjPo0ewuCw	0	0.43
7	Greenpeace UK	The biggest environmental disaster of 2015	https://www.youtube.com/watch?v=OpamTit0zrw	0	0.66
8	Conservation International	Nature is speaking: Liam Neeson is Ice	https://www.youtube.com/watch?v=qBBOue_AdcU	0	0.99
9	Conservation International	Nature is speaking: Reese Witherspoon is Home	https://www.youtube.com/watch?v=mkjwxmcdb0E	0	1.03
10	ON Gov	Let them figure it out	https://www.youtube.com/watch?v=C8B6QAt-YUU	0	1.07
11	Unilever	Farewell to the forest - A film by Unilever	https://www.youtube.com/watch?v=K0Qa9DgVvVM	1	1.28
12	Quercus	If you give up, they give up	https://www.youtube.com/watch?v=UU0SP91D9Js&list=PLC107611409349D4D&index=3	0	1.08
13	Climate reality	Our land, our climate, our future	https://www.youtube.com/watch?v=xxwCJhmhIJE	0	0.52
14	UN: Food and Agricutlture Organization	World Food Day 2016: Climate is changing. Food and Agriculture must too.	https://www.youtube.com/watch?v=wv5vTZk1CUU	1	0.71

15	Climate reality	Ten clear signs our climate is changing	https://www.youtube.com/watch?v=ganvjrYRNY0	0	0.45
16	Climate reality	Climate Reality Leader: Dan Kipnis	https://www.youtube.com/watch?v=WVX5Fv1PBB4	1	0.79
17	Climate reality	Climate Reality Leader: David Ellenberger	https://www.youtube.com/watch?v=mk76nKeXi-0	1	0.79
18	Greenpeace	Greenpeace: Dreams of Tomorrow	https://www.youtube.com/watch?v=HI8uRFdBGPs&index=4&list=PLC107611409349D4D	0	0.96
19	Greenpeace	Greenpeace: Onslaught	https://www.youtube.com/watch?v=odI7pQFyjso	0	0.97
20	Climate Reality	The Truth About Climate Change (Al Gore)	https://www.youtube.com/watch?v=PY-mboZkhD0	1	0.68
21	Greenpeace	Greenpeace: Earth Day Give a Hand	https://www.youtube.com/watch?v=Ep9MFiWXR8M	1	0.72
22	TERI: The Energy and Resources Institute	How climate change started	https://www.youtube.com/watch?v=QG9ZcsL4lNc&feature=youtu.be	0	1.29
23	National Academy of Sciences	Climate Change in 60 seconds	https://www.youtube.com/watch?v=n4e5UPu1co0	0	0.56
24	Climate stories NC	Climate stories NC	https://www.youtube.com/watch?v=pFMniT7XRxk	1	0.91
25	World Bank	High and Dry: Climate Chnage Increases Water Risks, Hampers Growth	https://www.youtube.com/watch?v=bTO6bNhsHl4	1	0.40
26	Comedy Central	Climate Change Debate: John Oliver - Short version	https://www.youtube.com/watch?v=UkBvsCMxrNU	0	1.06
27	Conservation International	Nature is speaking: Kevin Spacey is the Rainforest	https://www.youtube.com/watch?v=jBqMJzv4Cs8	0	1.32
28	Greenpeace	Greenpeace: Everything is not awesome	https://www.youtube.com/watch?v=qhbliUq0_r4	0	1.25
29	G-STAR RAW	Plastic	https://www.youtube.com/watch?v=e2ziBgSNxLI	1	0.97
30	Years of living dangerously	Years of living dangerously : America Ferrara	https://www.youtube.com/watch?v=BfkIFqezYw8	1	0.79
31	Climate Commission	The Impacts of Climate Change	https://www.youtube.com/watch?v=lhkgmKXOM1A	1	0.98
32	OxFam Australia	Food security and climate change in the Phillipines	https://www.youtube.com/watch?v=fN-ZnY61_C8	1	1.37
33	Years of living dangerously	Years of living dangerously: President Obama	https://www.youtube.com/watch?v=-cnjdqZi52s	1	0.79
34	National Geographic	Climate Change: It's up to us	https://www.youtube.com/watch?v=Ok8rMT2KCy0	1	0.56

35	Conservation International	Nature is speaking: Julia Roberts is Mother Nature	https://www.youtube.com/watch?v=WmVLcj-XKnM	0	1.19
36	Greenpeace UK	Fight breaks out in EU Parliament	https://www.youtube.com/watch?v=GRH6evaMZeM	1	1.22
37	Climate Nexus	2015: The hottest year on record	https://www.youtube.com/watch?v=feYJiZVTuHQ	0	1.09
38	Hungry Beast	I'm not a climate scientist	https://www.youtube.com/watch?annotation_id=annotation_633970&feature=iv&src_vid=LiYZxOlCN10&v=H7wdKg8rYL0	1	0.91
39	Climate Reality	Open Letter to World Leaders	https://www.youtube.com/watch?v=-KCgOpRUS0o	1	1.11
40	Conservation International	Nature is speaking: Harrison Ford is the ocean	https://www.youtube.com/watch?v=rM6txLtoaoc	0	1.23
41	Years of living dangerously	Years of living dangerously: Harrison Ford	https://www.youtube.com/watch?v=1DtRVEgixzk	0	1.43
42	IFOAM	Grow Food, Fight Climate Change	https://www.youtube.com/watch?v=HIVR-qb-OsI	1	0.63
43	Years of living dangerously	Years of living dangerously : Trailer 2	https://www.youtube.com/watch?v=Rn2Cd3Dwwnk	1	1.30
44	Years of living dangerously	Years of living dangerously: Jessica Alba	https://www.youtube.com/watch?v=uiaAPKrfViQ	1	0.91
45	Years of living dangerously	Years of living dangerously: Why I care - Matt Damon	https://www.youtube.com/watch?v=iDPXbCzMZFw	0	1.19
46	Rappler	Climate Change (according to children)	https://www.youtube.com/watch?v=Sv7OHfpIRfU	0	1.06
47	Years of living dangerously	Years of living dangerously : Thomas Friedman	https://www.youtube.com/watch?v=a5G5jg5l2E8	0	1.46
48	WWF	What is COP21 and why should we care	https://www.youtube.com/watch?v=5jOjEJq_fMw	1	0.85
49	Climate Nexus	The 2015 Lancet Commission on Health & Climate Change	https://www.youtube.com/watch?v=AV6Rx8uvUjk	1	0.76
50	Climate reality	Climate Leader : Diwaker Reddy	https://www.youtube.com/watch?v=V_Re2cgceZM	1	1.16
51	Years of living dangerously	Years of living dangerously : Mark Bittman	https://www.youtube.com/watch?v=e4esZ4HwXjo	0	1.19
52	350 Action	Climate Name Change	https://www.youtube.com/watch?v=eImoDX7748A	0	0.97
53	Climate Reality	Science Girl	https://www.youtube.com/watch?v=Eij91cInLHI	1	1.56
54	Sky News	Climate Change: What happens if the world warms by 5 degrees?	https://www.youtube.com/watch?v=qWoiBpfvdx0	0	0.73
55	Climate stories NC	Sally Eason: Trout Farmer	https://www.youtube.com/watch?v=-brc8SSAsXU	1	1.03

56	#Climatechangeisreal	Skiing the California Drought - No snow, no water)	https://vimeo.com/125655583	0	1.18
57	Climate Reality	Sir David Attenborough: The Truth About Climate Change	https://www.youtube.com/watch?v=S9ob9WdbXx0	0	1.07
58	UN: Food and Agricutlture Organization	Understanding -Climate Smart Agriculture	https://www.youtube.com/watch?v=lUdNMsVDIZ0	1	0.77
59	Nova's Secret Life of Scientists and Engineers	Katherine Hayboe: Climate Evangelist	https://www.youtube.com/watch?v=T1eGJLqxxKQ	1	0.75
60	Vox	What people get wrong about climate change	https://www.youtube.com/watch?v=EbjKcHPmxKQ	0	0.68
61	Greenpeace	Greenpeace - Inspiring Action	https://www.youtube.com/watch?v=zVu9eawb1QY	0	0.84
62	Climate Reality	Climate Reality Leader : Dr. Susan Pacheco	https://www.youtube.com/watch?v=BNfFG9qfzuE	1	1.28
63	Climate stories NC	Willie Phillips - Seafood Market Owner	https://www.youtube.com/watch?v=RSsUqdjZw5A	0	1.03
64	Climate stories NC	Leigh Catherine Bonner - Beekeeper	https://www.youtube.com/watch?v=gjBZgCIsX38	1	1.32
65	AJ+	Climate Change Animation shows devastating impacts	https://www.youtube.com/watch?v=S7jpMG5DS4Q	0	0.76
66	The Lancet	The 2015 Lancet Commission on Health & Climate Change	https://www.youtube.com/watch?v=d4YCPqz8NQU	1	0.52
67	Greenpeace	Elegy for the Arctic	https://www.youtube.com/watch?v=2DLnhdnSUVs	0	0.96
68	NASA	NASA: A Year in the Life of Earth's CO2	https://www.youtube.com/watch?v=x1SgmFa0r04	1	0.77
69	Defend Our Future	I will not wait	https://www.youtube.com/watch?v=C9nI4yPCAyE	0	1.56
70	AMSA global health- Think Tank Australia	Climate Code Green: the impacts of climate change on human health	https://www.youtube.com/watch?v=nIdebt9a_iI	0	0.80
71	Earth Day	Earth Day 2016	https://www.youtube.com/watch?v=huu4QGhMfXE	0	0.75
72	Business Insider	What would the earth look like if all the ice melted	https://www.youtube.com/watch?v=VbiRNT_gWUQ	0	0.63
73	Years of living dangerously	Years of living dangerously :Ian Sommerholder	https://www.youtube.com/watch?v=o5X2PuICmyI	0	1.64
74	Climate stories NC	Mike Bryant - Wildlife Refuge Manager	https://www.youtube.com/watch?v=mLjnkodGC7c	0	1.16
75	PAI.org	Aregash's Story: Weathering Change	https://www.youtube.com/watch?v=Frdo5Uw5VCk	0	1.32

76	UN	UN: Our Future (Narrated, Morgan Freeman)	https://www.youtube.com/watch?v=8YQIaOldDU8	1	1.16
77	Years of living dangerously	Years of living dangerously: Arnold Swartzenager	https://www.youtube.com/watch?v=TJcapPimRbg	1	1.16
78	The Daily Conversation	Fight Climate Change: Eat Less Meat	https://www.youtube.com/watch?v=lLhEmGx8YQE	0	0.80
79	Aplus	People said climate change was too big a problem to fix but he's not listening	https://www.youtube.com/watch?v=5qsbltiF-SM	1	1.08
80	HBO	A brutally honest climatologist	https://www.youtube.com/watch?v=kwCBmRufcjc	0	1.17
81	National Geographic	Climate Change 101: Bill Nye National Geographic	https://www.youtube.com/watch?v=EtW2rrLHs08	1	1.27
82	Climate stories NC	Kelly Darden:Hunter, Outdoorsman and Conservationist	https://www.youtube.com/watch?v=Cs2X2pcd1xA	1	1.04
83	Climate Reality	Climate 101 with Bill Nye	https://www.youtube.com/watch?v=3v-w8Cyfoq8	1	0.88
84	Veritasium	Climate Change is Boring	https://www.youtube.com/watch?v=eNx9tvCrvv8	1	0.77
85	Climate Reality	How off-grid solar powers Kenya	https://www.youtube.com/watch?v=v87sETVu7OY	1	1.16
86	Years of living dangerously	Years of living dangerously: Katharine Hayboe	https://www.youtube.com/watch?v=nY1HweENTeU	1	1.48
87	Our Children's trust	TRUST California	https://www.youtube.com/watch?v=htG-xs0Onj0	1	1.28
88	It's ok to be smart	Climate Change: What You Need to Know	https://www.youtube.com/watch?v=ffjIyms1BX4	1	0.95
89	It's ok to be smart	Why people don't believe in Climate Science	https://www.youtube.com/watch?v=y2euBvdP28c	1	0.83
90	Comedy Central	Climate Change Debate: John Oliver - Whole version	https://www.youtube.com/watch?v=cjuGCJJUGsg	1	1.31
91	Greg Craven	The most terrifying video you will ever see	https://www.youtube.com/watch?v=zORv8wwiadQ	0	0.68

Appendix F

Table 8

Mturk Study Stimuli, ordered by Narrative Structure Score (reduced set) – Study 2

Video ID	Producer	Title	Location	Narrative Structure Score
73	Years of living dangerously	Years of living dangerously :Ian Sommerholder	https://www.youtube.com/watch?v=o5X2PuICmyI	1.64
69	*Defend Our Future	I will not wait	https://www.youtube.com/watch?v=C9nI4yPCAyE	1.56
32	OxFam Australia	Food security and climate change in the Phillipines	https://www.youtube.com/watch?v=fN-ZnY61_C8	1.37
27	*Conservation International	Nature is speaking: Kevin Spacey is the Rainforest	https://www.youtube.com/watch?v=jBqMJzv4Cs8	1.32
64	*Climate stories NC	Leigh Catherine Bonner – Beekeeper	https://www.youtube.com/watch?v=gjBZgCIsX38	1.32
62	Climate Reality	Climate Reality Leader : Dr. Susan Pacheco	https://www.youtube.com/watch?v=BNfFG9qfzuE	1.28
56	#Climatechangeisreal	Skiing the California Drought – No snow, no water)	https://vimeo.com/125655583	1.18
80	HBO	A brutally honest climatologist	https://www.youtube.com/watch?v=kwCBmRufcjc	1.17
12	Quercus	If you give up, they give up	https://www.youtube.com/watch?v=UU0SP91D9Js&list=PLC107611409349D4D&index=3	1.08
26	Comedy Central	Climate Change Debate: John Oliver – Short version	https://www.youtube.com/watch?v=UkBvsCMxrNU	1.06
67	Greenpeace	Elegy for the Arctic	https://www.youtube.com/watch?v=2DLnhdnSUVs	0.96
48	WWF	What is COP21 and why should we care	https://www.youtube.com/watch?v=5jOjEJq_fMw	0.84
68	*NASA	NASA: A Year in the Life of Earth's CO2	https://www.youtube.com/watch?v=x1SgmFa0r04	0.77
14	UN: Food and Agricutlture Organization	World Food Day 2016: Climate is changing. Food and Agriculture must too.	https://www.youtube.com/watch?v=wv5vTZk1CUU	0.71
60	Vox	What people get wrong about climate change	https://www.youtube.com/watch?v=EbjKcHPmxKQ	0.68
42	IFOAM	Grow Food, Fight Climate Change	https://www.youtube.com/watch?v=HIVR-qb-OsI	0.63

72	Business Insider	What would the earth look like if all the ice melted	https://www.youtube.com/watch?v=VbiRNT_gWUQ	0.63
23	*National Academy of Sciences	Climate Change in 60 seconds	https://www.youtube.com/watch?v=n4e5UPu1co0	0.56
34	National Geographic	Climate Change: It's up to us	https://www.youtube.com/watch?v=Ok8rMT2KCy0	0.56
66	The Lancet	The 2015 Lancet Commission on Health & Climate Change	https://www.youtube.com/watch?v=d4YCPqz8NQU	0.52
15	Climate reality	Ten clear signs our climate is changing	https://www.youtube.com/watch?v=ganvjrYRNY0	0.45
25	*World Bank	High and Dry: Climate Change Increases Water Risks, Hampers Growth	https://www.youtube.com/watch?v=bTO6bNhsHl4	0.40

Note. *Indicates stimuli used in study 3

Appendix G

Table 9
Narrative Structure Coding, Inter-Coder Reliability - Study 2

Variable	Krippendorff's alpha	Percent Agreement
Narrator	0.810867293625914	91.2087912087912
Main character - Male	0.708967223252938	93.4065934065934
Music	0.691477272727273	93.4065934065934
Male narrator	0.655595917661304	87.9120879120879
If there is a character, setting, goal	0.628426518536409	81.3186813186813
Setting	0.82834304294811	92.3076923076923
Plot	0.338160011701038	72.5274725274725
More than one character	0.594948849104859	84.6153846153846
Human	0.823414634146342	91.2087912087912
Identifiable Character	0.835561323815704	92.3076923076923

Appendix H

Table 10

Narrative Transportation Scale – Short Form (TS-SF)

Item Nr.	Item
1	I could picture myself in the scene of events described in the video.
2	I was mentally involved in the narrative while watching the video.
3	I wanted to learn how the narrative ended.
4	The narrative affected me emotionally.
5	While watching the video, I had a vivid image of the main character.

Note. Items were presented with 7-point response scales from 1 (*not at all*) to 7 (*very much*). Source: Appel et al, 2012

Appendix I

Table 11
Model Selection, Narrative Structure and Narrative Transportation - Study 2

Model	LL	DF	*N*	BIC	ΔBIC
NT ~ StoryInfo + (1 | Mturk_ID)	-1836.624	4	90	3691.247	0.00
NT ~ (1 | Mturk_ID)	-1852.331	3	90	3718.161	26.91

Table 12
Fixed and Random Effects Estimates for the Most Predictive Model of Narrative Transportation – Study 2

Parameter	Coefficients
Fixed Effects	
Intercept	22.16 (0.49)
High/LowNS	4.30 (0.69)
Random Effects	
Mturk_ID /intercept	32.25 (5.68)

Note. Standard errors are in the parentheses for fixed effect. Standard deviation is in the parentheses for random effects.

Appendix J

Table 13

Final Stimuli, Study 3

Video ID	Producer	Title	Location	Residual Emotional Valence	Narrative Transportation Score	Narrative Structure Score
HIGH NARRATIVE STRUCTURE VIDEOS						
69	Defend Our Future	I will not wait	https://www.youtube.com/watch?v=C9nI4yPCAyE	0	27.75	1.56
27	Conservation International	Nature is speaking: Kevin Spacey is the Rainforest	https://www.youtube.com/watch?v=jBqMJzv4Cs8	0	27.74	1.32
64	Climate stories NC	Leigh Catherine Bonner - Beekeeper	https://www.youtube.com/watch?v=gjBZgCIsX38	1	27.26	1.32
LOW NARRATIVE STRUCTURE VIDEOS						
68	NASA	NASA: A Year in the Life of Earth's CO2	https://www.youtube.com/watch?v=x1SgmFa0r04	1	20.78	0.77
23	National Academy of Sciences	Climate Change in 60 seconds	https://www.youtube.com/watch?v=n4e5UPu1co0	0	20.71	0.56
25	World Bank	High and Dry: Climate Chnage Increases Water Risks, Hampers Growth	https://www.youtube.com/watch?v=bTO6bNhsHl4	1	19.42	0.40

Appendix K

Additional Methodological Detail, Study 3

Parasympathetic measures of cardiac (sampling rate 1kHz) and electrodermal activity (sampling rate 250 Hz) were collected using a Biopac MP150 data acquisition system and BioNomadix® transmitters and recorded with AcqKnowledge® software version 4.2 (Biopac Inc., Goleta, CA). To measure cardiac activity, participants were fitted with three disposable Ag-AgCI electrocardiogram (ECG) electrodes on the right mid-clavicle, left ribcage, and left outer clavicle using a Lead(III) configuration. To measure skin conductance, two disposable Ag-AgCI electrodermal (EDA) electrodes were placed on participants' distal phalanx surfaces of the middle and index fingers of their non-dominant hand. Before placement of the EDA electrodes, participants washed hands with non-detergent bar soap.

Data Analysis. Following data collection, the data were manually inspected in AcqKnowledge® software version 4.2 (Biopac Inc., Goleta, CA). Skin conductance waveforms were visually inspected for brief periods of signal loss, and data drop-offs shorter than 1 sin length were replaced with averages from adjacent parts of the waveform. Additionally, waveform noise due to experimenter-observed movement was smoothed using mean-value replacement from adjacent parts of the waveform. Next, a 10-Hzlow-pass filter was applied to the waveform to remove high-frequency noise (Norris, Larsen, & Cacioppo, 2007), and a square root transformation was applied to adjust for skew inherent to skin conductance data (Meye & Digirolamo, 2007; Schulte-Mecklenbeck, Kuehberger, & Ranyard, 2011). After transformations, average skin conductance level (SCL) was extracted for 30 seconds prior to onset of each stimulus and for the duration of each narrative. These values were used to calculate percent change in SCL from each proximal baseline to the narrative.

ECG artifacts were manually removed from the data. Data were further passed through the band-pass finite impulse response (FIR) filter, to remove both high- and low-frequency noise, and then smoothed. R-R intervals were identified and extracted from Biopac and imported into Kubios software for derivation of heart rate variability (HF-HRV) measures, including the high frequency (HF) component as the measure of vagal control. Linear trend components were removed from the data prior to HF-HRV analysis. The HF power was extracted from 0.12 to 0.4 Hz band and then log transformed as suggested by (Lewis, Furman, McCool, & Porges, 2012).

Appendix L

Table 14
Model Selection, Narrative Structure on Physiology – Study 3
HRV

Model	LL	DF	*N*	BIC	ΔBIC
EDA = (1 | ID)	287.2035	3	514	-555.6802	0.00
EDA = HighLow + (1 | ID)	283.7574	4	514	-542.5460	13.13

EDA

Model	LL	DF	*N*	BIC	ΔBIC
EDA = (1 | ID)	287.2035	3	514	-555.6802	0.00
EDA = HighLow + (1 | ID)	283.7574	4	514	-542.5460	13.13

ECG-RR

Model	LL	DF	*N*	BIC	ΔBIC
ECG_RR = HighLow + (1 | ID)	579.3775	4	514	-1133.786	0.00
ECG_RR = (1 | ID)	570.7981	3	514	-1122.870	10.92

Appendix M

Table 15

Model Selection, Narrative Structure and Physiology on Narrative Transportation – Study 3

Model	LL	DF	*N*	BIC	ΔBIC
NT_score = HighLow + (1 | ID)	-1535.786	4	514	3096.540	0.00
NT_score = HighLow + ECG_RR + (1 | ID)	-1533.321	5	514	3097.853	1.31
NT_score = HighLow + HRV + (1 | ID)	-1533.795	5	514	3098.802	2.26
NT_score = HighLow + EDA + (1 | ID)	-1534.045	5	514	3099.302	2.76
NT_score = HighLow + HRV + ECG_RR + (1 | ID)	-1531.286	6	514	3100.025	3.49
NT_score = HighLow + EDA + ECG_RR + (1 | ID)	-1531.533	6	514	3100.519	3.98
NT_score = HighLow + HRV + EDA + (1 | ID)	-1532.084	6	514	3101.622	5.08
NT_score = HighLow + HRV + EDA + ECG_RR + (1 | ID)	-1529.556	7	514	3102.808	6.27
NT_score = ECG_RR + (1 | ID)	-1623.563	4	514	3272.095	175.55
NT_score = EDA + ECG_RR + (1 | ID)	-1621.659	5	514	3274.529	177.99
NT_score = HRV + ECG_RR + (1 | ID)	-1621.901	5	514	3275.012	178.47
NT_score = (1 | ID)	-1629.112	3	514	3276.951	180.41
NT_score = HRV + EDA + ECG_RR + (1 | ID)	-1619.957	6	514	3277.368	180.83

Model	LL	DF	*N*	BIC	ΔBIC
Donation = HRV_c * Residualvalence + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2529.659	10	514	5121.740	0.00
Donation = HighLow + HRV_c * Residualvalence + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2526.944	11	514	5122.552	0.81
Donation = EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2538.172	8	514	5126.282	4.54
Donation = HighLow + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2535.522	9	514	5127.224	5.48
Donation = NT_score_c + HRV_c * Residualvalence + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2529.465	11	514	5127.594	5.85
Donation = HighLow + NT_score_c + HRV_c * Residualvalence + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2526.746	12	514	5128.399	6.66
Donation = HRV_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2539.688	8	514	5129.314	7.57
Donation = HighLow + HRV_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2536.928	9	514	5130.036	8.30
Donation = HRV_c * Residualvalence + EDA_c * Residualvalence + (1 | ID)	-2540.328	8	514	5130.593	8.85
Donation = HighLow + HRV_c * Residualvalence + EDA_c * Residualvalence + (1 | ID)	-2537.797	9	514	5131.774	10.03
Donation = NT_score_c + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2537.995	9	514	5132.170	10.43
Donation = HighLow + NT_score_c + EDA_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2535.304	10	514	5133.031	11.29
Donation = ECG_RR_c * Residualvalence + (1 | ID)	-2548.728	6	514	5134.910	13.17
Donation = EDA_c * Residualvalence + (1 | ID)	-2548.796	6	514	5135.044	13.30

Donation = NT_score_c + HRV_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2539.483	9	514	5135.146	13.41
Donation = HighLow + ECG_RR_c * Residualvalence + (1 | ID)	-2546.053	7	514	5135.801	14.06
Donation = HighLow + NT_score_c + HRV_c * Residualvalence + ECG_RR_c * Residualvalence + (1 | ID)	-2536.746	10	514	5135.915	14.17
Donation = HighLow + EDA_c * Residualvalence + (1 | ID)	-2546.301	7	514	5136.297	14.56
Donation = NT_score_c + HRV_c * Residualvalence + EDA_c * Residualvalence + (1 | ID)	-2540.252	9	514	5136.683	14.94
Donation = HRV_c + EDA_c + ECG_RR_c + (1 | ID)	-2549.991	6	514	5137.436	15.70
Donation = HighLow + NT_score_c + HRV_c * Residualvalence + EDA_c * Residualvalence + (1 | ID)	-2537.588	10	514	5137.598	15.86
Donation = EDA_c + ECG_RR_c + (1 | ID)	-2553.673	5	514	5138.557	16.82
Donation = HighLow + HRV_c + EDA_c + ECG_RR_c + (1 | ID)	-2547.546	7	514	5138.787	17.05
Donation = HRV_c * Residualvalence + (1 | ID)	-2550.776	6	514	5139.004	17.26
Donation = HRV_c + ECG_RR_c + (1 | ID)	-2554.024	5	514	5139.258	17.52
Donation = HighLow + EDA_c + ECG_RR_c + (1 | ID)	-2551.229	6	514	5139.912	18.17
Donation = HighLow + HRV_c * Residualvalence + (1 | ID)	-2548.240	7	514	5140.176	18.44
Donation = ECG_RR_c + (1 | ID)	-2557.659	4	514	5140.287	18.55
Donation = HighLow + HRV_c + ECG_RR_c + (1 | ID)	-2551.577	6	514	5140.607	18.87

Donation = NT_score_c + ECG_RR_c * Residualvalence + (1 | ID)	-2548.570	7	514	5140.835	19.10
Donation = HRV_c + EDA_c + (1 | ID)	-2554.967	5	514	5141.145	19.41
Donation = NT_score_c + EDA_c * Residualvalence + (1 | ID)	-2548.730	7	514	5141.155	19.41
Donation = HighLow + ECG_RR_c + (1 | ID)	-2555.212	5	514	5141.636	19.90
Donation = HighLow + NT_score_c + ECG_RR_c * Residualvalence + (1 | ID)	-2545.866	8	514	5141.670	19.93
Donation = HighLow + NT_score_c + EDA_c * Residualvalence + (1 | ID)	-2546.072	8	514	5142.082	20.34
Donation = EDA_c + (1 | ID)	-2558.649	4	514	5142.266	20.53
Donation = HighLow + HRV_c + EDA_c + (1 | ID)	-2552.593	6	514	5142.639	20.90
Donation = HRV_c + (1 | ID)	-2559.095	4	514	5143.159	21.42
Donation = NT_score_c + HRV_c + EDA_c + ECG_RR_c + (1 | ID)	-2549.951	7	514	5143.598	21.86
Donation = HighLow + EDA_c + (1 | ID)	-2556.276	5	514	5143.764	22.02
Donation = (1 | ID)	-2562.742	3	514	5144.211	22.47
Donation = HighLow + NT_score_c + HRV_c + EDA_c + ECG_RR_c + (1 | ID)	-2547.303	8	514	5144.543	22.80
Donation = HighLow + HRV_c + (1 | ID)	-2556.722	5	514	5144.654	22.91
Donation = NT_score_c + EDA_c + ECG_RR_c + (1 | ID)	-2553.634	6	514	5144.721	22.98

Donation = NT_score_c + HRV_c * Residualvalence + (1 | ID)	-2550.712	7	514	5145.120	23.38
Donation = NT_score_c + HRV_c + ECG_RR_c + (1 | ID)	-2553.980	6	514	5145.414	23.67
Donation = HighLow + NT_score_c + EDA_c + ECG_RR_c + (1 | ID)	-2550.989	7	514	5145.673	23.93
Donation = HighLow + (1 | ID)	-2560.371	4	514	5145.710	23.97
Donation = HighLow + (1 | ID)	-2560.371	4	514	5145.710	23.97
Donation = HighLow + NT_score_c + HRV_c * Residualvalence + (1 | ID)	-2548.048	8	514	5146.033	24.29
Donation = HighLow + NT_score_c + HRV_c + ECG_RR_c + (1 | ID)	-2551.333	7	514	5146.361	24.62
Donation = NT_score_c + ECG_RR_c + (1 | ID)	-2557.621	5	514	5146.453	24.71
Donation = HighLow + NT_score_c + ECG_RR_c + (1 | ID)	-2554.980	6	514	5147.413	25.67
Donation = HighLow + NT_score_c + HRV_c + EDA_c + (1 | ID)	-2552.343	7	514	5148.382	26.64
Donation = NT_score_c + EDA_c + (1 | ID)	-2558.710	5	514	5148.632	26.89
Donation = HighLow + NT_score_c + EDA_c + (1 | ID)	-2556.029	6	514	5149.512	27.77
Donation = NT_score_c + HRV_c + (1 | ID)	-2559.161	5	514	5149.532	27.79
Donation = HighLow + NT_score_c + HRV_c + (1 | ID)	-2556.470	6	514	5150.393	28.65
Donation = NT_score_c + (1 | ID)	-2562.814	4	514	5150.597	28.86
Donation = HighLow + NT_score_c + (1 | ID)	-2560.133	5	514	5151.477	29.74

Appendix N

Table 16
Model selection and BIC scores for (Full) Pruned Model (Hayes, 2013) – Study 3

Model	LL	DF	*N*	BIC	ΔBIC
Donation = ECG_RR_c * Residualvalence + (1 | ID)	-2548.728	6	514	5134.910	0.00
Donation = HighLow + ECG_RR_c * Residualvalence + (1 | ID)	-2546.053	7	514	5135.801	0.89
Donation = ECG_RR_c + (1 | ID)	-2557.659	4	514	5140.287	5.38
Donation = NT_score_c + ECG_RR_c * Residualvalence + (1 | ID)	-2548.570	7	514	5140.835	5.93
Donation = HighLow + ECG_RR_c + (1 | ID)	-2555.212	5	514	5141.636	6.73
Donation = HighLow + NT_score_c + ECG_RR_c * Residualvalence + (1 | ID)	-2545.866	8	514	5141.670	6.76
Donation = (1 | ID)	-2562.742	3	514	5144.211	9.30
Donation = HighLow + (1 | ID)	-2560.371	4	514	5145.710	10.80
Donation = NT_score_c + ECG_RR_c + (1 | ID)	-2557.621	5	514	5146.453	11.54
Donation = HighLow + NT_score_c + ECG_RR_c + (1 | ID)	-2554.980	6	514	5147.413	12.50
Donation = NT_score_c + (1 | ID)	-2562.814	4	514	5150.597	15.69
Donation = HighLow + NT_score_c + (1 | ID)	-2560.133	5	514	5151.477	16.57

Appendix O

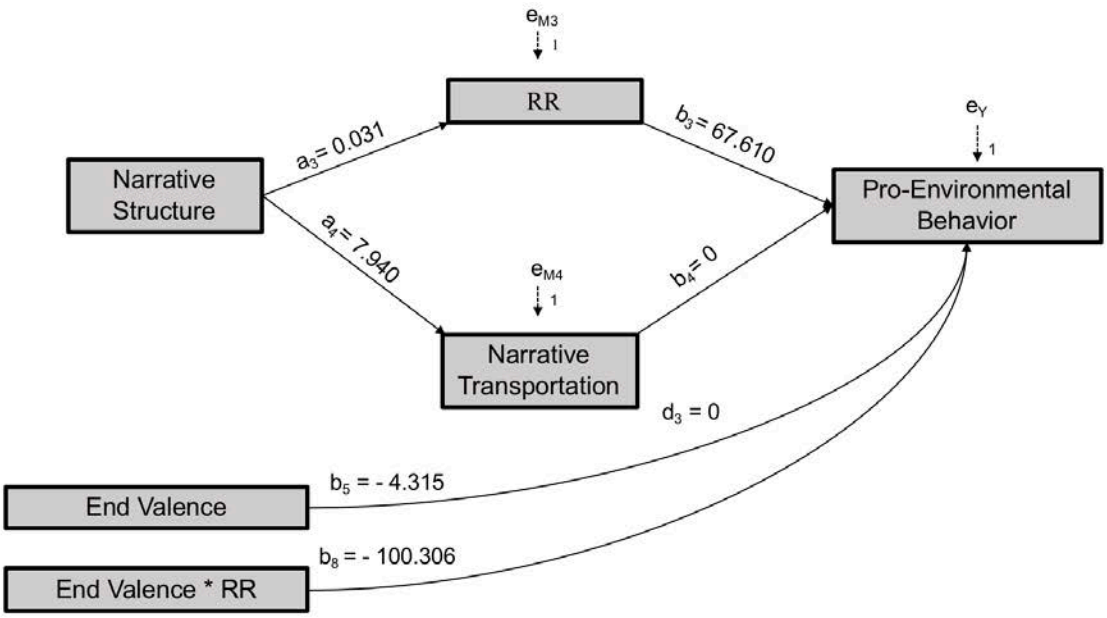


Figure 4. Statistical Diagram, Pruned Model using Hayes (2013) Method – Study 3

Appendix P

Table 17

Main Results on the Effect of Narrative Structure on Pro-Environmental Behavior, Pruned Model – Study 3

		Consequent				
		M_3 (RR)		M_4 (Narrative Transportation)		Y (Donation)
Antecedent		Coeff. (SE)		Coeff. (SE)		Coeff. (SE)
Narrative Transportation (X)	a_3	0.031 (0.006)	a_4	7.940 (0.515)		----
RR (M_3)		-------		-------	b_3	67.610 (43.298)
Narrative Transportation (M_4)		-------		-------	b_4	-------
End Valence (V)		-------		-------	b_5	-4.315 (4.278)
Interaction: RR * End Valence (M_3 * V)		-------		-------	b_8	-100.306 (82.032)
Constant	i_3	- 0.004 (0.005)	i_4	17.41 (0.648)	i_5	60.104 (8.070)
		Variance (SD)		Variance (SD)		Variance (SD)
ID/Random Intercept		0.000 (0.023)		22.84 (4.779)		4496.00 (67.05)
		R^2c/ R^2m		R^2c/ R^2m		R^2c/ R^2m
		0.149/0.046		0.555/0.227		0.680/0.003

Paper B

(Un)Happy Endings in Climate Change Appeals: Risk Perception & Efficacy

Purpose: Building on the findings of Paper A, Paper B focuses on studying the role of emotional end valence on risk perception and outcome efficacy. Research question: 'Do stories with negative end valence increase climate change risk perception more than those with positive end valence?'

Design/Methodology/Approach: I conducted four online survey experiments using controlled, naturalistic, and hybrid stimuli as well as self-reported measures of emotional arousal and climate change risk perception.

Findings: Negative end valence makes people more keenly aware of the threat and danger of climate change. It also gives people a greater sense of outcome efficacy – the belief that their own personal actions influence climate change. These effects were particularly pronounced in typically disengaged audience segments (e.g. conservatives and those holding individualistic or hierarchical worldviews.)

Research limitations: The studies use data from online panels and self-reported measures. These factors limit the generalizability of the studies yet provide the opportunity to improve ideological variation in the sample.

Practical implications: To increase the likelihood that individuals will perceive the risk of climate change and have a sense that their own actions have impact, communication appeals should end with negative affective valence.

(Un)Happy Endings in Climate Change Appeals: Risk Perception & Efficacy

Brandi S. Morris

Aarhus BSS, Department of Management, Aarhus University,

Fuglesangs Allé 4, DK-8210 Aarhus V, Denmark

Abstract

The use of emotion in climate change appeals is a hotly debated topic. There is scant empirical evidence to support the scientific reliability of categorizing emotion into discrete categories but valence is a universally accepted, empirical property of affective experience. This work investigates how the affective end valence of climate change stories influences risk perception and outcome efficacy. In studies 1-3, I explore how the end valence of climate change appeals impacts risk perception through emotional arousal and find that stories concluding with negative valence heighten risk perception more than their positive counterparts, an effect that varies by political ideology and cultural worldview. Exposure to stories with negative end valence indirectly increased risk perception via heightened emotional arousal among all ideological groups, but particularly for those who held either individualistic or hierarchical worldviews, or who self-identified as politically conservative. In study 4, I build on these findings to understand how positive and varying degrees of negative valence at the end of climate change appeals impact beliefs people hold about whether or not their own individual actions matter for climate change (efficacy). The findings of the fourth study suggest that people were *less likely* to believe that their own actions actually influence global climate change after being exposed to a story ending with positive affect. More, there was no statistically significant difference between negative and 'doom and gloom' endings in terms of how participants perceived their own ability to influence global warming.

Keywords: Climate change communication, affect, risk perception, values, efficacy

Climate change is a cognitively complex and psychologically distant threat (Lorenzoni, Pidgeon, & O'Connor, 2005) lacking attributes that typically make risk salient (Leiserowitz, 2006). Among other things, it does not easily spark the affective engagement known to be critical for the rational assimilation of information and accurate risk assessment (Slovic, Finucane, Peters, & MacGregor, 2004). There is heated debate about the use of emotion in climate change appeals (Chapman, Lickel, & Markowitz, 2017). Critics dub campaigns with ominous messaging as "climate disaster porn" (Atkin, 2017), alleging the use of negative affect fosters paralysis rather than action (Freedman, 2017). Some scientists have even gone so far as to claim pessimistic messaging is as harmful to engagement efforts as climate change denial (Mann, Hassol, & Toles, 2017), contributing to pervasive, public psychological numbing (Fetherstonhaugh, Slovic, Johnson, & Friedrich, 1997).

This paper makes three claims and provides supporting evidence for them. The first claim concerns the causal importance of negative affective endings in climate change stories for heightening risk perception. Positive messages about climate change might comfort a public suffering from chronic 'apocalypse fatigue' (Moser & Dilling, 2011; Nordhaus & Shellenberger, 2009), but do they support efforts to increase public perception of climate change risk? When it comes to risk management, negative affect is the "wellspring of action" (Peters & Slovic, 2000) and there is some evidence that this is no less true for the threat of climate change (Schwartz & Loewenstein, 2017; Weber, 2006). Several studies have found that sadness (Schwartz & Loewenstein, 2017), worry (Smith & Leiserowitz, 2014), fear (Feldman & Hart, 2015), anxiety (Weber, 2006), hope and anger (Feldman & Hart, 2015) are strongly associated with climate change engagement (Feldman & Hart, 2015; Weber, 2006) while others observe no association with anger or fear (Smith & Leiserowitz, 2014). Witte and Allen (2000) found that fear appeals are ineffective when perceived efficacy is low. However, there is more evidence to support the claim that these discrete emotions are human constructs based on

subjective perception (Barrett, 2006b) as opposed to distinctive, quantifiable, internal states characterized by biological or behavioral markers (Barrett, 2017; Barrett & Niedenthal, 2004). This raises serious questions about the scientific reliability of categorizing affective experience in this way (Barrett, 2006a). In contrast, emotional valence has been shown to be a universally identifiable (Barrett, 2006b) and well-documented empirical property (see Russell and Barrett (1999) for a review), useful for categorizing what is variant and invariant about affective experience (Barrett, 2006a).

The second claim is that negative affect exerts its influence on risk perception through emotional arousal. Whereas valence indicates the *value* or expected consequence of a specific piece of information (Barrett, 2006b), arousal indicates the *urgency*. Arousal is a bodily cue to the urgency of specific information and signals a need for action or behavior as the brain's way of optimizing bodily budgets. The third claim relates to how the values of a story receiver influence risk perception. Risk is a multifaceted social construct (Slovic, 1999), highly influenced by *who* is assessing, and communicating, the threat (Kahan, Braman, Slovic, Gastil, & Cohen, 2007; Slovic, 1999). In some countries, a person's stance on the issue of climate change has become an important cue to values, worldview and identity strongly linked to social in-group belonging. This has important implications for risk perception because the risk of social alienation from the adoption of beliefs not congenial to one's in-group may be (subconsciously) evaluated as more dangerous than the psychologically distant threat of climate change. The next section provides support for these three claims. Together they suggest that, absent negative affect, the brain does not perceive the need to expend scarce bodily resources on emotional arousal that makes the threat of climate change salient and signals a need for action.

Affective Valence, Arousal & Risk Perception

Extensive research has demonstrated that hindering affective engagement in favor of analytical processing significantly degrades the quality of judgment and decision-making (Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Tranel, & Damasio, 1997; Wilson & Schooler, 1991), particularly in situations characterized by uncertainty (Damasio, 2003; Peters & Slovic, 2000). The neurophysiological state of core affect described as a "faint whisper of emotion" (Slovic et al., 2004) is a form of heuristic (Finucane, Alhakami, Slovic, & Johnson, 2000) which can be categorized along two dimensions: 1) valence: the inherently positive or negative charge of an emotion and 2) arousal: high vs. low (Russell & Barrett, 1999). Each affective dimension provides a different form of information crucial to judgment and decision-making (Storbeck & Clore, 2008).

Valence

Valence is thought to be a form of psychological valuation which exerts distinctive influence on judgment and decision-making based on the perceived importance, desirability (Damasio, 2011) or expected consequence of a specific piece of information (Barrett, 2006b). There is an inverse relationship between affect and risk judgments. Negative affect has been shown to *increase* estimations of risk probability while positive affect *reduces* it (Finucane et al., 2000; Ganzach, 2000). Positive affect increases dopamine levels in the brain (Ashby & Isen, 1999), suggesting that all is well and reducing the motivation to expend cognitive effort on further information-seeking (Schwarz & Clore, 1983). Humans tend to be positive affect maximizers (Lang, Newhagen, & Reeves, 1996) but have an inclination to give more weight to negative information (Slovic, 1999). As a result, they approach positive messages and avoid negative ones. Receptivity to new information as a result of negative affect is thought to be a form of danger-control mechanism (Witte & Allen, 2000), but when people have a low sense of efficacy they will avoid further information to reduce negative affect (Witte & Allen, 2000). In line with the principle of loss aversion (Tversky & Kahneman, 1992), negative affect is also more likely to be associated with loss- rather than gain frames.

Research suggests that positive affect (Yang & Kahlor, 2013) and an optimistic outlook in conjunction with climate change lead to the purposeful avoidance of new information with the potential to cause distress whereas negative affect in this context had the opposite effect (Brashers, 2001; Yang & Kahlor, 2013). Evidence that positive affect about climate change causes information avoidance diverges from findings in the field of health communication, where it was observed to encourage further information-seeking in conjunction with clinical trial enrollment for disease management (Yang et al., 2011). One plausible explanation for this variance is perceived efficacy, which has been shown to be an important predictor of

engagement with climate change (Feldman & Hart, 2015). People are less likely to take action if they feel overwhelmed or hopeless (Bandura, 1986). Enrolling in a clinical trial for disease management is very much within one's control whereas the solutions for climate change are systemic, complicated and seemingly removed from individual influence. Self-efficacy relates to the confidence that an individual has about his/her ability to enact a behavior whereas outcome expectancy relates to the belief about the likelihood that a particular behavior will influence an outcome (Bandura, 1977).

Negative affective valence can be considered a form of cognitive discomfort and, as the *peak end rule* illustrates (Do, Rupert, & Wolford, 2008; Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993), people will willingly choose situations with objectively more overall pain as long as the event *ends* with relatively *less pain*. Negative affect serves as an early warning sign that action may be necessary to achieve the optimal allocation of bodily resources (Barrett, 2016) and drives information seeking as an evolutionarily adaptive response to attentional prioritization (Griffin et al., 2008; Kahlor, 2010).

Arousal

Through internal bodily sensations known as interoception (Barrett, 2017), affect provides a steady stream of data used by the brain to run simulations and inform predictions for the optimization of scarce bodily resources (Barrett, 2016). It is thought to be a form of an evolutionary orienting mechanism that directs attention (Armony, Servan-Schreiber, Cohen, & LeDoux, 1995), allowing us to efficiently navigate complexity and take action in dangerous environments (Zajonc, 1980). Affect facilitates experiential processing which is less metabolically costly than the process of analytical evaluation (Barrett, 2017) and serves as an important cue for probability judgments (Slovic et al., 2004). Arousal determines which threats merit space in the 'affective niche' (i.e. what we care about or pay attention to at a given

moment in time) (Barrett, 2017). For the brain to order bodily action, it must perceive the need and construct an instance of emotion which manifests as arousal - involuntary changes in the autonomic nervous system (ANS) (Barrett, 2017).

Risk Assessment & Values

The assessment of risk is subjective and inextricably connected to judgments made on the basis of core values. These values influence what we fear and why (Slovic, 1999; Slovic et al., 2004; Wildavsky & Dake, 1990). In some countries belief in anthropogenic climate change is associated with liberal ideology (McCright & Dunlap, 2011; McCright, Dunlap, & Marquart-Pyatt, 2016). Since the acknowledgement that human activity is influencing the climate implies a need for outside regulation, it poses a threat to certain values and worldviews. People tend to subconsciously avoid and mistrust information on issues which threaten their identity and/or values, or which have the potential to cause estrangement from social in-groups (Kahan, 2015; Kahan, Braman, Slovic, et al., 2007).

Cultural cognition theory asserts that core values shape information processing and risk assessment via two dimensions, or types of "cultural worldviews" which express preferences for ideal societal ordering (Kahan & Braman, 2006): the Group dimension represents individual preferences for how strongly they are bound to other members of society. Individualists believe that people should be left alone to pursue their own best interest without outside regulation whereas communitarians believe that the best interest of society should be pursued and outweigh individual interests. The Grid dimension expresses values about the degree to which an individual believes that their choices are controlled and limited by their own roles within society. People with hierarchical worldviews affirm top-down authority, bottom-up obedience, and willingly accept disparity in the allocation of power, privileges, goods and roles based on "highly conspicuous and largely fixed characteristics such as gender,

race, and class" (Kahan et al., 2012, p. 1). Egalitarians take an opposing view, valuing equality in how these are distributed throughout society (Kahan, Braman, Gastil, Slovic, & Mertz, 2007). Research suggests that Group/Grid cultural worldviews explain beliefs about climate change more than any other individual characteristic (Kahan, Braman, Slovic, Gastil, & Cohen, 2009; Kahan, Braman, Slovic, et al., 2007; Kahan, Jenkins-Smith, & Braman, 2011).

Stories & Character Identification

Numeracy and scientific literacy have been shown to be weak predictors of engagement with the issue of climate change and analytical processing can even *increase* resistance (Hart & Nisbet, 2012; Kahan et al., 2011). Narratives structured as emotional stories with negatively valenced endings, however, appear to more effectively motivate pro-environmental behavior vis-à-vis informational messages (Morris et al., 2018a) because they trigger experiential processing and the affective engagement known to be critical for rational information assimilation. Through a state known as Narrative Transportation, story receivers become immersed to the point that they experience a temporary suspension of reality and detachment from existing pre-existing schema and opinions (vanLaer, Ruyter, Visconti, & Wetzels, 2014).

In contrast to the process of cognitive elaboration which fosters scrutiny to the major points of an argument, narrative transportation encourages experiential processing which reduces counterarguing and critical thoughts (Green & Brock, 2000). It appears that identification and the forging of emotional connections with story characters is one of the main mechanisms by which narrative transportation occurs (vanLaer et al., 2014; Zak, 2015). Work by Morris and colleagues (2018) provides evidence that audiences typically dismissive of the perils of climate change report higher risk perception after encountering stories featuring characters who share their closely-held values and worldviews. Through identification (vanLaer et al., 2014), stories have the potential to function as a form of observational learning

and vicarious personal experience (Hertwig, Barron, Weber, & Erev, 2004) shown to indirectly influence heightened concern, risk perception and action-taking on climate change (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013; Broomell, Budescu, & Por, 2015; Spence, Poortinga, Butler, & Pidgeon, 2011; Whitmarsh, 2008).

Against this backdrop, I expect that the end valence of climate change stories will influence risk perception and efficacy through emotional arousal, as shown in Figure 5. To this author's knowledge, there is little empirical research studying how the affective end valence of climate change narratives structured as stories influences risk perception and outcome efficacy in audiences with diverse ideological commitments and it is here that this work makes a contribution. Across four experiments I explicate how this effect varies across groups with diverse ideological commitments. Specifically, I expect that stories ending with negative affective valence will heighten emotional arousal more than those with positive affective valence. Since emotional valence usually fluctuates throughout a narrative, I focus specifically on the valence at the end of a narrative and how this influences risk perception. I further expect that the influence of emotional arousal on risk perception will be attenuated by the values of the story receiver. A smaller effect is expected for those with liberal ideology, including those who hold communitarian or egalitarian worldviews, because they tend to have higher baseline levels of concern about climate change than conservatives and those holding individualist or hierarchical worldviews.

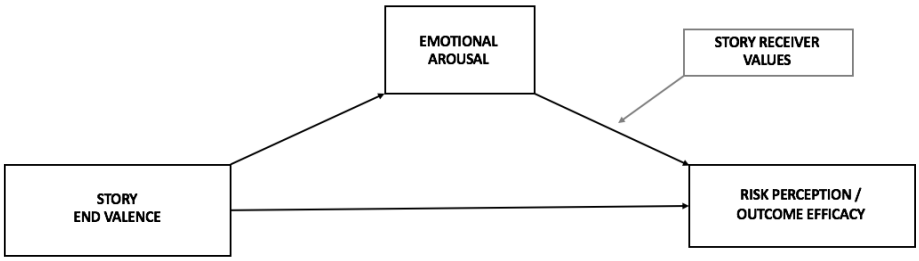


Figure 5. Conceptual Model with Overview of Studies.
Note. In study 4, we test the model using outcome efficacy as the dependent variable.

To test the model with diverse audiences, I conducted four survey experiments using online samples shown to have a more diverse pool of subjects than student convenience samples (Huff & Tingley, 2015; Ipeirotis, 2010; Levay, Freese, & Druckman, 2016). Study 1 tests the model by comparing the impact of a written climate change video with a positive affective ending versus one with a negative ending, on emotional arousal and risk perception, across groups with differing political ideology. Study 2 adds ecological validity through the use of the original video stimuli and a more nuanced measure of values in the form of cultural worldviews. Study 3 replicates tests of the model using hybrid-stimuli (i.e. video + written from studies 1 and 2) and includes an ideologically balanced sample. Study 4 further explores the paths outlined in the model with an additional condition and using outcome efficacy instead of risk perception and a nationally representative sample. Table 18 provides details of the experimental treatments, sample and main dependent variables for each study presented in this paper.

Table 18
Overview of Studies

Study	Experimental Treatment (Independent Variable)	Data/ Participants	Main Dependent Variables
1	Written stimuli adapted from naturalistic video with either positive (N = 101) or negative (N = 99) end valence	U.S. residents, Mturk; (N = 239)	• Perception of climate change risk • Emotional arousal • Values (political ideology)
2	(Naturalistic) climate change video with either positive (N = 144) or negative (N = 147) end valence	U.S. residents, Mturk; (N = 299)	• Perception of climate change risk • Emotional arousal • Values (political ideology, cultural worldviews)
3	(Naturalistic) hybrid: climate change video + written with either positive (N = 228) or negative (N = 221) end valence	U.S. residents, Mturk; (N = 450) (179 liberal; 114 moderate; 156 conservative)	• Perception of climate change risk • Emotional arousal • Values (political ideology, cultural worldviews)
4	Written stimuli adapted from naturalistic video with either positive (N = 375), negative (N = 375), or 'doom' (N = 365) end valence	U.S. residents, YouGov (N = 1,115)(352 liberal; 392 moderate; 371 conservative)	• Outcome efficacy assessment • Emotional arousal • Values (political ideology, cultural worldviews)

Study 1

The aim of this first study was to test the conceptual model using stimuli with minimal noise. By using written stimuli adapted from a naturalistic video as treatment, I hoped to isolate the effect of end valence on emotion arousal and risk perception, without the distraction of rapid-sequence visuals and audio input. Political ideology was used to understand how values moderate the influence of emotional arousal on risk perception.

Methods and Materials

In a single factor, between-subjects online experiment, 239 U.S.-based residents were recruited through Mturk (35.5% female; M_{age} = 34.60, SD_{age} = 10.35). Written informed consent was obtained and participants were compensated with USD 1.20 through their Mturk accounts. Prior to analysis, I removed 39 participants for failed attention checks, leaving 200 for analysis. After completing demographic items, participants were randomly assigned to one of two conditions where the end valence of the stimuli was either positive (N = 101) or negative (N =

99*)*. The stimulus was an adaptation of the written transcript from a climate change video produced by the University of North Carolina, accompanied by photos from the original video. The video follows a woman who shares the story of how she became a beekeeper together with her observations about how changing weather patterns and climate change are impacting bee populations. The two versions of the story were identical except for the valence of their endings, which diverge in the final segment of the stimuli (Appendix Q). Each story segment was followed by an attention filter.

After reading the story, I assessed climate change risk perception using the item, *"How much risk do you believe global warming poses to human health, safety, or prosperity?"* (2012; Kahan, 2017). Self-reported response was measured using an 8-point Likert scale ranging from zero to seven, where each point on the axis was labeled *('none at all,' 'very low,' 'low,' 'between low and moderate,' 'moderate,' 'between moderate and high,' 'high,' and 'extremely high risk'*) in addition to two binary items for cross-validation. To gauge self-reported emotional arousal, I adapted an item from Salgado and Kingo (2017) shown to correlate strongly with physiologic measures. For the purposes of the study, the original measure, *"How physically intense was it for you to read this story"* was adapted to *"How emotionally intense was it for you to read this story"* because I believed this phrasing would be easier for the panel to decode. However, for the sake of validation, both items were included in the study. Emotional arousal was measured on a 7-point Likert scale ranging from one (*'minimal intensity')* to seven *(maximal intensity*). These items were followed by a manipulation check and measures of political affiliation, (see Appendix R for all measures). The moderator (values) was operationalized as political ideology and coded as a categorial variable with three levels: '1' (47% liberal), '2' (30.5% moderate) and '3' (22.5% conservative).

Results and Discussion

The results of a t-test indicated that participants in the positive end valence condition rated the story as more positive (M = 4.63, SE = .15) than those in the negative end valence condition (M = 1.92, SE = .10), $t(1,198) = -14.94$ $p < .000$.

The first part of the model was tested to investigate the influence of the independent variable, end valence, on the mediator, emotional arousal, where the former was coded as a dichotomous variable, '1' (negative end valence) and '2' (positive end valence). The results of an independent t-test indicate a significant effect of end valence on emotional arousal, $t(198) = 3.165$, p = .002, d = .62, with participants in the negative end valence condition reporting greater emotional arousal (M = 4.44; SE = .16) than those in the positive end valence condition (M = 3.75; SE = .15). Next, a simple linear regression was calculated to predict the dependent variable, risk perception, based on emotional arousal. A significant regression equation was found ($F(1,198)= 36.26$, $p <.000$), with an R^2 of .158.

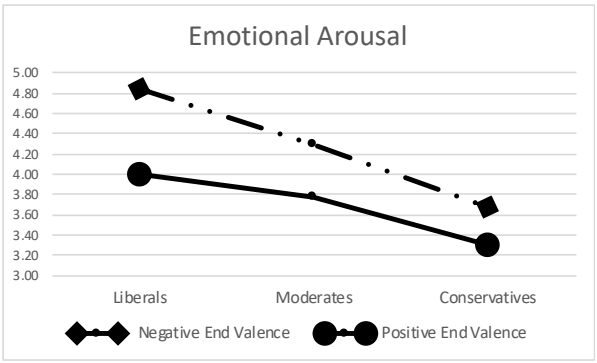
To explore the moderated mediation depicted in Figure 5, conditional process analysis was conducted using the PROCESS 3.0 macro (Model 14; 5000 bootstraps) for SPSS (Hayes, 2013), controlling for age and gender. Based on the results, it can be inferred that the indirect effect of the end valence on risk perception through emotional arousal differs significantly at different levels of political ideology, as indicated by the indices of moderated mediation: ab_1 = - .151, SE = .09; 95% bias-corrected CI [- .369, -.012], R^2 = .40. Results suggest an interaction between emotional arousal and political ideology for all groups as shown in Table 19 (see Appendix S for all path coefficients and descriptives). There was no evidence of a direct effect of end valence on risk perception.

Table 19

Study 1 - Indirect Effects of End Valence (Condition) on Climate Change Risk Perception Through Emotional Arousal at Various Levels of Political Ideology

Political Ideology	Coefficient	*SE*	Unstandardized 95% bootstrapped confidence intervals (bias corrected)	
			Lower	Upper
Liberal (1)	-.105	.06	-.221	-.001
Moderate (2)	-.256	.11	-.489	-.071
Conservative (3)	-.407	19	-.838	-.091

The results of this first study support the idea that the end valence of climate change stories plays a key role in triggering emotional arousal, which impacts the perception of climate change risk. Moreover, it appears that the influence of emotional arousal on risk perception varies for people with politically liberal, moderate and conservative views. As shown in Figure 6, the self-reported emotional arousal of participants in the positive condition was considerably higher among liberals. However, when it comes to risk perception, the greatest differences were observed for conservatives, with those in the positive condition reporting significantly lower concern about climate change than those in the negative condition. To increase external validity a second study was designed using the original video version of the stimulus. Moreover, having observed that political ideology moderates the influence of emotional arousal on risk perception in this first study, I add a more nuanced measure of ideological commitments, cultural worldviews.



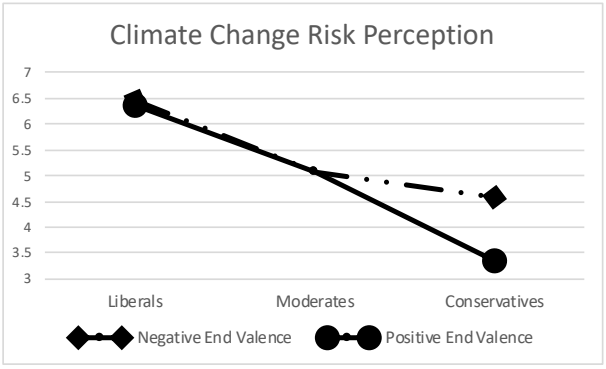


Figure 6. Study 1 - Emotional Arousal and Risk Perception by Condition x Ideology
Note. Emotional arousal scale runs from 1 (*Minimal intensity) to* 7 (*Maximal intensity).* Risk perception scale runs from 0 (*None At All) to* 7 (*Extremely High Risk)*.

Study 2

This second study had several aims. The first is to further probe the robustness of the model with the added vividness and ecological validity of the original video stimulus. A second goal was to better understand the moderating role of values by using a more nuanced measure of ideological commitments - cultural worldviews.

Methods and Materials

In a single factor, between-subjects online experiment, 299 U.S.-based residents were recruited through Mturk (55.3% female; M_{age} = 35.06, SD_{age} =10.68). Written informed consent was obtained, and participants were compensated with USD 1.20. Prior to analysis, nine participants were removed for failed attention checks, leaving 295 for analysis. The protocol was similar to study 1 except that the stimulus was the original video corresponding to the

written transcript, as well as a version with an alternative ending. There were two stimuli versions which were identical in every way except that their affective valence varied in the final six seconds: one contained positive (N =144) end valence and the other negative end valence (N = 147*)*. End valence was coded as a dichotomous variable, '0' (negative end valence) and '1' (positive end valence). The same measures of climate change risk perception and emotional arousal were used except that only the single adapted item from study 1, '*How emotionally intense was it for you to watch this video'* was included.

To measure the moderator, story receiver values, three different measures were employed and analyzed individually: (i) political ideology (as in study 1) (ii) Group (communitarian vs. individualistic) worldviews, and (iii) Grid (egalitarian vs. hierarchical) worldviews. These two dimensions of cultural cognition theory (Kahan et al., 2009; Kahan, Braman, Slovic, et al., 2007) were measured using the cultural worldview scale (short-form) (Kahan, 2012), which includes 12 items (see Appendix T for full measures). Group and Grid orientations were coded as dichotomous variables: '0' (Communitarians; N = 206) and '1' (Individualists; N = 85) / '0' (Egalitarians; N = 254) and '1' (Hierarchists; N = 37). Following measures of cultural worldviews, participants completed political items, manipulation and attention checks.

Results and Discussion

Using the same manipulation check procedure as in the first study, a t-test showed that participants in the positive end valence condition rated the story as more positive (M = 4.65, SE = .13), t(1,289) = -23.456 p < .000 than those in the negative end valence condition (M = 2.86, SE = .13). The findings also suggest that there was no significant difference in the perceived intensity of the positive (M = 4.85, SE = .14) or negative (M = 5.04, SE = .14) stimuli versions, t(1,193) = .982 p = .327.

The results of an independent t-test provide no evidence that end valence has a statistically significant influence on emotional arousal, $t(289) = .920$, $p = .358$, $d = .11$, although the results do suggest that participants in the negative end valence condition experienced higher emotional arousal ($M = 4.35$, $SE = .12$) compared with those in the positive end valence condition ($M = 4.20$, $SE = .12$). A simple linear regression revealed a significant influence of emotional arousal on risk perception ($F(1,289)= 59.03$, $p <.000$), with an R^2 of .170.

To explore the moderated mediation depicted in Figure 5, conditional process analysis was conducted using the PROCESS 3.0 macro (Model 14; 5000 bootstraps) for SPSS (Hayes, 2013), controlling for age and gender. First, the moderator (values) was operationalized as political ideology. The indices of moderated mediation, $ab_1 = -.010$, $SE = .03$; 95% bias-corrected *CI* [-.086, .035] and $ab_1 = -.044$, $SE = .08$; 95% bias-corrected *CI* [-.207, .116] provide no evidence that the indirect effect of the end valence on risk perception through emotional arousal differed significantly at different levels of political ideology. There was no evidence of a direct effect of end valence on risk perception.

The same analysis was conducted using Group cultural worldviews as the moderator. The index of moderated mediation, $ab_1 = -.009$, $SE = .03$; 95% bias-corrected *CI* [- .100, .035] provided no evidence that the indirect effect of the end valence on risk perception through emotional arousal differed significantly for communitarian versus individualist cultural worldviews.

Finally, based on the results of the same analysis for Grid cultural worldviews, there is no evidence that the indirect effect of the end valence on risk perception through emotional arousal differed significantly for egalitarian versus hierarchical cultural worldviews, as evinced by the index of moderated mediation $ab_1 = -.028$, $SE = .06$; 95% bias-corrected *CI* [- .156, .086].

The comparative emotional arousal levels for the written stimuli used in study 1 and video stimuli from study 2 are shown in Figure 7 (See Appendix U for descriptives.)

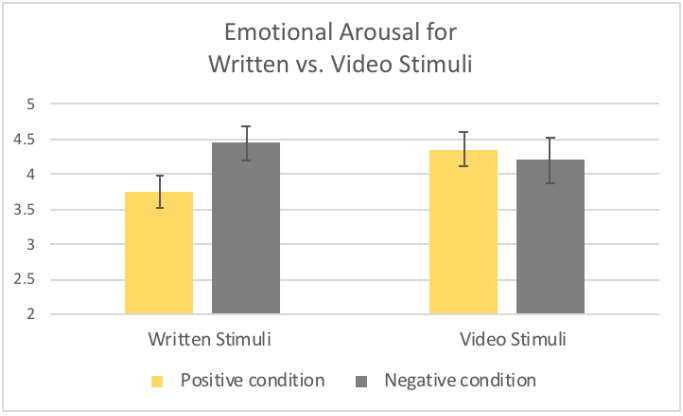


Figure 7. Study 1 & 2 - Emotional Arousal by Stimulus Medium
Note. Emotional arousal scale runs from 1 (*Minimal intensity) to* 7 (*Maximal intensity).*

Unlike study 1, the results of this second study did not provide support for the model. While the manipulation check indicated that participants accurately perceived a difference in the end valence of the stimuli and results suggest that the overall effect is in the same direction as study 1, there was no significant difference between the emotional arousal or risk perception scores of the two groups.

One plausible explanation is the natural fluctuation of attentional focus. In this study, viewers had little control over the pacing or advancement of the story while watching the video, whereas the written text in study 1 was presented in segments, which a reader could read (and re-read if, for example, their attention wandered) before advancing to the next part of the story. Another explanation might be that the multi-sensorial experience of viewing a video heightens not only vividness, but also the baseline rate of emotional arousal. It appears that there were bigger differences in arousal for negative versus positive versions of the written stimuli than for the video. For the video, participants reported slightly higher emotional arousal with the positive affective ending than for the negative ending. With audio and moving visual images, this video version of the story contains substantially more sensory input than the text version, which inevitably introduces more noise. This noise may have eclipsed the effect of the end

valence in proportion to the overall treatment and explain the group convergence on measures of arousal and risk. It is also noteworthy that participants reported higher emotional arousal in response to the video with positive end valence than they did with the written stimuli. A third study was designed to 1) make the treatment effect more salient, 2) recruit an ideologically-balanced sample, and 3) replicate the first and second studies.

Study 3

One aim of the third study is to explore the model further and counteract the noise which may have influenced the results of study 2 by strengthening the manipulation (end valence) as recommended by (Meyvis & Van Osselaer, 2017). To this end the stimuli were optimized by creating a hybrid, video/written version of those used in studies 1 and 2. Another aim was to mitigate sampling error through the recruitment of an equal number of participants from each ideological group.

Methods and Materials

In a single factor, between-subjects online experiment, 450 U.S.-based residents (179 liberal; 114 moderate; 156 conservative) were recruited through Mturk (49.9% female; M_{age} = 39.78, SD_{age} = 12.31). Written informed consent was obtained and participants were compensated with USD 1.20 through their Mturk accounts. Prior to analysis, 1 participant was removed for failed attention checks. The protocol was similar to study 2 except that after the video stimuli, participants were also asked to read the final two written segments used in study 1 (see Appendix Q); one with positive (N = 228) and the other with negative end valence (N = 221). The same measures were used as in study 1 to ensure identical experimental protocols.

Results and Discussion

First an independent t-test was conducted, the results of which indicate a significant effect of the independent variable, end valence, on the mediator, emotional arousal, $t(347) = 3.081$, $p = .002$, $d = .29$, with participants in the negative end valence condition reporting greater emotional arousal ($M = 4.49$; $SE = .11$) than those in the positive end valence condition ($M = 4.02$; $SE = .11$). Next, a simple linear regression was calculated to predict the dependent variable, risk perception, based on emotional arousal. A significant regression equation was found ($F(1,447)= 162.24$, $p <.000$), with an R^2 of .266.

To explore the moderated mediation depicted in Figure 5, conditional process analysis was conducted using the PROCESS 3.0 macro (Model 14; 5000 bootstraps) for SPSS (Hayes, 2013), controlling for age and gender. The moderator (values) was operationalized in the same way as in study 2. The indices of moderated mediation, (W1) $ab_1 = - .097$, $SE = .06$; 95% bias-corrected *CI* [- .215, -.033] and $ab_1 = - .191$, $SE = .08$; 95% bias-corrected *CI* [- .372, -.052] provide evidence that the indirect effect of the end valence on risk perception through emotional arousal differs significantly at different levels of political ideology as can be seen in Figure 8. The results suggest an interaction between emotional arousal and political ideology for liberals, moderates and conservatives as shown in Table 20 (see Appendix V for all path coefficients and Appendix W for descriptives). There was no evidence of a direct effect of end valence on risk perception.

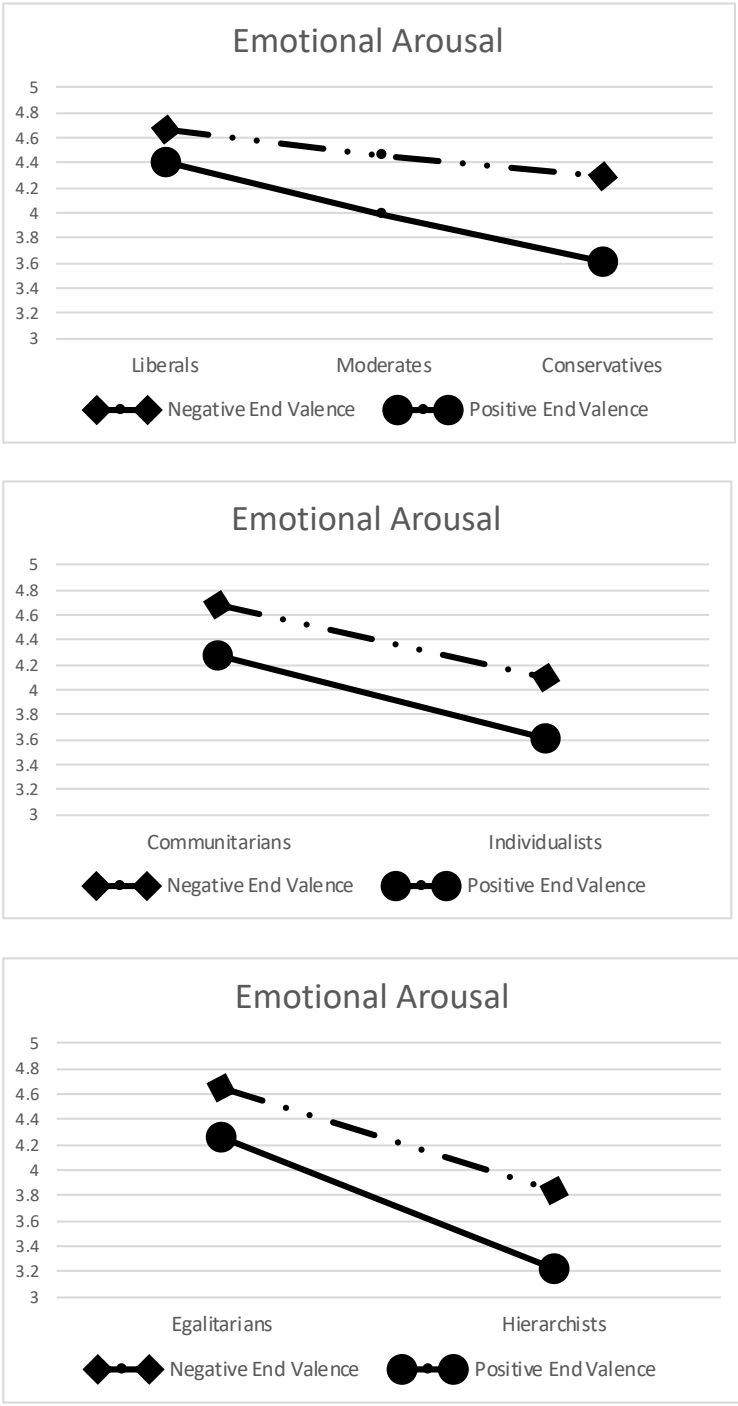


Figure 8. Mean Emotional Arousal by Condition x Ideology, Study 3

Note. Emotional arousal scale runs from 1 (*Minimal intensity) to* 7 (*Maximal intensity)*.

Next, I conducted the same analysis for values operationalized as cultural worldviews and found evidence that the indirect effect of end valence on risk perception through emotional arousal differs significantly for both levels of Group cultural worldviews, as evinced by the index of moderated mediation, ab_1 = - .133, *SE* = .07; 95% bias-corrected *CI* [- .283, -.027]. Results suggest an interaction between emotional arousal and Group cultural worldviews for both communitarians and individualists, as shown in Table 21 (see Appendix V for all path coefficients and Appendix W for descriptives.)

Table 20
Study 3 - Indirect Effects of End Valence (Condition) on Climate Change Risk Perception Through Emotional Arousal at Various Levels of Political Ideology

Political Ideology	Coefficient	*SE*	Unstandardized 95% bootstrapped confidence intervals (bias corrected)	
			Lower	Upper
Liberal (1)	-.115	. 05	-.215	-.033
Moderate (2)	-.212	.08	-.390	-.063
Conservative (3)	-.306	.11	-.528	-.099

Table 21
Study 3 - Indirect Effects of End Valence (Condition) on Climate Change Risk Perception Through Emotional Arousal at Various Levels of Group Cultural Worldviews

Cultural Worldview (Group)	Coefficient	*SE*	Unstandardized 95% bootstrapped confidence intervals (bias corrected)	
			Lower	Upper
Communitarians (0)	-.179	.06	-.307	-.061
Individualists (1)	-.313	.11	-.551	-.102

For Grid orientation, the index of moderated mediation, ab_1 = - .164, *SE* = .08; 95% bias-corrected *CI* [- .336, -.037] provides evidence that the indirect effect of end valence on risk perception through emotional arousal differs significantly for both levels of the moderator. Results suggest an interaction between emotional arousal and Grid cultural worldviews for both egalitarians and hierarchists as shown in Table 22 (see Appendix V for all path coefficients and Appendix W for descriptives).

Table 22
Study 3 - Indirect Effects of End Valence (Condition) on Climate Change Risk Perception Through Emotional Arousal at Various Levels of Grid Cultural Worldviews

Cultural Worldview (Grid)	Coefficient	*SE*	Unstandardized 95% bootstrapped confidence intervals (bias corrected)	
			Lower	Upper
Egalitarians (0)	-.161	.06	-.277	-.054
Hierarchists (1)	-.325	.08	-.579	-.104

The results of this third study replicate the findings of study 1 and provide support for the proposed conceptual model. It appears that the end valence of a climate change story does influence risk perception through emotional arousal, and this differs across political ideology and cultural worldviews as depicted in Figure 9. Interestingly, people holding conservative values or individualist/hierarchical worldviews exhibit the greatest difference in risk perception as a result of affective end valence. Because prior work has shown a strong association between risk perception and efficacy, the fourth study is designed to understand how affective valence influences an individual's beliefs that their own actions influence climate change.

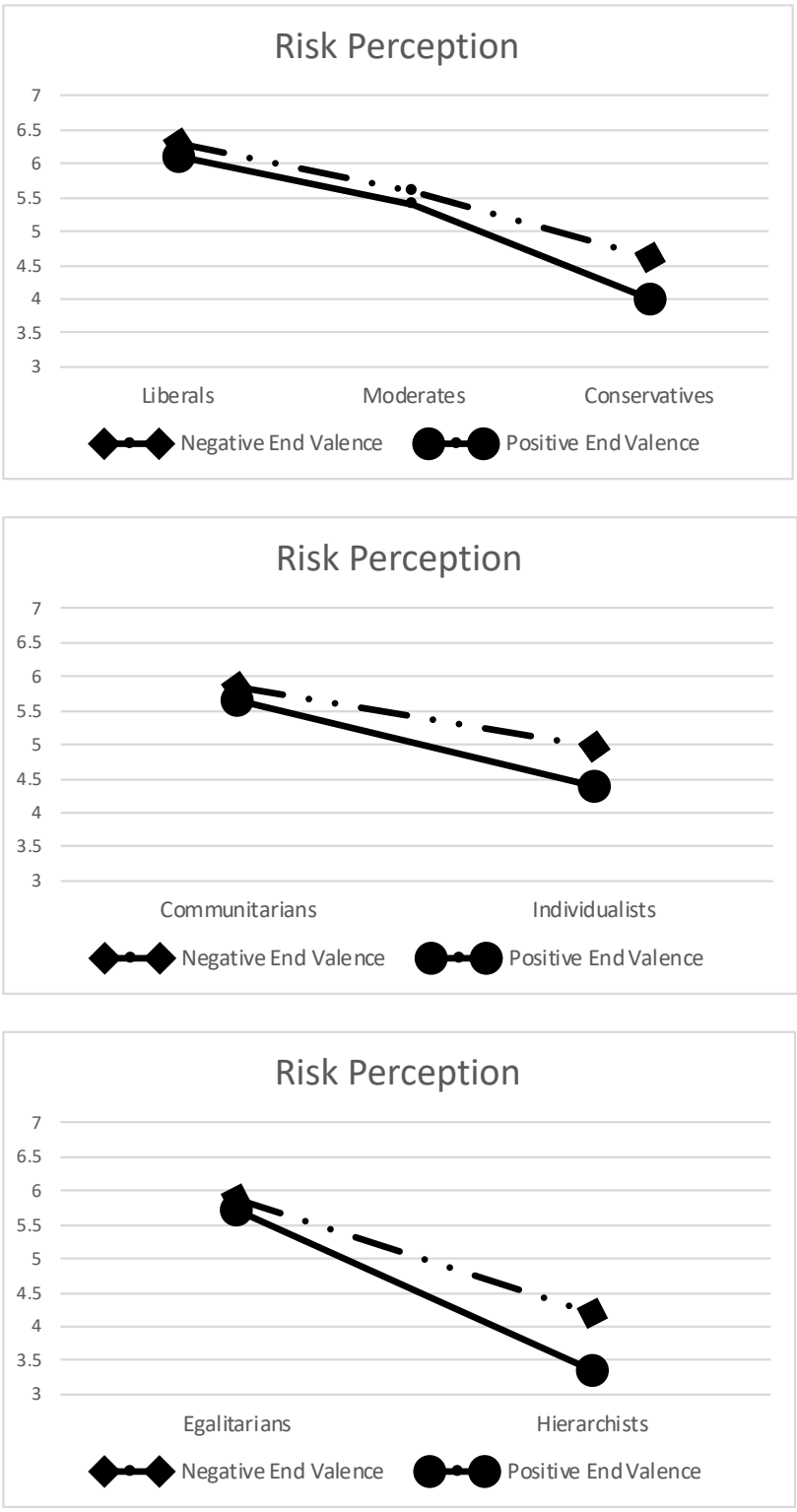


Figure 9. Mean Climate Change Risk Perception by Condition x Ideology, Study 3

Note. Risk perception scale runs from 0 (*None At All) to* 7 (*Extremely High Risk)*

Study 4

There are several aims with this fourth study, which builds on the findings of studies 1-3. The first is to test the model with a different dependent variable strongly associated with risk perception: efficacy. Prior work suggests that negative affective appeals can backfire unless threat appraisal and efficacy are both high. As such, one goal here is to understand how the end valence of climate change stories impacts the beliefs that individuals hold about the connection between their own actions and climate change. To this same end, a stimulus version with extreme negative affect is added in order to investigate how degrees of negativity influence outcome efficacy. Finally, this study seeks to improve upon the first three experiments by using a nationally representative sample.

Methods and Materials

In a single factor, between-subjects online experiment, 1,115 U.S.-based residents (352 liberal; 392 moderate; 371 conservative) were recruited through a nationally representative panel, YouGov (54.3% female; $M_{age} = 49.75$, $SD_{age} = 16.82$). Written informed consent was obtained and participants were compensated with points through their YouGov accounts. The protocol and measures were similar to study 3 with the following exceptions: 1) In addition to positive ($N = 375$) and negative ($N = 375$) conditions, a 'doom and gloom' stimulus version was added ($N = 365$) (Appendix X). The affective ending of this stimulus is even more negative than the negative condition, making the claim that it is likely already too late to do anything about climate change. 2) In lieu of risk perception, the main dependent variable was a single item developed by Kellstedt, Zahran, and Vedlitz (2008) and adapted for our purposes to: "*I believe my actions have an influence on climate change.*" This was measured on a 4-point scale (*strongly disagree, disagree, agree, strongly agree)*.

Results and Discussion

First a one-way ANOVA was conducted to compare the effect of end affective valence on emotional arousal in positive, negative, and 'doom' conditions. There was a significant effect of the independent variable, end valence, on the mediator, emotional arousal, at the $p < 0.001$ level for the three conditions $F(2,1112) = 8.342$, $p < .000$. Post hoc tests using the Bonferroni test indicated that the mean score for the positive condition ($M = 3.22$; $SE = .10$) was lower than for the negative ($M = 3.69$; $SE = .10$) and doom conditions ($M = 3.74$; $SE = .10$). As can be seen in Figure 10, however, there was no significant difference between the negative and doom conditions. Taken together these results suggest that affective end valence does influence emotional arousal. Specifically, the findings suggest that negative affect is more emotionally arousing than positive affective valence.

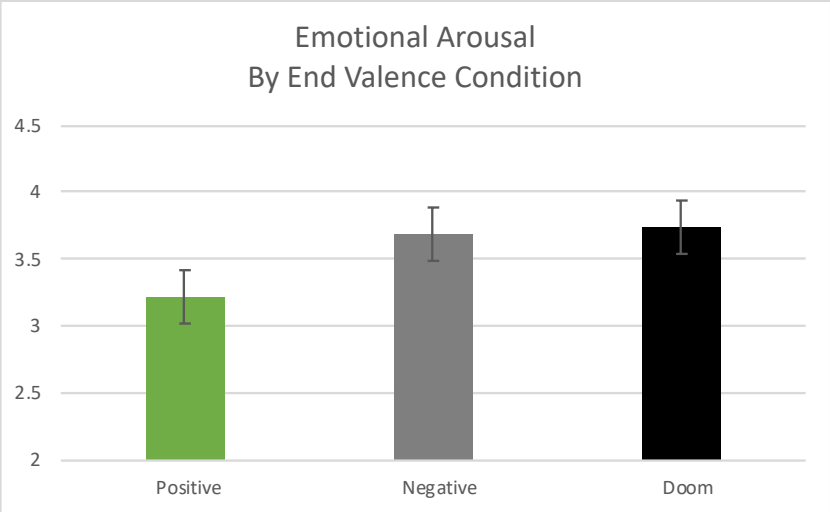
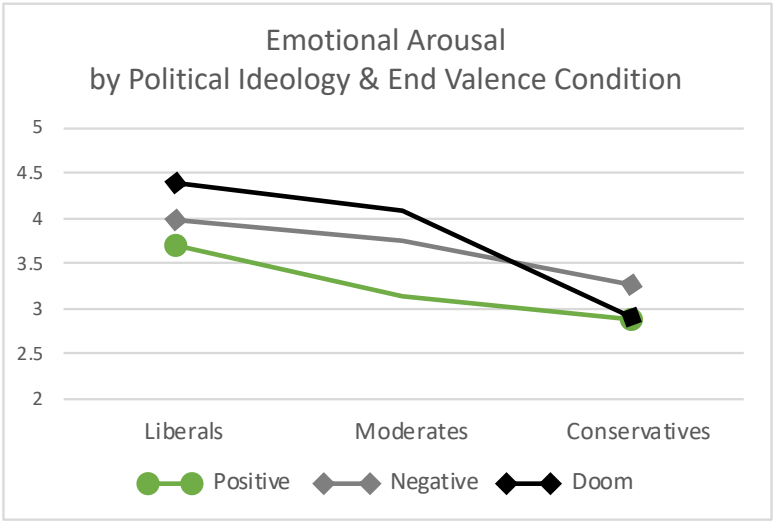
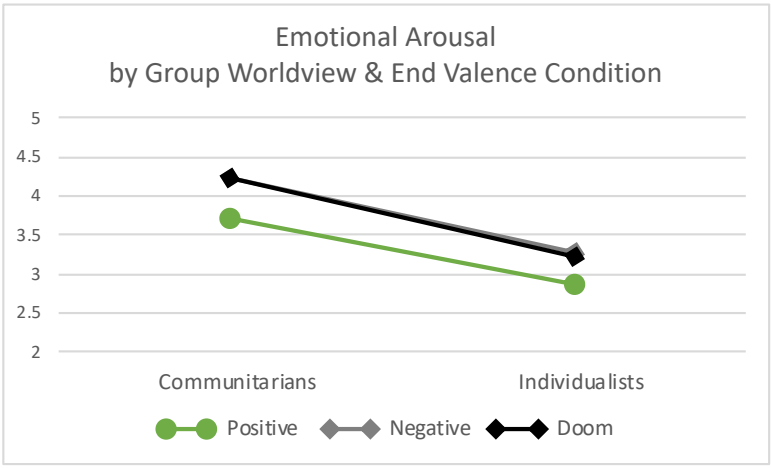


Figure 10. Emotional Arousal by End Affective Valence Condition, Study 4

Note. Emotional arousal scale runs from 1 (*Minimal intensity) to* 7 (*Maximal intensity)*.

More, as can be seen the graphs in Figure 11, levels of emotional arousal vary by ideology and end valence.





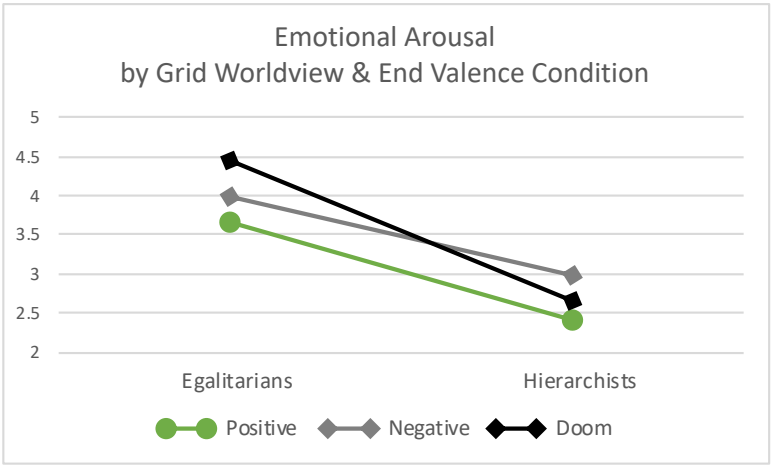


Figure 11. Emotional Arousal by Values & End Affective Valence Condition, Study 4
Note. Emotional arousal scale runs from 1 (*strongly disagree) to* 7 (*strongly agree).*

Next, a simple linear regression was calculated to predict the dependent variable, outcome efficacy based on emotional arousal. A significant regression equation was found ($F(1,1113)= 245.41$, $p <.000$), with an R^2 of .181. Outcome efficacy scores were highest for the negative end valence condition, although there was no statistically significant difference between negative and doom conditions. To explore the moderated mediation depicted in the conceptual model conditional process analyses were conducted separately for each moderator as in study 3 (political ideology, Group and Grid cultural worldviews) using the PROCESS 3.0 macro (Model 14; 5000 bootstraps) for SPSS (Hayes, 2013), using age, gender, and the Generalized Self-Efficacy Scale to measure trait efficacy (Schwarzer & Jerusalem, 1995), as covariates. The indices of moderated mediation, X1 (positive vs. negative affective valence) ab_1 = .052, *SE* = .02; 95% bias-corrected *CI* [.018, .090] and X2 (negative vs. doom affective valence) ab_1 = .063, *SE* = .02; 95% bias-corrected *CI* [.030, .104] provide evidence that the indirect effect of the end valence on risk perception through emotional arousal differs significantly at different levels of political ideology. The results suggest an interaction between emotional arousal and political ideology for moderates in the negative (ab_3 = .070, *SE* = .02, 95% LLCI: = .024, 95% ULCI = .119) and doom conditions (ab_3 = .085, *SE* = .03, 95% LLCI: = .036, 95% ULCI = .135). This same interaction was also observed for conservatives in the negative (ab_4 = .122, *SE* = .04, 95% LLCI: = .043, 95% ULCI = .204) and doom conditions (ab_4 = .147, *SE* = .04, 95% LLCI: = .063, 95% ULCI = .235). There was no evidence of a direct effect of end valence on risk perception.

Next, the same analysis was conducted for values operationalized as cultural worldviews and resulted in similar results for Group orientation, as evinced by the index of moderated mediation, ab_1 = .089, *SE* = .04; 95% bias-corrected *CI* [.022, .173]. Results suggest an interaction between emotional arousal and Group cultural worldviews for individualists in the

negative (ab_3 = .107, *SE* = .04, 95% LLCI: = .034, 95% ULCI = .188) and doom conditions (ab_3 = .098, *SE* = .04, 95% LLCI: = .025, 95% ULCI = .179).

For Grid orientation, the index of moderated mediation, ab_1 = .067, *SE* = .03; 95% bias-corrected *CI* [.020, .121] also suggests a conditional indirect effect of end valence on outcome efficacy. Results suggest an interaction between emotional arousal and Grid cultural worldviews for communitarians in the negative- (ab_3 = .036, *SE* = .02, 95% LLCI: = .009, 95% ULCI = .068) and doom affective endings (ab_3 = .043, *SE* = .02, 95% LLCI: = .014, 95% ULCI = .078). The same interaction was found for individualists in the negative- (ab_3 = .092, *SE* = .04, 95% LLCI: = .022, 95% ULCI = .167) as well as doom affective endings (ab_3 = .110, *SE* = .04, 95% LLCI: = .039, 95% ULCI = .184).

There is a strong association between risk perception and efficacy where high threat appraisal and low efficacy have the potential to discourage action taking. Every ideological group *with the exception of conservatives and hierarchists* found the hopeless affective scenario (doom) as most affectively arousing; these latter two groups both found the negative end valence scenario most emotionally arousing, followed by the doom condition and then positive affect. Interestingly, the results of this fourth study suggest that negative affective end valence in climate change narratives is generally better at heightening outcome efficacy in groups most likely to be disengaged with the issue (i.e. political conservatives, individualists and hierarchists). Conservatives and those holding hierarchical worldviews in particular were more convinced of the efficacy of their individual action when confronted with both negative and doom end valence.

For individualists, positive and negative end valence were roughly equal and the most hopeless, valenced ending was least convincing. In contrast, moderates, egalitarians and communitarians were most persuaded to believe in the efficacy of their actions by the hopeless ending, followed thereafter by the positive affective end. For those identifying as political

liberals, positive affect was most effective. These findings have important implications for disengaged audiences where it appears that the negative, rather than doom scenarios, are most affectively arousing and effective at motivating a sense of efficacy among conservatives and those with hierarchical worldviews. This is in line with the elaboration likelihood model (Petty & Cacioppo, 1986) and domain-specific work (Matthes, Wonneberger, & Schmuck, 2014) which suggests that affective appeals will be particularly effective with environmentally disengaged audiences who have little involvement with the issue and are therefore not motivated to expend energy on the metabolically costly process of cognitive elaboration.

General Discussion

Affect is a critical component of rationality but how it should be used in climate change appeals is a hotly debated topic. In the United States public engagement with climate change is low (Leiserowitz, 2017) and even in Europe, very few people feel a sense of personal responsibility for the effects (European Commission, 2014). Given the steady stream of negative news in the media, it is understandable that communicators feel pressure to bring the public more hopeful messages. However, the findings of four studies presented in this work suggest that doing so will be (mostly) counterproductive to the achievement of engagement goals. There has been little systematic experimental research examining how positive versus negative affective endings in climate change stories influence risk perception and outcome efficacy across ideological groups. This paper presents the findings of four studies designed to fill this gap, together with implications for practitioners and scholars.

A first clear finding concerns the affective valence at the end of climate change stories. In line with predictions shown in the conceptual model, the results of two of three studies provide evidence that negative affective endings are indeed more effective at heightening both emotional arousal and risk perception compared with positive affective endings. This held true

for all audiences but the effects were particularly pronounced in those that usually exhibit low-levels of concern about global warming (i.e. conservatives and those holding individualistic or hierarchical worldviews). There is emerging evidence that biology may influence differences in how conservatives and liberals process risk. A recent study using functional imaging showed that these two groups had visibly different brain structures, with conservatives exhibiting higher activity in the right amygdala and increased sensitivity to threatening stimuli (Schreiber et al., 2013) compared with liberals. Another recent study found that conservative audiences adopted more socially progressive views after being primed with a visualization exercise that made them feel physically safe (Napier, Huang, Vonasch, & Bargh, 2018).

Second, in contrast to work positing that "fear appeals" may hinder efficacy (e.g. O'Neill & Nicholson-Cole, 2009), the results of this fourth study suggest that, for most groups, negative affective endings actually increased people's belief that their own individual behavior matters for climate change. There were significant differences in how degrees of affective negativity influenced emotional arousal and outcome efficacy in ideologically diverse groups. Political moderates, communitarians and egalitarians, for example, were more inclined to believe their own behavior made a difference to climate change when exposed to messages with 'apocalyptic' end valence. Most other audiences, however, had a higher sense of outcome efficacy when treated with the non-apocalyptic, but still negative, affective endings. The positive affective ending gave self-identified liberals the greatest sense of efficacy while negative and positive endings fostered equal levels of efficacy in people holding individualistic worldviews. Self-reported levels of emotional arousal were highest with the doom condition (followed by negative) for moderates, liberals, communitarians, and egalitarians while conservatives, individualists and hierarchists reported the negative condition more arousing. One plausible explanation for this could be that these ideologically conservative groups find the use of 'doom'-level affective valence a form of 'disaster porn' that interrupts the experience

of narrative transportation and undermines the credibility of the story. This finding should serve as a warning to climate change communicators that apocalyptic messaging is likely to backfire in ideologically conservative audiences.

Another important finding from this work relates to the non-significant findings of study 2. The studies used variations of controlled and naturalistic stimuli; however, the real-world climate change video stimuli used in study 2 was the most ecologically valid of the four and highlights the very real challenges communicators face as they encode messages in various types of media. Although effects pointed in the same direction as studies 1 and 3, they were considerably smaller. There could be multiple explanations for this. The fast-paced, multi-sensory experience of video resulted in higher baseline emotional arousal in addition to other noise, which may have weakened not only the manipulation, but also the overall effect on risk perception. These results suggest that the vividness of video comes at a price. Increasing exposure repetition and frequency might mitigate some of these differences but in practice, communicators are continually competing for scarce attentional resources and it is not unlikely that audiences will be exposed to a message only once. Complicating matters further, decoding is likely to occur in noisy and distracting environments. As such, practitioners should not underestimate tradeoffs between the vividness and noise of a communication medium and the environment in which it will be received. Rather than acquiescing to trends, they must test the interaction of treatment and medium, continually asking, 'Does this format/medium help or hinder the achievement of our communication goals?'

Taken together, these findings affirm the critical role of negative affect but also highlight additional implications for climate change scholars, communicators and policymakers. For one, practitioners should recognize the need for sophisticated segmentation and messaging strategies tailored to ideologically diverse audiences. Negative affect appears to be a powerful and effective tool in communication but the optimal degree of negativity will

vary for different audiences. This also raises questions similar to those asked by Hastings, Stead, and Webb (2004) regarding how individuals and society might become reliant on high-arousal appeals and desensitized over time. Affect is a powerful lever which can cause us to be overly sensitive to small changes in the environment while desensitizing us to large shifts of much greater consequence (Slovic et al., 2004). It can foster irrational levels of alarm regarding threats with low levels of likelihood (Rottenstreich & Hsee, 2001) and deluded levels of optimism in the face of potentially catastrophic consequences (Sharot, 2011). There is also evidence that the effects of affective climate change messages are short-lived and do not contribute to lasting pro-environmental behavioral change (Schwartz & Loewenstein, 2017). What are the long-term effects of various affective combinations on risk perception and efficacy? How do these translate into climate-change related behavior and do these effects persist over time? These are questions worth answering in future work. Finally, this work focuses specifically on the affective valence at the *end* of climate change stories. Future research could investigate how various combinations of affective valence at various points in stories influence risk perception and efficacy.

Limitations

The current study designs utilized online panels in order to maximize sample variation. Climate change skeptics and those with low levels of engagement are particularly underrepresented in university student convenience samples. However, despite its many benefits, Mturk also presents challenges to researchers on certain politically polarized issues such as climate change (Kahan, 2013a, 2013b). Although I attempted to mitigate this weakness by recruiting an ideologically balanced sample in study 3 and using a nationally representative panel in study 4, future research would benefit from testing the model in field studies to improve the external validity of these findings.

Moreover, there are natural limitations to the ability of any individual to accurately self-report a complex and largely sub-conscious phenomenon such as emotional arousal. Future research on affective engagement with climate change would benefit from the use of objective psychophysiological measures to provide more reliable insights into the causal influence of emotional arousal on risk perception and efficacy. It should also be noted that any single item measure has its own limitations. In the case of outcome efficacy, it is also possible that this could be misinterpreted as a causal belief measure (i.e., "my behavior is causing climate change, rather than solving it.") More, there are likely interactions between the dependent variables used in these studies (risk perception and efficacy), which we did not explore.

Conclusion

This research advances our understanding of how the affective valence at the end of climate change stories influences perception of climate change risk and efficacy. The findings of four studies suggest that negative affective valence plays a critical role in facilitating climate change engagement in the form of risk perception and outcome efficacy. This research submits that if we want the real-life story of anthropogenic climate change to have a happy ending for humans, we may need to use public appeals with unhappy endings.

References

Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. (2013). Do people "personally experience" global warming, and if so how, and does it matter? *Global Environmental Change, 23*(1), 81-91. doi:10.1016/j.gloenvcha.2012.07.006

Armony, J. L., Servan-Schreiber, D., Cohen, J. D., & LeDoux, J. E. (1995). An anatomically constrained neural network model of fear conditioning. *Behavioral neuroscience, 109*(2), 246.

Ashby, F. G., & Isen, A. M. (1999). A neuropsychological theory of positive affect and its influence on cognition. *Psychological Review, 106*(3), 529.

Atkin, E. (2017). The Power and Peril of "Climate Disaster Porn". *The New Republic*. Retrieved from The New Republic website: https://newrepublic.com/article/143788/power-peril-climate-disaster-porn

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*: Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

Barrett, L. F. (2006a). Are emotions natural kinds? *Perspectives on psychological science, 1*(1), 28-58.

Barrett, L. F. (2006b). Valence is a basic building block of emotional life. *Journal of Research in Personality, 40*(1), 35-55.

Barrett, L. F. (2016). The theory of constructed emotion: an active inference account of interoception and categorization. *Social Cognitive and Affective Neuroscience*, nsw154. doi:10.1093/scan/nsw154

Barrett, L. F. (2017). *How Emotions Are Made*. New York, NY: Houghton-Mifflin-Harcourt.

Barrett, L. F., & Niedenthal, P. M. (2004). Valence focus and the perception of facial affect. *Emotion, 4*(3), 266.

Bechara, A., Damasio, H., Damasio, A. R., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*(1), 7-15. doi:10.1016/0010-0277(94)90018-3

Bechara, A., Damasio, H., Tranel, D., & Damasio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293-1295.

Brashers, D. E. (2001). Communication and uncertainty management. *Journal of Communication, 51*(3), 477-497.

Broomell, S. B., Budescu, D. V., & Por, H.-H. (2015). Personal experience with climate change predicts intentions to act. *Global Environmental Change, 32*, 67-73.

Chapman, D. A., Lickel, B., & Markowitz, E. M. (2017). Reassessing emotion in climate change communication. *Nature Climate Change, 7*(12), 850-852. doi:10.1038/s41558-017-0021-9

Damasio, A. (2011). Neural basis of emotions. *Scholarpedia, 6*(3), 1804. doi:10.4249/scholarpedia.1804

Damasio, A. R. (2003). *Descartes' error : emotion, reason, and the human brain* (Repr. ed.). New York: Quill.

Do, A. M., Rupert, A. V., & Wolford, G. (2008). Evaluations of pleasurable experiences: The peak-end rule. *Psychonomic Bulletin & Review, 15*(1), 96-98.

European Commission. (2014). *Climate Change, Special Barometer* Retrieved from http://ec.europa.eu/public_opinion/archives/ebs/ebs_409_en.pdf.

Feldman, L., & Hart, P. S. (2015). Using Political Efficacy Messages to Increase Climate Activism: The Mediating Role of Emotions. *Science Communication, 38*(1), 99-127. doi:10.1177/1075547015617941

Fetherstonhaugh, D., Slovic, P., Johnson, S., & Friedrich, J. (1997). Insensitivity to the value of human life: A study of psychophysical numbing. *Journal of Risk and Uncertainty, 14*(3), 283-300.
Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of behavioral decision making, 13*(1), 1-17.
Freedman, A. (2017). No, New York Mag: Climate change won't make the earth uninhabitable by 2100. *Mashable*. Retrieved from https://mashable.com/2017/07/10/new-york-mag-climate-story-inaccurate-doomsday-scenario/?europe=true#Qr0U8y0_wPqE
Ganzach, Y. (2000). Judging risk and return of financial assets. *Organizational Behavior and Human Decision Processes, 83*(2), 353-370.
Green, M. C., & Brock, T. C. (2000). The Role of Transportation in the Persuasiveness of Public Narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. doi:10.1037/0022-3514.79.5.701
Griffin, R. J., Yang, Z., Ter Huurne, E., Boerner, F., Ortiz, S., & Dunwoody, S. (2008). After the flood: Anger, attribution, and the seeking of information. *Science Communication, 29*(3), 285-315.
Hart, P. S., & Nisbet, E. C. (2012). Boomerang Effects in Science Communication : How Motivated Reasoning and Identity Cues Amplify Opinion Polarization About Climate Mitigation Policies. *Communication Research, 39*(6), 701-723. doi:10.1177/0093650211416646
Hastings, G., Stead, M., & Webb, J. (2004). Fear appeals in social marketing: Strategic and ethical reasons for concern. *Psychology & marketing, 21*(11), 961-986.
Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.
Hertwig, R., Barron, G., Weber, E. U., & Erev, I. (2004). Decisions from Experience and the Effect of Rare Events in Risky Choice. *Psychological Science, 15*(8), 534-539. doi:10.1111/j.0956-7976.2004.00715.x
Huff, C., & Tingley, D. (2015). "Who are these people?" Evaluating the demographic characteristics and political preferences of MTurk survey respondents. *Research & Politics, 2*(3), 2053168015604648.
Ipeirotis, P. G. (2010). Demographics of mechanical turk.
Kahan, D. (2012). Cultural cognition as a conception of the cultural theory of risk. In D. Kahan (Ed.), *Handbook of risk theory* (pp. 725-759): Springer.
Kahan, D. (2013a). Fooled twice, shame on who? Problems with Mechanical Turk samples, Part 2.
Kahan, D. (2013b). What's a valid sample? Problems with Mechanical Turk Samples, Part 1.
Kahan, D. M. (2015). Climate‐Science Communication and the Measurement Problem. *Political Psychology, 36*(S1), 1-43. doi:10.1111/pops.12244
Kahan, D. M. (2017). 'Ordinary science intelligence': a science-comprehension measure for study of risk and science communication, with notes on evolution and climate change. *Journal of Risk Research, 20*(8), 995-1016. doi:10.1080/13669877.2016.1148067
Kahan, D. M., & Braman, D. (2006). Cultural Cognition and Public Policy. *Yale Law & Policy Review, 24*(1), 149-172.
Kahan, D. M., Braman, D., Gastil, J., Slovic, P., & Mertz, C. (2007). Culture and identity‐protective cognition: Explaining the white‐male effect in risk perception. *Journal of Empirical Legal Studies, 4*(3), 465-505.
Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature nanotechnology, 4*(2), 87.

Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. L. (2007). The second national risk and culture study: Making sense of-and making progress in-the american culture war of fact.
Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147-174. doi:10.1080/13669877.2010.511246
Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*(10), 732-735.
Kahlor, L. (2010). PRISM: A planned risk information seeking model. *Health Communication, 25*(4), 345-356.
Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When More Pain Is Preferred to Less: Adding a Better End. *Psychological Science, 4*(6), 401-405. doi:10.1111/j.1467-9280.1993.tb00589.x
Kellstedt, P. M., Zahran, S., & Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis: An International Journal, 28*(1), 113-126.
Lang, A., Newhagen, J., & Reeves, B. (1996). Negative video as structure: Emotion, attention, capacity, and memory. *Journal of Broadcasting & Electronic Media, 40*(4), 460-477.
Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change, 77*(1), 45-72.
Leiserowitz, A., Maibach, E., Roser-Renouf, C., Rosenthal, S., Cutler, M., & Kotcher, J. (2017). *Climate change in the American mind: October 2017*. Retrieved from New Haven, CT:
Levay, K. E., Freese, J., & Druckman, J. N. (2016). The demographic and political composition of Mechanical Turk samples. *Sage Open, 6*(1), 2158244016636433.
Lorenzoni, I., Pidgeon, N. F., & O'Connor, R. E. (2005). Dangerous climate change: the role for risk research. *Risk Analysis: An International Journal, 25*(6), 1387-1398.
Mann, M. E., Hassol, S. J., & Toles, T. (2017). Doomsday Scenarios are as Harmful as Climate Change Denial. *The Washington Post*. Retrieved from
Matthes, J., Wonneberger, A., & Schmuck, D. (2014). Consumers' green involvement and the persuasive effects of emotional versus functional ads. *Journal of Business Research, 67*(9), 1885-1893.
McCright, A. M., & Dunlap, R. E. (2011). The politicization of climate change and polarization in the American public's views of global warming, 2001–2010. *The Sociological Quarterly, 52*(2), 155-194.
McCright, A. M., Dunlap, R. E., & Marquart-Pyatt, S. T. (2016). Political ideology and views about climate change in the European Union. *Environmental Politics, 25*(2), 338-358. doi:10.1080/09644016.2015.1090371
Meyvis, T., & Van Osselaer, S. M. (2017). Increasing the Power of Your Study by Increasing the Effect Size. *Journal of Consumer Research, 44*(5), 1157-1173.
Morris, B. S., Chrysochou, P., Christensen, J., Orquin, J., Barraza, J. A., Zak, P. J., & Mitkidis, P. (2018a). Stories Trump Facts: Triggering Visceral Response to Climate Change *Working Paper*.
Morris, B. S., Chrysochou, P., Mitkidis, P., & Leiserowitz, A. (2018). The Messenger is the Message. *Working Paper*.
Moser, S. C., & Dilling, L. (2011). Communicating climate change: closing the science-action gap. *The Oxford handbook of climate change and society*, 161-174.

Napier, J. L., Huang, J., Vonasch, A. J., & Bargh, J. A. (2018). Superheroes for change: Physical safety promotes socially (but not economically) progressive attitudes among conservatives. *European Journal of Social Psychology, 48*(2), 187-195.
Nordhaus, T., & Shellenberger, M. (2009). Apocalypse fatigue: Losing the public on climate change. *Yale environment, 360*, 16.
O'Neill, S., & Nicholson-Cole, S. (2009). "Fear won't do it" promoting positive engagement with climate change through visual and iconic representations. *Science Communication, 30*(3), 355-379.
Peters, E., & Slovic, P. (2000). The Springs of Action: Affective and Analytical Information Processing in Choice. *Personality and Social Psychology Bulletin, 26*(12), 1465-1475. doi:10.1177/01461672002612002
Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in experimental social psychology, 19*, 123-205.
Rottenstreich, Y., & Hsee, C. K. (2001). Money, kisses, and electric shocks: On the affective psychology of risk. *Psychological Science, 12*(3), 185-190.
Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant. *Journal of Personality and Social Psychology, 76*(5), 805.
Schreiber, D., Fonzo, G., Simmons, A. N., Dawes, C. T., Flagan, T., Fowler, J. H., & Paulus, M. P. (2013). Red brain, blue brain: Evaluative processes differ in Democrats and Republicans. *PLoS One, 8*(2), e52970.
Schwartz, D., & Loewenstein, G. (2017). The Chill of the Moment: Emotions and Proenvironmental Behavior. *Journal of Public Policy & Marketing, 36*(2), 255-268.
Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. *Journal of Personality and Social Psychology, 45*(3), 513.
Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy Scale *Measures in health psychology: a user's portfolio. Causal and control beliefs* (pp. 35-37). Windsor, UK: NFER-Nelsen.
Sharot, T. (2011). The optimism bias. *Current biology, 21*(23), R941-R945.
Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19*(4), 689-701.
Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis, 24*(2), 311-322. doi:10.1111/j.0272-4332.2004.00433.x
Smith, N., & Leiserowitz, A. (2014). The Role of Emotion in Global Warming Policy Support and Opposition. *Risk Analysis, 34*(5), 937-948. doi:10.1111/risa.12140
Spence, A., Poortinga, W., Butler, C., & Pidgeon, N. F. (2011). Perceptions of climate change and willingness to save energy related to flood experience. *Nature Climate Change, 1*(1), 46.
Storbeck, J., & Clore, G. L. (2008). Affective arousal as information: How affective arousal influences judgments, learning, and memory. *Social and personality psychology compass, 2*(5), 1824-1843.
Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5*(4), 297-323.
vanLaer, T., Ruyter, K. d., Visconti, L. M., & Wetzels, M. (2014). The Extended Transportation-Imagery Model: A Meta-Analysis of the Antecedents and Consequences of Consumers' Narrative Transportation. *Journal of Consumer Research, 40*(5), 797-817. doi:10.1086/673383

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change, 77*(1), 103-120.
Whitmarsh, L. (2008). Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. *Journal of Risk Research, 11*(3), 351-374.
Wildavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why? *Daedalus*, 41-60.
Wilson, T. D., & Schooler, J. W. (1991). Thinking too much: introspection can reduce the quality of preferences and decisions. *Journal of Personality and Social Psychology, 60*(2), 181.
Witte, K., & Allen, M. (2000). A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns. *Health Education & Behavior, 27*(5), 591-615. doi:10.1177/109019810002700506
Yang, Z. J., & Kahlor, L. (2013). What, Me Worry? The Role of Affect in Information Seeking and Avoidance. *Science Communication, 35*(2), 189-212. doi:10.1177/1075547012441873
Yang, Z. J., McComas, K. A., Gay, G., Leonard, J. P., Dannenberg, A. J., & Dillon, H. (2011). Information seeking related to clinical trial enrollment. *Communication Research, 38*(6), 856-882.
Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35*(2), 151.
Zak, P. J. (2015). *Why Inspiring stories make us react: The neuroscience of narrative.* Paper presented at the Cerebrum: the Dana Forum on Brain Science.

Appendix Q

Stimuli, Study 1

Common to both versions:

My name is Leigh-Kathryn Bonner and I just graduated from NC State. I'm 26 years old and a third-generation beekeeper. I suppose it's been in my blood. My grandfather is a beekeeper, my uncle is a beekeeper, and so is my cousin. I was around bees a lot growing up and it's so much fun. You're constantly learning.

I'm passionate about beekeeping and was working at the American Tobacco Campus interning for the owner when I asked him if I could put one hive on his roof. All I wanted was one hive and he said, 'sure!' North Carolina's largest clear observatory hive is at Burt's Bees world headquarters, which is nearby. My boss said, 'let's talk to them!' We did, and ended up installing a bunch of hives and over 180,000 bees on the rooftops at American Tobacco. All of our rooftop hives are custom painted in vivid colors by a local artist and they're beautiful.

Bees are actually healthier in urban areas because they're in stable environments they've got more forage throughout the year. And because people like to have colorful gardens, there's food for the bees year-round. Over eighty percent of the food we as humans eat is actually from a pollinator. Every one-third bite of food you eat is thanks to a honeybee. Honeybees contribute 153 billion dollars annually to the world's economy. *We really need bees and they're dying at an alarming rate.*

In 2012, American beekeepers lost fifty percent of their honeybee populations! It hurts to see that happen because you get attached to them and you want them to do well. It breaks my heart.

Our world is changing and it's our responsibility to protect it and we're not doing a very good job of that. The last couple years in North Carolina we've had very long winters, very short springs, and really hot summers. We'll have 80 degrees one day, and then we'll have 30 degrees the next. The bees aren't getting as much nectar throughout these shortened springs. You know, the flowers aren't blooming when it's 110 degrees outside so there's no nectar, no food for the bees.

Changing weather patterns and the shortened seasons throw honeybees off and a lot of that is due to climate change. We're just destroying our environment and the bees can't adapt as quickly as we are destroying it. If you ask a beekeeper enough questions, they'll eventually get to the point where they're saying, *'well, you know this year was a bad spring and, actually, we've had that five years in a row now.*' And I'm thinking, *'Huh – well, yeah...that's climate change.'*

Ending: positive end valence condition

Younger beekeepers are much more vocal about climate change. Millennials want to make a change they're very aware of what's going on, and they want to voice their opinions. We can make a change in the world! So many Millennials are taking the jobs where they feel like they'll actually make a difference and where their voice will be heard. Younger beekeepers are much quicker to say, *'this is this is partially because of human-caused climate change and we will do something about that!'*

Ending: negative end valence condition

The problems keep growing and we keep losing bees. Without honeybees to pollinate plants, we would only be able to sustain ourselves and our food supply for about 4 years before our world would just crumble. If we continue on the road we are on, without doing something about climate change, we are going to be in VERY big trouble.

Appendix R

Measures, Study 1

Emotional Arousal Measures

*How **physically intense** was it for you to read this article?*

1 = Minimal intensity 7 = Maximal intensity

Note. **Physical intensity** refers to when the bodies are in a heightened sense of physical activity, typically with adrenaline coursing through the system and activating the muscles. Physical intensity includes all types of bodily activation I might feel when engaged in certain activities.

*How **emotionally intense** was it for you to read this article?*

1 = Minimal intensity 7 = Maximal intensity

Note. **Emotional intensity** refers to when the bodies are in a heightened sense of physical activity, typically with adrenaline coursing through the system and activating the muscles. Emotional intensity includes all types of bodily activation I might feel when engaged in certain activities.

Emotion – Pleasure vs. Displeasure item

When I think about climate change I feel …

1 = Despairing 7 = Hopeful

Manipulation check

Would you say that this story <u>ended</u> on a positive or negative note?

1 = Negative 7= Positive

Political items

Generally speaking do you consider yourself as a…

1= Strong Democrat

2= Weak Democrat

3= Independent Democrat

4= Independent Independent

5= Independent Republican

6= Weak Republican

7= Strong Republican

Generally speaking, do you consider yourself politically…

1= Very liberal

2= Liberal

3= Moderate

4= Conservative

5= Very conservative

Very liberal and liberal were grouped as ‘liberal’

Moderates remained their own category

Conservative and very conservative were grouped as ‘conservative’

Appendix S

Table 23

Study 1 – Model Coefficients for the Conditional Process Model Depicted in Figure 5.

		Consequent						
		M (AROUSAL)				Y (RISK)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X(ENDVALENCE)	*a*	- .665	.219	.003	*c´*	- .149	.217	.493
M (AROUSAL)		---	---	---	b_1	- .069	.167	.678
W (IDEOLOGY)		---	---	---	b_2	-1.961	.359	.000
M x W		---	---	---	b_3	.227	.084	.008
Constant	i_m	4.848	.525	0.000	i_y	8.191	.882	.000
		R^2 = .062				R^2 = .399		
		F(3,196) = 4.303,				*F*(6,193) = 21.34,		
		p = .006				*p* = .000		

Note. Age and gender are included in the model as covariates.

Table 24

Study 1 - Descriptives

	Negative End Valence	Positive End Valence	Negative End Valence	Positive End Valence
Political Ideology	Emotional Arousal Mean (SD)	Emotional Arousal Mean (SD)	Risk Perception Mean (SD)	Risk Perception Mean (SD)
Liberal (1)	4.837 (1.532)	4.000 (1.446)	6.449 (.818)	6.356 (.645)
Moderate (2)	4.290 (1.510)	3.767 (1.455)	5.064 (2.220)	5.067 (1.760)
Conservative (3)	3.684 (1.455)	3.308 (1.715)	4.579 (1.953)	3.346 (2.297)

Appendix T

Cultural Worldview Measures

Short-form versions of two 6-item scales developed by Kahan (2007)

Table 25
Cultural Worldview Items, Short-Form

Individualism – Communitarianism (Individualism)	
IINTRSTS	The government interferes far too much in our daily lives.
CHARM	Sometimes the government needs to make laws that keep people from hurting themselves.
IPROTECT	It's not the government's job to try to protect people from themselves.
IPRIVACY	The government should stop telling people how to live their lives.
CPROTECT	The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.
CLIMCHOI	Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

Hierarchy - Egalitarianism (Hierarchy)	
HEQUAL	We have gone too far in pushing equal rights in this country.
EWEALTH	The society would be better off if the distribution of wealth was more equal.
ERADEQ	We need to dramatically reduce inequalities between the rich and poor, whites and people of color, and men and women.
EDISCRIM	Discrimination against minorities is still a very serious problem in the society.
HREVDIS2	It seems like blacks, women, homosexuals and other groups don't want equal rights, they want special rights just for them.
HFEMIN	Society as a whole has become too soft and feminine.

Appendix U

Table 26
Study 2 - Descriptives

	Negative End Valence	Positive End Valence	Negative End Valence	Positive End Valence
Cultural Worldview	Emotional Arousal Mean (SD)	Emotional Arousal Mean (SD)	Risk Perception Mean (SD)	Risk Perception Mean (SD)
Communitarian (0)	4.527 (1.386)	4.323 (1.403)	5.818 (1.220)	5.948 (1.070)
Individualist (1)	3.838 (1.463)	3.958 (1.352)	4.973 (1.518)	4.938 (1.731)
Egalitarian (0)	4.425 (1.406)	4.284 (1.391)	5.843 (1.144)	5.819 (1.212)
Hierarchist (1)	3.900 (1.552)	3.588 (1.278)	4.100 (1.586)	4.059 (1.784)

Appendix V

Table 27

Study 3 – Model Coefficients for the Conditional Process Model Depicted in Figure 5 – Moderator: Political Ideology

		Consequent						
		M (AROUSAL)				Y (RISK)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X(ENDVALENCE)	*a*	- .457	.154	.003	*c´*	- .145	.118	.218
M (AROUSAL)		---	---	---	b_1	.252	.061	.000
W1 (IDEOLOGY)		---	---	---	b_2	-1.510	.435	.001
W2 (IDEOLOGY)		---	---	---	b_3	-3.346	.382	.000
M x W1		---	---	---	b_4	.211	.094	.025
M x W2		---	---	---	b_5	.419	.083	.000
Constant	i_m	4.213	.280	0.000	i_y	5.658	.341	.000
		R^2 = .024				R^2 = .488		
		F(3,445 = 3.59,				*F*(8,440) = 52.34,		
		p = .014				*p* = .000		

Note. Age and gender are included in the model as covariates.

Table 28

Study 3 – Model Coefficients for the Conditional Process Model Depicted in Figure 5 – Moderator: Cultural Worldviews - GROUP

		Consequent						
		M (AROUSAL)				Y (RISK)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X(ENDVALENCE)	*a*	- .457	.280	.003	*c´*	- .155	.132	.239
M (AROUSAL)		---	---	---	b_1	.393	.051	.000
W (IDEOLOGY)		---	---	---	b_2	-1.849	.370	.000
M x W		---	---	---	b_3	.292	.084	.001
Constant	i_m	4.211	.280	0.000	i_y	8.191	.882	.000
		R^2 = .024				R^2 = .357		
		F(3,445 = 3.59,				*F*(6,442) = 40.97,		
		p = .014				*p* = .000		

Note. Age and gender are included in the model as covariates.

Table 29

Study 3 – Model Coefficients for the Conditional Process Model Depicted in Figure 5 – Moderator: Cultural Worldviews (GRID)

		Consequent						
		M (AROUSAL)				Y (RISK)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X(ENDVALENCE)	*a*	- .457	.280	.003	*c´*	- .153	.121	.206
M (AROUSAL)		---	---	---	b_1	.351	.044	.000
W (IDEOLOGY)		---	---	---	b_2	-2.900	.356	.000
M x W		---	---	---	b_3	.360	.086	.000
Constant	i_m	4.211	.280	0.000	i_y	4.961	.287	.000
		R^2 = .024				R^2 = .458		
		F(3,445 = 3.59,				*F*(6,442) = 62.33,		
		p = .014				*p* = .000		

Note. Age and gender are included in the model as covariates.

Appendix W

Table 30
Study 3 – Descriptives by Political Ideology

	Negative End Valence	Positive End Valence	Negative End Valence	Positive End Valence
Political Ideology	Emotional Arousal Mean (SD)	Emotional Arousal Mean (SD)	Risk Perception Mean (SD)	Risk Perception Mean (SD)
Liberal (1)	4.674 (1.444)	4.411 (1.607)	6.329 (1.074)	6.100 (1.050)
Moderate (2)	4.448 (1.391)	3.982 (1.773)	5.603 (1.024)	5.375 (1.520)
Conservative (3)	4.297 (1.819)	3.610 (1.577)	4.595 (1.790)	4.000 (2.061)

Table 31
Study 3 - Descriptives by Cultural Worldview

	Negative End Valence	Positive End Valence	Negative End Valence	Positive End Valence
Cultural Worldview	Emotional Arousal Mean (SD)	Emotional Arousal Mean (SD)	Risk Perception Mean (SD)	Risk Perception Mean (SD)
Communitarian (0)	4.678 (1.512)	4.270 (1.645)	5.839 (1.326)	5.638 (1.332)
Individualist (1)	4.097 (1.620)	3.610 (1.631)	4.972 (1.760)	4.402 (2.238)
Egalitarian (0)	3.837 (1.424)	4.257 (1.643)	5.882 (1.222)	5.720 (1.276)
Hierarchist (1)	3.900 (1.951)	3.226 (1.515)	4.209 (1.922)	3.340 (2.183)

Appendix X

Stimulus Material, Study 4 - Doom condition

The problems keep growing and we keep losing bees. Without honeybees to pollinate plants, we will only be able to sustain ourselves and the food supply for about 4 years before the world will crumble. At this point, no matter what we do about climate change it's just too late to turn things around.

Paper C

The Messenger IS the Message: Identification with Story Characters Influences Climate Change Risk Perception

Purpose: The purpose of this paper is to explore how value congeniality between a 'messenger' and a 'listener' influences risk perception through the forces of counterarguing and character identification. Research question: 'Does perceived value congeniality between a story character and receiver influence climate change risk perception by reducing counterarguing and increasing identification with the messenger?'

Design/Methodology/Approach: I conducted four online survey experiments using controlled, written stimuli, and self-reported measures of counterarguing, character identification, and climate change risk perception.

Findings: Scientists are not necessarily the most trusted messengers on the issue of climate change. Value congeniality is critical to heightening risk perception in disengaged audiences (e.g. religious and people holding individualistic or hierarchical worldviews), whereas value misalignment was more effective for audiences with high baseline levels of concern.

Research limitations: The nature of online experiments limits the generalizability of the studies yet provided me with the opportunity to improve sample variation in a controlled setting.

Practical implications: To increase risk perception in ideologically diverse audiences, communicators and policy makers should tell climate change stories featuring characters whose values mirror those of the most disengaged segments rather than stereotypical liberal characters.

The Messenger is the Message:

Identification with Story Characters Influences Climate Change Risk Perception

Brandi S. Morris*[a], Polymeros Chrysochou[b], Panagiotis Mitkidis[c], Anthony Leiserowitz[d]

[ab] Department of Management, Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V, Denmark; [c] Department of Management, Aarhus University, Fuglesangs Allé 4, 8210 Aarhus V, Denmark & Center for Advanced Hindsight, Duke University, 334 Blackwekk st., Durham NC 27701 [d]Yale Program on Climate Change Communication, Yale University, New Haven, CT, USA

Acknowledgments. Research for this paper was funded by the Aarhus University Supplementary Pool and Interacting Minds Center at Aarhus University. Correspondence should be addressed to Brandi S. Morris, Department of Management, Aarhus University, Fuglesangsallé 4, 8210 Aarhus V, Denmark. Email: bsm@mgmt.au.dk.

Abstract

Scientists are the de facto messengers for communicating the urgency and risk of climate change. However, while several studies have demonstrated that accepting the scientific consensus is an important 'gateway belief' for engagement with climate change, others have shown that science comprehension and literacy do not predict belief on politically polarized issues. Not well studied is how the values of an audience and messenger impact assimilation of information and perception of climate change risk. We conducted a series of experiments to investigate the assumption that the more the values of a story receiver match the messenger's, the less likely they are to generate critical thoughts or counterargue, which in turn heightens the receiver's identification with the messenger and increases the likelihood of post-narrative influence in the form of heightened perception of climate change risk. The results of our first study suggest that when viewing real-world climate change videos, people counterargue less and identify more with conservative political 'messengers' than with scientists even when controlling for education and political affiliation. This positively impacted risk perception. Using controlled stimuli in three subsequent experiments we find that messengers with religious, individualistic or hierarchical values are more effective at heightening risk perception in all audiences, including those who are non-religious, communitarian or egalitarian. In other words, value-congeniality made a messenger more effective at heightening risk perception in typically disengaged audiences while misalignment had a greater impact on the risk perception of those with ideologically liberal values and worldviews. Taken together, our results suggest that rejection of information by disengaged audiences may not primarily be due to the information itself, but to a lack of identification with messengers who are not perceived to share important values.

Keywords: climate change, communication, values, identification, motivated cognition

In countries where the issue is contentious and "contaminated by social meaning" (Kahan, 2012b) (e.g. United States, United Kingdom and Australia (Dryzek, Norgaard, & Schlosberg, 2011; Tranter & Booth, 2015)), an individual's stance on climate change has become an important identity cue (Kahan, Braman, Slovic, Gastil, & Cohen, 2007). Scientists are often the de facto climate change communicators by virtue of their perceived impartiality and reliance on empirical evidence. Yet when it comes to controversial issues, the public does not necessarily view scientists and risk communicators as neutral or above the political fray, associating them with the partisan inclinations of the specific issue they are addressing (Vraga, Myers, Kotcher, Beall, & Maibach, 2018) and liberal political ideology more broadly (Funk & Rainy, 2015). The issue of climate change has become strongly associated with liberal values and political ideology (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Rosenthal, 2015) and Conservative Republicans in particular tend to distrust scientists more because of a perceived liberal bias (Funk & Rainy, 2015).

While public opinion research suggests that communicating the global scientific consensus message on climate change (i.e. '97% of scientists agree climate change is happening, and this phenomenon is being impacted by human activity') lifts risk perception among American audiences 12-15 percentage points (Ding, Maibach, Zhao, Roser-Renouf, & Leiserowitz, 2011; Lee, Markowitz, Howe, Ko, & Leiserowitz, 2015), there is also strong empirical support for the claim that science literacy and comprehension do not necessarily predict belief on issues which have become markers of social identity (Kahan, 2017; Kahan, Braman, Slovic, Gastil, & Cohen, 2009). Biased assimilation of information serves to protect individuals against potential threats to their identity and social affiliations. Danger is real but risk is socially constructed, contextual, and highly influenced by who is assessing and communicating the risk (Slovic, 1999). Given the evolutionary importance of in-group acceptance for survival, a rational individual's (sub-conscious) risk calculations naturally

include the potential cost of adopting beliefs incongruent with one's identity or close social ties. Perceived value similarity is a critical component of credibility and trust (Earle, Siegrist, & Gutscher, 2010; Siegrist, Cvetkovich, & Roth, 2000). Consequently, when it comes to communicating risk on controversial issues such as climate change, the messenger *is* the message.

In this research, we investigate how perceived value congruency between a messenger and a message 'receiver' influences the perception of climate change risk. Building on prior research suggesting that enrobing information in story structure is more effective than analytical narratives for motivating action-taking on climate change (Morris et al., 2018a), we examine one essential feature of stories: the identifiable character (i.e. the 'messenger'). More specifically, we investigate how value- and worldview congeniality influence identification with a messenger who has undergone a metamorphosis from being highly skeptical about climate change to being deeply concerned. Through a series of survey experiments in which we manipulate the values of the messenger, we explore whether counterarguing and identification mediate this influence on risk perception among study participants. We posit that value congeniality reduces counterarguing and critical thoughts about both the messenger and his message. Through reduced counterarguing, we predict that a story receiver is more likely to identify with the messenger, which will subsequently influence his or her own perception of climate change risk.

Identity and Identity-Protective Cognition

According to Social Identity Theory, people derive a sense of "social and personal self-worth from the identities they hold"(Cohen et al., 2007). As such, they are most likely to adopt views which reinforce their social connections (Kahan, Jenkins-Smith, & Braman, 2011) and identity (Cohen et al., 2007). In situations where these are imperiled, the advantages of

intellectual curiosity and factual accuracy may pale in comparison with the psychological costs of updating beliefs (Cohen et al., 2007). Identity-protective cognition is a form of bias where individuals subconsciously process empirical facts in ways that are consistent with their identity and worldview (Kahan, 2012a) in order to avoid cognitive dissonance and estrangement from valued social groups. Indeed, Kahan and his team find that exposure to scientific evidence on climate change increased concern among those already concerned but caused those predisposed to be dismissive to become *even more dismissive* (Kahan, 2017; Kahan, Wittlin, et al., 2011).

Risk assessment is inherently subjective and dependent on value-laden judgments, which influence not only what we fear, but why (Slovic, 1999; Slovic, Finucane, Peters, & MacGregor, 2004; Wildavsky & Dake, 1990). Values are "(a) concepts or beliefs (b) about desirable end states or behaviors (c) that transcend specific situations (d), guide selection of behavior and events, and (e) are ordered by importance" (Douglas & Wildavsky, 1982, p. 551) and expressed in different motivational domains (Schwartz & Bilsky, 1987). Values color the way we see the world and how we calculate risk. People are less likely to trust information with policy implications that threaten their values and ideological commitments (Campbell & Kay, 2014; Kahan, Jenkins-Smith, et al., 2011). The acknowledgment that climate change is happening and impacted by human activity implies, at least on some level, a need for outside regulation. This external interference represents a viable threat to certain values and worldviews about how society should be ordered. Motivation influences the likelihood of elaboration (Petty & Cacioppo, 1986). An individual whose identity, worldview, way of life, and social affiliations are at risk if they update their beliefs on climate change, may lack the requisite motivation to accurately assimilate new information on the issue unless they perceive a more eminent and viable threat.

It appears that these tendencies can be mitigated by framing information in a way that affirms, rather than threatens, an individual's closely held values, goals and identity. According to the elaboration likelihood model, on issues of low-involvement, individuals are more likely to be persuaded by the characteristics of the source rather than by the quantity or quality of arguments (Petty & Cacioppo, 1986). Kelman (1961) highlighted identification as one of three main social influence processes where the messenger, rather than the message itself, is made appealing to the story receiver. A growing body of interdisciplinary research suggests that stories are superior to informational frames at motivating pro-social behavior (Barraza, Alexander, Beavin, Terris, & Zak, 2015; Lin, Grewal, Morin, Johnson, & Zak, 2013; Loewenstein, 2010; Morris et al., 2018a), and the 'identifiable character' is one of the main mechanisms whereby this influence is thought to occur (vanLaer, Ruyter, Visconti, & Wetzels, 2014). Through emotional connections with characters, stories more effectively trigger affective engagement and physiological response than informational frames (Morris et al., 2018a), which in turn, heightens risk perception (Loewenstein, Weber, Hsee, & Welch, 2001; Slovic, Finucane, Peters, & MacGregor, 2007). Unfortunately, there is no one-story-fits-all because there is no one character-fits-all. Identification is influenced by perceived values and goals.

Character Identification

We adopt Cohen's (2001a) definition of character identification as 'a process of self-other merging, where the story receiver shares 1) the *perspective of*, rather than *judgments about,* and 2) *feelings with*, rather than *feelings about*, the character in a story.' There is an important distinction between the psychological distance maintained by a story receiver when she experiences identification *with* a character versus when she maintains a spectator's perspective *about* them (Oatley, 1999). Identification has an internal component, which differentiates it

from mere external and behavioral imitation (Wollheim, 1974). Through identification, a story receiver psychologically merges with a character, increasing the likelihood that they will adopt their goals and become invested in seeing these realized through the story's plot (Oatley, 1995, 1999).

Story characters can serve as educators who, "extend our emotional horizons and social perspectives" (Cohen, 2001b), modelling 'new' behaviors on which we may pattern our own. When a story receiver identifies with a character, it can result in the shaping of their own identity and social attitudes (Erikson, 1994). Through identification with characters, story receivers have the potential to experience social reality from another perspective (Cohen, 2001b). Stories can function as proxies for personal experience and a form of observational learning because they are experientially, rather than analytically processed. When a story receiver's values and goals match that of the story character (i.e. 'messenger'), they are less likely to have critical thoughts (Fiske, 1989) or to counterargue (Green & Brock, 2000; Slater & Rouner, 2002), more likely to self-report identification, and to be influenced by the character (Jones, 2014; Jones & Song, 2014).

Character identification enhances the persuasive impact of communication by reducing critical thoughts (Fiske, 1989) and counterarguing (Green & Brock, 2000; Moyer-Gusé & Nabi, 2010; Slater & Rouner, 2002), but we propose that identification is the *result* of reduced counterarguing, which is made more likely when there is a match between character and story receiver values and worldview. In other words, to the extent that a story receiver perceives a match between their own values and that of the messenger, the less likely they are to have critical thoughts about that messenger and their message. This reduced counterargument, in turn, increases the likelihood that they will experience the self-other merging of identification. Moreover, prior work suggests that identification with a character who comes to terms with

her own vulnerability may allow a story receiver who has felt insulated from risk to perceive her own exposure (Cohen, 2001b; Nabi, Moyer-Gusé, & Byrne, 2007).

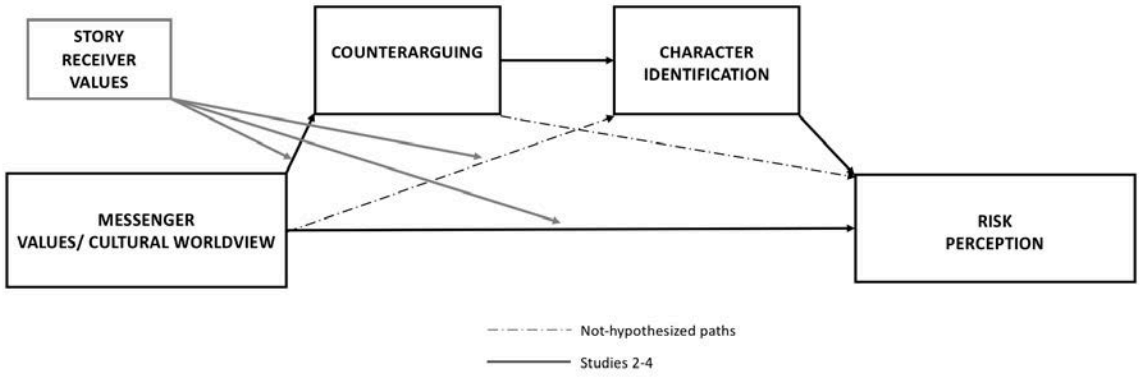


Figure 12. Conceptual model with overview of studies

Bearing all of this in mind, we predict that identification with a character who has undertaken a journey from climate change skepticism to belief will heighten perception in story receivers to the degree there is congeniality between their values and worldview. Using a series of survey experiments, we examine the mediating role that counterarguing and identification play in the relationship between the messenger and risk perception. In our first study, we investigate whether the messenger influences risk perception through decreased counterarguing and increased identification. In studies 2 through 4, we explore the robustness of the full conceptual model illustrated in Figure 12 to understand whether value congeniality between the messenger and story receiver (participant) moderates the relationships depicted.

Study 1

The aim of study 1, an online experiment, was to understand how two types of climate change messengers – politicians and scientists - influence risk perception, and whether counterarguing and character identification mediate this relationship.

Methods and Materials

In a single factor design, 1,015 US-based participants were recruited through Mturk (51% female; M_{age} =38.57, SD_{age} = *13.47*). Written informed consent was obtained and participants were compensated with USD 1.60 through their Mturk accounts. After completing demographic items, participants were randomly assigned to one of two conditions where the messenger was either A) international conservative politicians (*N = 511*) or B) a climate scientist (*N = 504)* (see Appendix Y). The two videos are naturalistic stimuli with the same theme (the belief that climate change is happening and that it is caused by humans) as well as duration (222 seconds).

After viewing one of the videos, we assessed climate change risk perception (Kahan, 2012c; Kahan, 2017) using the item, *"How much risk do you believe global warming poses to human health, safety, or prosperity?"* Self-reported response was measured using an 8-point Likert scale ranging from zero to seven, where each point on the axis was labeled *('none at all,' 'very low,' 'low,' 'between low and moderate,' 'moderate,' 'between moderate and high,' 'high,' and 'extremely high risk'*), together with two binary items for cross-validation. This was followed by measures of counterarguing (Silvia, 2006), identification (Cohen, 2001a), and several demographic items (see Appendix Z for full measures, alphas, means, standard deviations, and correlations.) Composite mean scores were calculated for counterarguing and identification.

Results

The first step in our analysis was to assess discriminant validity between the model's constructs. Following extant literature (DeVellis, 2003) confirmatory factor analysis was conducted in SmartPLS 3 (Ringle, Wende, & Becker, 2015). Discriminant validity was assessed using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler, Ringle, &

Sarstedt, 2015). All values were below the critical value of 0.90 (Henseler et al., 2015), and thus we conclude that the constructs are empirically distinct.

To test if the messenger influences the three measures of the proposed model (i.e. risk perception, counterarguing, and character identification), an analysis of variance was conducted controlling for age, gender, political ideology and education. As shown in Figure 13, we find a significant main effect of the messenger on counterarguing, $F(1, 1009) = 12.255$, $p = .000$, $\omega = .01$, with receivers counterarguing more with the scientist messenger ($M = 3.16$; $SE = .06$) than with the conservative messenger ($M = 2.84$; $SE = .06$). As seen in Figure 14, our findings also suggest a main effect of the messenger on character identification, $F(1, 1009) = 25.930$, $p = .000$, $\omega = .03$, with receivers identifying more with a conservative messenger ($M = 5.48$; $SE = .05$) than with the scientist messenger ($M = 5.12$; $SE = .05$). We find no evidence for a main effect of the messenger on risk perception, $F(1, 1009) = .011$, $p = .000$, $\omega = .00$ (Figure 15).

To explore whether the influence of messenger type on risk perception is serially mediated through counterarguing and identification, we conducted conditional process analysis using the PROCESS 3.0 macro (Model 6; 5000 bootstraps) for SPSS (Hayes, 2013), controlling for the same covariates. The analysis provides evidence for the hypothesized serial mediation with a significant indirect effect estimated as $a_1d_{21}b_2 = 0.05$, $SE = .017$; 95% bias-corrected CI [.023, 091] (see Appendix AA for all path coefficients and descriptives).

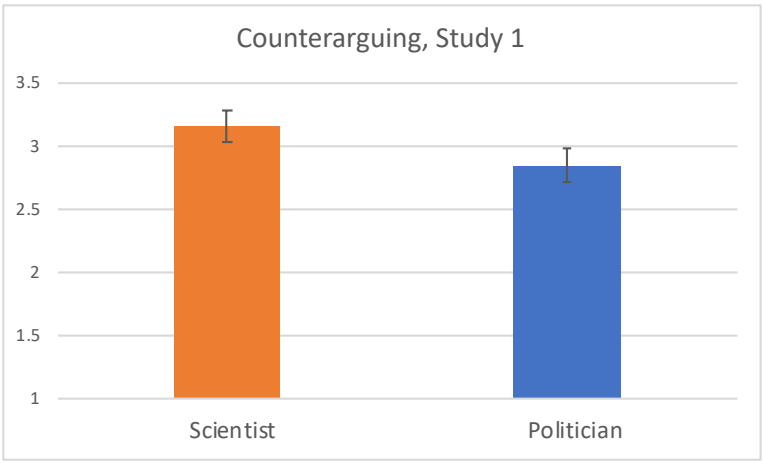


Figure 13. Study 1, Mean Counterarguing Scores (age, gender, education & political affiliation as covariates) *Note.* Counterarguing scale runs from 1(*Strongly Disagree)* to 7 (*Strongly Agree)*

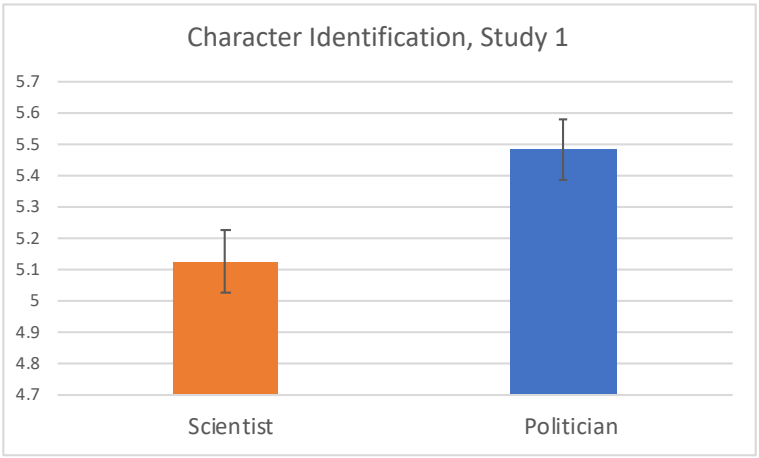


Figure 14. Study 1, Mean Character Identification Scores (age, gender, education & political affiliation as covariates) *Note.* Character identification scale runs from 1(*Strongly Disagree)* to 7 (*Strongly Agree)*

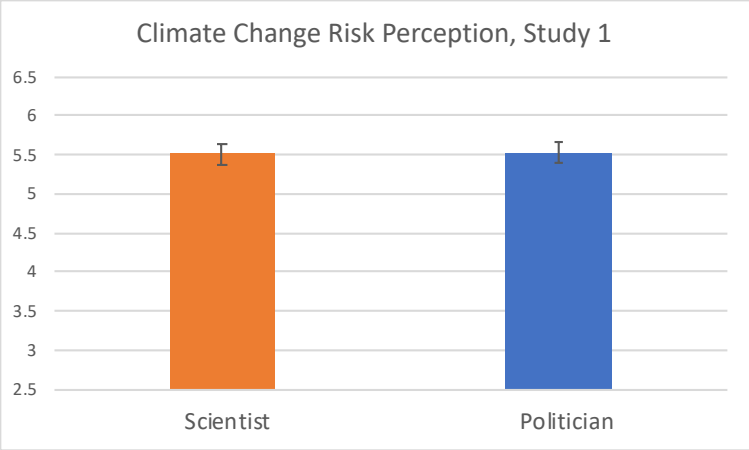


Figure 15. Study 1, Mean Climate Change Risk Perception Scores (age, gender, education & political affiliation as covariates) *Note.* Risk perception scale runs from 0 (*None At All) to* 7 (*Extremely High Risk)*.

Discussion

Although scientists are frequent messengers for communicating the urgency of climate change, our findings suggest that may not be an optimal choice. Participants in our study counterargued more, and identified less, with scientists than with international conservative politicians. This is perhaps surprising given their high educational level and topic-specific expertise, but recent research presents a very mixed picture of how the public views science and scientists. Though trust in scientists as sources of information is generally higher than for most other groups in society with the exception of the military (Funk, 2017), the exuberance of that trust has decreased over the years with only 21 percent of respondents from a nationally representative survey reporting that they had "a great deal" of confidence in scientists to act in the best interest of the public (Funk, 2017). Just 39 percent of those surveyed reported "strong" trust in information from climate scientists and 28 percent expressed "strong" trust in scientists' understanding of the causes of climate change (Funk, 2017). Moreover, on controversial issues, scientists are not viewed as impartial sources of information: both liberals and conservatives tend to ascribe the partisan views associated with a particular issue to the scientist

communicators themselves (Vraga et al., 2018). This suggests that a perceived gap in values influences the source credibility of scientists just as it does with any other messenger.

The inherent variation in our naturalistic stimuli introduces noise into the data: videos did not contain the same number of characters, were not produced by the same content providers, nor were they identical in style, audio, or visual content, despite their common focus on belief in climate change. To accommodate these weaknesses and to probe our questions further, we designed a series of online experiments that used controlled stimuli to investigate how perceived value congeniality influences risk perception.

Studies 2-4

In addition to exploring the mediating roles of counterarguing and character identification in the relationship between the messenger and risk perception, our goal with studies 2-4 was to discover whether a match in values between messenger and receivers moderates the relationships depicted in Figure 12.

Study 2

Methods and Materials

In a two by two factor design, 220 US-based participants were recruited through Mturk (52% female; M_{age} =36.49, $SD_{age} = 10.95$) during spring 2018. Sample size for studies 2-4 was calculated beforehand using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) to conduct power analyses. Given the anticipated statistical analyses, it was determined that the sample size used in these studies would be sufficient to detect the significance (at $p < 0.05$) of "medium" effects at a power exceeding the conventional 0.80 cutoff (Cohen, 1988; Cohen, Cohen, West, & Aiken, 2003). Written informed consent was obtained and participants passing attention filters received $.68 through their Mturk accounts. Participants failing attention

checks or completing the experiments in an unrealistic amount of time (< 60 seconds) were removed prior to analysis.

After completing initial demographic items, participants were randomly assigned to read a text about a man (messenger) who undergoes a transformation from climate change skeptic to believer after a discussion with a close friend. In one condition, the messenger was religious (N = 111), in the other, non-religious (N = 109) (Appendix BB). After reading the text, the same measures of climate change risk perception, counterarguing, character identification, and demographic items were used as in study 1. The moderator, 'story receiver values,' was measured after the dependent variable, using five categories to indicate the importance of religion in the participant's daily life. Choices ranged from '*center of my life*' to *'not at all religious*.' To indicate alignment with the messenger, a binary 'religiosity' variable was coded where all involvement levels with religion were coded as 'religious' (1) and 'not at all religious' (0).

Manipulation checks were conducted to ensure construct validity, and pilot studies to ensure discriminant validity. The four items measuring character identification were averaged (α = 0.87). A planned contrast comparing the matched to the unmatched condition (weights: 1, -1) was highly significant, $t(207) = -3.68$, $p < 0.001$. As expected, people in the matched conditions experienced higher self-reported identification (M = 4.71) than those in the unmatched conditions (M = 4.10).

Results

As in the previous study we first assessed discriminant validity between the model's constructs using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015). All values were below the critical value of 0.90 (Henseler et al., 2015), and thus we conclude that the constructs are empirically distinct.

To test whether the messenger influences the three main measures of the proposed model (i.e. risk perception, counterarguing, and character identification), a two-way analysis of variance was conducted while controlling for age and gender. These same covariates were used in analyses for studies 2-4. Results reveal a significant main effect of the messenger on counterarguing $F(1, 214) = 4.739$, $p = .03$, $\omega = .02$ with planned contrasts indicating that non-religious receivers counterargued religious messengers significantly more ($M = 3.34$; $SE = .18$) compared with non-religious messengers ($M = 2.68$; $SE = .19$) (Figure 16). There was no evidence of a significant main effect of messenger on character identification; however, the results indicate a significant interaction between the religiosity of the messenger and the receiver, which influenced identification $F(1, 214) = 12.12$, $p = .001$, $\omega = .05$. Planned contrasts reveal that non-religious receivers had significantly higher identification with a non-religious messenger ($M = 4.79$; $SE = .16$) compared with a religious messenger ($M = 3.99$; $SE = .15$) (Figure 17). There was no evidence of a main effect of the messenger's religiosity on risk perception or of an interaction between messenger and receiver religiosity on risk perception (Figure 18).

To explore the moderated serial mediation model depicted in Figure 12, we again conduct conditional process analysis - this time using a custom model-builder (Frank, 2017) for PROCESS 3.0 (Hayes, 2013) (5000 bootstraps) for SPSS (Hayes, 2013) controlling for age and gender as covariates (used in studies 2-4). We find evidence for the hypothesized moderated serial mediation, estimated as $a_1d_{21}b_2 = 0.11$, $SE = .07$; 95% bias-corrected CI [.015, .275] (see Appendix CC for statistical model and Appendix DD for all path coefficients).

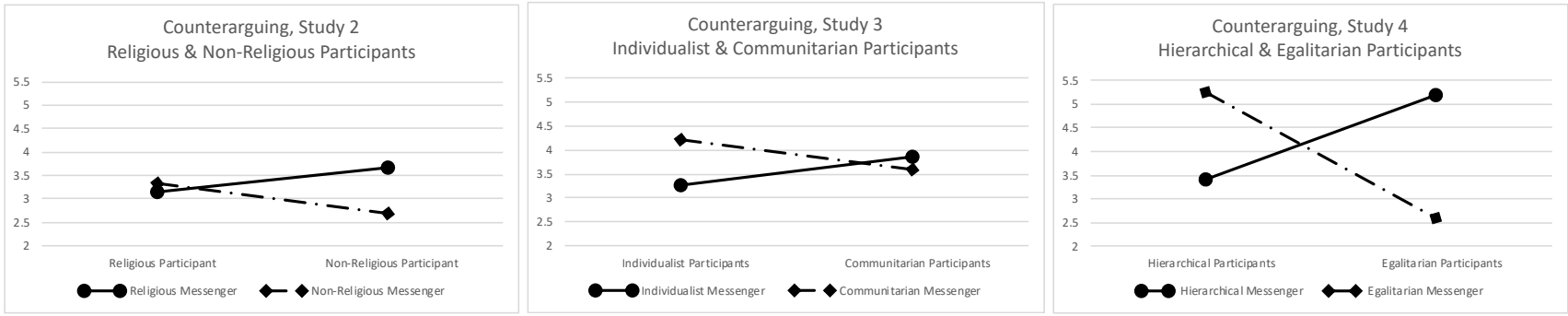


Figure 16. Studies 2-4, Mean Receiver Counterarguing Scores (age & gender as covariates)

Note. Counterarguing scale runs from 1(*Strongly Disagree)* to 7 (*Strongly Agree)*. *Source:(Silvia, 2006).

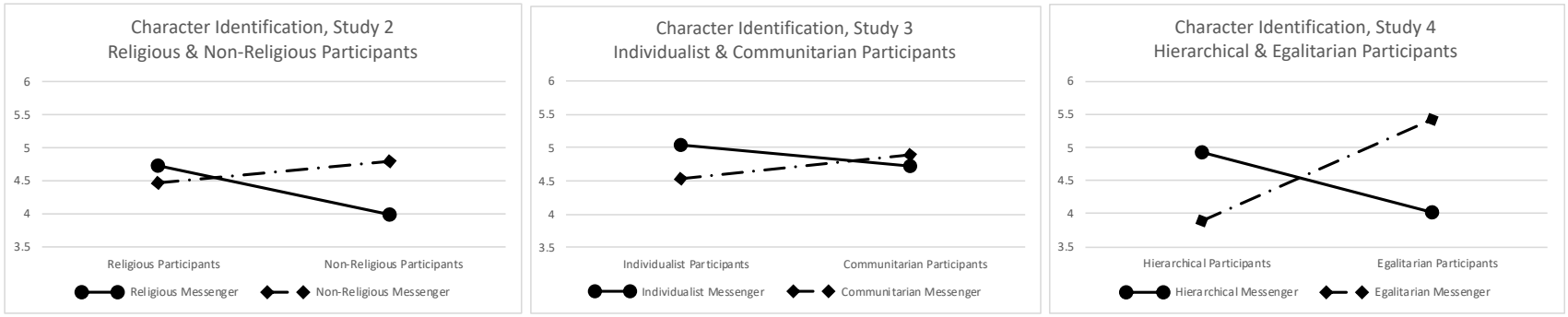


Figure 17. Studies 2-4, Mean Receiver Character Identification Scores (age & gender as covariates) *Note.* Character identification scale runs from 1(*Strongly Disagree)* to 7 (*Strongly Agree)*. *Source: (Cohen, 2001b).

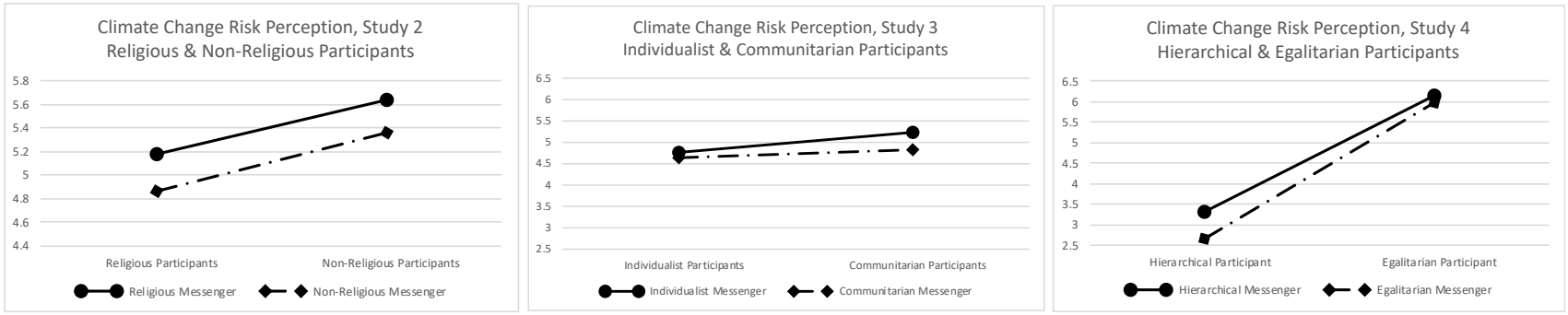


Figure 18. Studies 2-4, Mean Receiver Climate Change Risk Perception Scores (age & gender as covariates) *Note.* Risk perception scale runs from 0 (*None At All) to* 7 (*Extremely High Risk)*. *Source: (Kahan et al., 2012)

Discussion

Our results suggest that there is a significant difference in the levels of counterarguing and character identification for non-religious receivers: they counterargued significantly more, and identified significantly less, with religious messengers as opposed to non-religious messengers. This pattern also held true for religious receivers but the difference was not statistically significant. Interestingly, for non-religious receivers, higher counterarguing and lower character identification still resulted in significantly higher risk perception. Our finding that receiver religiosity directly influences risk perception confirms what prior research tells us about the negative association between climate change risk perception and religiosity (Morrison, Duncan, & Parton, 2015). The religious messenger heightened risk perception most in both religious and non-religious receivers. In addition to the role that value congeniality likely played for religious receivers, we propose that the element of surprise presents another plausible explanation for the influence on risk perception of non-religious receivers.

The brain's primary function is to run simulations and predictions based on past experience so as to maintain the optimal regulation of bodily functions, and external stimuli do not easily interrupt this process (Barrett, 2017). A religious messenger is a counter-stereotypical ambassador for the dangers of climate change (Morrison et al., 2015), making his message more neurologically noteworthy than that of a concerned, non-religious messenger. This element of neurological 'surprise' makes it more likely that the information will be placed in the 'affective niche', which determines what we care about and what demands our attention or action at a given moment (Barrett, 2017). It therefore stands to reason that a counter-stereotypical messenger may heighten risk perception to a greater degree than a more predictable character. To further test the robustness of our model and better understand the role

of value congeniality in messenger effectiveness, we designed the next study to test another set of values as expressed in the form of cultural worldviews.

Study 3

The goal of study 3 is to further explore the moderating role of values in our serial mediation model. To this end we use another measure, cultural cognition theory (Kahan et al., 2009; Kahan, Braman, Slovic, et al., 2007), which posits that individual information processing and perceptions of risk are shaped by *core values* that can be classified as 'cultural worldviews.' These cultural worldviews function as 'orienting mechanisms' which shape and influence risk perception (Slovic, 1999). Cultural cognition builds on the "cultural theory of risk" (Douglas & Wildavsky, 1982), arguing that social structures differ along two primary axes in terms of how they perceive and assess threats: Individualism-Communitarianism (study 3) and Hierarchy-Egalitarianism (study 4). Both sets of worldviews reflect values that manifest themselves in divergent perspectives about how society should be ordered and what constitutes a threat to those ideals.

The former refers to a set of attitudes about the degree to which individuals feel bound by solidarity with members of their society. People holding an individualistic cultural worldview believe that individuals should pursue their own interests unhindered by outside interference, including the government. Communitarians, on the other hand, believe that society is responsible for ensuring the conditions necessary for individual wellbeing, and that societal interests should weigh more heavily than individual interests.

Methods and Materials

In study 3, a two by two factor design, 267 US-based participants were recruited through Mturk (54% female; M_{age} =36.8, SD_{age} = *11.76*) during spring 2018. Written informed consent was

obtained from all participants and those passing attention filters received $.80 through their Mturk accounts. Study 3 used the same experimental protocol and analyses as described in study 2 with two exceptions. First, stimuli featured a messenger with either an individualist (N = 138), or a communitarian worldview(N = 129), (Appendix EE). Second, in order to ensure a balanced design in terms of sample, participants were prescreened using the short-form versions of two 6-item scales measuring individualist or communitarian worldview dispositions (Kahan, Braman, Gastil, Slovic, & Mertz, 2007; Kahan, Braman, Slovic, et al., 2007) (Appendix FF).

Results

As in previous studies, we first assessed discriminant validity between the model's constructs using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015). All values were below the critical value of 0.90 (Henseler et al., 2015), and thus we conclude that the constructs are empirically distinct.

To test whether the messenger influences the three main measures of the proposed model (i.e. counterarguing, character identification, and risk perception), a two-way analysis of variance reveals a significant main effect of the messenger on counterarguing $F(1, 261) = 4.287$, $p = .04$, $\omega = .02$, as well as significant interaction between the worldview of the messenger and participant on counterarguing $F(1, 261) = 13.070$, $p = .000$, $\omega = .05$. Planned contrasts indicate that participants with an individualist worldview counterargued communitarian messengers significantly more ($M = 4.21$; $SE = .16$) compared with individualist messengers ($M = 3.26$; $SE = .17$) (Figure 16). There was no evidence of a significant main effect of messenger worldview on character identification; however, the results indicate a significant interaction between the worldview of the messenger and the participant, which influenced identification $F(1, 261) = 5.92$, $p = .02$, $\omega = .02$. Planned contrasts indicate that individualist participants had significantly

higher identification with an individualist messenger (M = 5.04; SE =.14) compared with a communitarian messenger (M = 4.54; SE =.13) (Figure 17). We found no evidence to suggest a main effect of the messenger's cultural worldview on risk perception (Figure 18).

Conditional process analysis was conducted in the same manner as in study 2. We find that the indirect effect of the messenger on risk perception through counterarguing and character identification differs significantly at the two levels of our moderator, as indicated by the index of moderated mediation, estimated as $a_1d_{21}b_2$ = 0.15, SE = .08; 95% bias-corrected CI [.022, .335] (see Appendix GG for all path coefficients).

Discussion

The results of this third study suggest that both individualists and communitarians counterargued less and identified more with messengers that shared their values and worldview. However, when it comes to risk perception, it appears that the individualist messenger heightened risk perception in both groups. This corroborates the findings of study 2 and may have a similar explanation. As described earlier, people subscribing to an individualist worldview believe they should be allowed to pursue their own individual interest without interference, while communitarians believe in pursuing the public interest above individual gain. We *expect* communitarians to be environment-oriented but encountering an individualist who is also worried about climate change challenges stereotypes and represents a potential threat to their ideological commitments.

We continue to explore this connection between value congeniality and messenger effectiveness in a fourth study examining the second dimension of cultural cognition: hierarchical vs. egalitarian cultural worldviews.

Study 4

In study 4, we examine the moderating influence of values as operationalized by the second dimension of cultural cognition theory, hierarchy vs. egalitarianism. Like individualism vs. communitarianism, this 'Grid' dimension categorizes deeply held values about how an ideal society should be organized with important implications for risk assessment. The hierarchy/ egalitarian dimension is associated with the degree to which someone believes that an individual's choices are controlled and limited by their roles within society. People holding hierarchical values willingly accept the differential distribution of authority, rights, goods and roles based on "highly conspicuous and largely fixed characteristics such as gender, race, and class" (Kahan et al., 2012, p. 1). Their worldview affirms hierarchy and top-down authority as well as bottom-up obedience. Those who subscribe to egalitarian values believe in the equal distribution of wealth and power irrespective of the aforementioned characteristics (Kahan, Braman, Gastil, et al., 2007).

Methods and Materials

In study 4, a two by two factor design, 240 US-based participants were recruited for an online survey experiment through Mturk (54% female; M_{age} =38.23, SD_{age} = *11.40*) during spring 2018. Written informed consent was obtained from all participants and those passing attention filters received $.87 through their Mturk accounts. The experimental protocol and analyses were identical to those of study 3, except that the character in the stimuli text was either hierarchical or egalitarian (Appendix HH). Moreover, to ensure a balanced design in terms of sample, participants were pre-screened using the short-form versions of two 6-item scales measuring hierarchical (N = 125) egalitarian (N = 116) worldview dispositions (Kahan, Braman, Gastil, et al., 2007; Kahan, Braman, Slovic, et al., 2007).

Results

As in previous studies, we first assessed discriminant validity between the model's constructs using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015). All values were below the critical value of 0.90 (Henseler et al., 2015), and thus we conclude that the constructs are empirically distinct.

To test whether the messenger influences the three main measures of the proposed model (i.e. counterarguing, character identification, and risk perception), a two-way analysis of variance and results reveal a significant main effect of the messenger on counterarguing $F(1, 234) = 4.276$, $p = .04$, $\omega = .02$, as well as a significant interaction between the worldview of messenger and receiver on counterarguing $F(1, 234) = 153.525$, $p = .000$, $\omega = .40$. Planned contrasts revealed significant differences at both levels of the moderator: receivers with hierarchical worldviews counterargued more with egalitarian messengers ($M = 5.24$; $SE = .20$) than with hierarchical ones ($M = 3.40$; $SE = .20$), while receivers with egalitarian worldviews counterargued significantly more with hierarchical messengers ($M = 5.18$; $SE = .15$) than with egalitarian messengers ($M = 2.60$; $SE = .15$) (Figure 16).

There was no evidence of a significant main effect of messenger worldview on character identification; however, the results indicate a significant interaction between the worldview of the messenger and the receiver, which influenced identification $F(1, 235) = 57.52$, $p = .000$, $\omega = .20$. Planned contrasts revealed significant differences at both levels of the moderator: hierarchical receivers had significantly higher identification with a hierarchical messenger ($M = 4.93$; $SE = .18$) compared with an egalitarian messenger ($M = 3.88$; $SE = .14$), and egalitarian receivers identified more with an egalitarian messenger ($M = 5.42$; $SE = .14$) than the hierarchical messenger ($M = 4.02$; $SE = .13$) (Figure 17). Our results indicate that there is a main effect of the messenger's cultural worldview on risk perception $F(1, 235) = 4.86$, $p = .03$, $\omega = .02$ (Figure 18). Conditional process analysis was then conducted as described for studies

2-3. We can infer that the indirect effect of the messenger on risk perception through counterarguing and character identification differs significantly at different levels of the moderator, as indicated by the indices of moderated mediation: $a_1d_{21}b_2 = 0.56$, *SE* = .18; 95% bias-corrected *CI* [.229, .952] (see Appendix II for all path coefficients).

Discussion

The results of this study provide not only evidence of a direct effect of the messenger on risk perception but also support for the theory that value congeniality between messenger and story receiver reduces counterarguing and increases identification. When it comes to risk perception, we found that both hierarchical and egalitarian participants had higher risk perception when exposed to the story of the hierarchical messenger.

General Discussion

Based on the findings of this research, we posit that when it comes to communicating climate change risk, the messenger really is the message. The primary aim of climate change communications is usually to motivate concern and action-taking in the public, yet engagement is weak and significant portions of the public do not perceive or accurately assess the risk of the anthropogenic threat. Campaigns often take the form of informational narratives featuring scientists or other 'messengers' conveying the urgency of peer-reviewed evidence as if this was a fail-safe strategy with every audience. While knowledge and awareness play an important role in facilitating risk perception, scientific literacy does not predict belief on issues that carry social meaning. Humans are inclined to assimilate information in a biased manner when it threatens their identity, values or social affiliation. For some people, the risk of social alienation as a result of adopting views not congenial to one's in-group is (subconsciously) calculated as greater than the perceived risk of a distal threat the likes of climate change. In such

circumstances, motivated and identity-protective cognition may prevent the rational assimilation of information at the expense of factual accuracy. Providing additional information, even in the form of peer-reviewed evidence, is not likely to remedy resistance.

Recent research suggests that enrobing information in story structure that fosters the creation of emotional connection with characters may be a more effective way of overcoming these counterproductive tendencies. Stories trigger affective engagement and action taking through identification with story characters, yet little is known about how the perceived values of messengers in climate change stories influences post-narrative risk perception. We attempt to fill this gap by contributing new knowledge about how value congeniality between a messenger and a message receiver influences counterarguing, character identification and risk perception in the context of climate change.

Across four studies, our findings indicate that identification with a messenger indirectly influence a message receiver's risk perception. As predicted in our model, participants consistently counterargued *more*, and identified *less*, with messengers who did not share their own values or cultural worldview. Yet our findings paint a nuanced picture of how counterarguing and identification affect risk perception. In each study, we found that the more 'conservative' messenger was most effective for heightening risk perception. Groups typically associated with low levels of concern about climate change (i.e. religious, individualist, and hierarchists) had higher risk perception when exposed to a messenger who *shared* their values or worldview (i.e. were religious, individualist, and hierarchists), while groups associated with higher baseline levels of concern about climate change (i.e. non-religious, communitarians, egalitarians) reported increased risk perception when exposed to a messenger *who did not* share their values or worldview. In short, both groups were more alarmed and had greater risk perception when confronted with a story character who defies stereotypes about the type of person who cares about the threat of climate change.

For groups with low baseline levels of concern, we posit that through character identification, stories function as a form of cognitive rehearsal for belief change. Scientists and other groups associated with liberal values may not be persuasive to disengaged audiences due to a perceived lack of value congruence that results in a lack of identification. Perceived value congeniality, we posit, enables empathic connection and identification with characters who provide new scripts for how to engage with this issue while lowering the estimated likelihood of social alienation.

There are also limitations to the findings. To minimize noise and allow for balance in the samples, our experiments were carried out in an online setting using panel participants and a combination of naturalistic and controlled stimuli. Future research should address these weaknesses through the use of field studies, which would provide greater ecological validity. More, while risk perception is an important precursor to action taking, perceived self- and outcome efficacy also play important roles to this end. How does character identification influence efficacy? This should be investigated in future work. Finally, our measure of risk perception is an operationalization of risk perception and causal beliefs about climate change, not an objective measure. Future research would benefit from the use of more objective measures of risk perception such as behavior or physiologic response.

Conclusion

The findings of this research have important implications for communication practitioners and scholars alike. Using story characters who dare to diverge from ideological in-groups on an issue such as climate change without compromising their core values may provide message receivers with a greater sense of social 'safety' which allows them to resolve cognitive dissonance and more accurately assess the risk of climate change. Messengers

embodying values that affirm those of disengaged audience segments heightens risk perception with both in- and out-group audiences.

References

Barraza, J. A., Alexander, V., Beavin, L. E., Terris, E. T., & Zak, P. J. (2015). The heart of the story: peripheral physiology during narrative exposure predicts charitable giving. *Biol Psychol, 105*, 138-143. doi:10.1016/j.biopsycho.2015.01.008

Barrett, L. F. (2017). *How Emotions Are Made*. New York, NY: Houghton-Mifflin-Harcourt.

Campbell, T. H., & Kay, A. C. (2014). Solution aversion: On the relation between ideology and motivated disbelief. *Journal of Personality and Social Psychology, 107*(5), 809.

Cohen, G. L., Sherman, D. K., Bastardi, A., Hsu, L., McGoey, M., & Ross, L. (2007). Bridging the Partisan Divide : Self-Affirmation Reduces Ideological Closed-Mindedness and Inflexibility in Negotiation. *Journal of Personality and Social Psychology, 93*(3), 415-430. doi:10.1037/0022-3514.93.3.415

Cohen, J. (1988). Statistical power analysis for the behavioral sciences 2nd edn: Erlbaum Associates, Hillsdale.

Cohen, J. (2001a). Defining identification: A theoretical look at the identification of audiences with media characters. *Mass communication & society, 4*(3), 245-264.

Cohen, J. (2001b). Defining Identification: A Theoretical Look at the Identification of Audiences With Media Characters. *Mass Communication and Society, 4*(3), 245-264. doi:10.1207/S15327825MCS0403_01

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, N.J.: Routledge.

DeVellis, R. (2003). In L. Bickman & D. Rog (Series Eds.). *Applied Social Research Methods Series, 26*.

Ding, D., Maibach, E. W., Zhao, X., Roser-Renouf, C., & Leiserowitz, A. (2011). Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nature Climate Change, 1*(9), 462-466.

Douglas, M., & Wildavsky, A. (1982). *Risk and culture : an essay on the selection of technical and environmental dangers*. Berkeley: University of California Press.

Dryzek, J. S., Norgaard, R. B., & Schlosberg, D. (2011). *The Oxford handbook of climate change and society*. Oxford: Oxford University Press.

Earle, T. C., Siegrist, M., & Gutscher, H. (2010). Trust, risk perception and the TCC model of cooperation. *Trust in risk management: Uncertainty and scepticism in the public mind*, 1-50.

Erikson, E. H. (1994). *Identity: Youth and crisis*: WW Norton & Company.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods, 39*(2), 175-191.

Fiske, J. (1989). Popular television and commercial culture: Beyond political economy. *Television studies: Textual analysis*, 21-37.

Frank, D. (2017). Serial Mediation Macro for PROCESS.

Funk, C. (2017). Mixed Messages about Public Trust in Science. *Issues in Science & Technology, 34*(1), 86-88.

Funk, C., & Rainy, L. (2015). Public and Scientists' Views on Science and Society. Retrieved from doi:http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/

Green, M. C., & Brock, T. C. (2000). The Role of Transportation in the Persuasiveness of Public Narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. doi:10.1037/0022-3514.79.5.701

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.
Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115-135.
Jones, M. D. (2014). Cultural characters and climate change: How heroes shape our perception of climate science. *Social Science Quarterly, 95*(1), 1-39.
Jones, M. D., & Song, G. (2014). Making Sense of Climate Change: How Story Frames Shape Cognition. *Political Psychology, 35*(4), 447-476. doi:10.1111/pops.12057
Kahan, D. (2012a). Cultural cognition as a conception of the cultural theory of risk. In D. Kahan (Ed.), *Handbook of risk theory* (pp. 725-759): Springer.
Kahan, D. (2012b). Why we are poles apart on climate change. *Nature, 488*(7411), 255.
Kahan, D. M. (2012c). Cultural cognition as a conception of the cultural theory of risk *Handbook of risk theory* (pp. 725-759): Springer.
Kahan, D. M. (2017). 'Ordinary science intelligence': a science-comprehension measure for study of risk and science communication, with notes on evolution and climate change. *Journal of Risk Research, 20*(8), 995-1016. doi:10.1080/13669877.2016.1148067
Kahan, D. M., Braman, D., Gastil, J., Slovic, P., & Mertz, C. (2007). Culture and identity‐protective cognition: Explaining the white‐male effect in risk perception. *Journal of Empirical Legal Studies, 4*(3), 465-505.
Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2009). Cultural cognition of the risks and benefits of nanotechnology. *Nature nanotechnology, 4*(2), 87.
Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. L. (2007). The second national risk and culture study: Making sense of-and making progress in-the american culture war of fact.
Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147-174. doi:10.1080/13669877.2010.511246
Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*(10), 732-735.
Kahan, D. M., Wittlin, M., Peters, E., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. N. (2011). The Tragedy of the Risk-Perception Commons: Culture Conflict, Rationality Conflict, and Climate Change *Temple University Legal Studies Research Paper No. 2011-26; Cultural Cognition Project Working Paper No. 89; Yale Law & Economics Research Paper No. 435; Yale Law School, Public Law Working Paper No. 230.*
Kelman, H. C. (1961). Three processes of social influence. *Public Opinion Quarterly, 25*, 57-78.
Lee, T. M., Markowitz, E. M., Howe, P. D., Ko, C.-Y., & Leiserowitz, A. A. (2015). Predictors of public climate change awareness and risk perception around the world. *Nature Climate Change, 5*(11), 1014-1020. doi:10.1038/nclimate2728
Leiserowitz, A., Maibach, E., Roser-Renouf, C., Feinberg, G., & Rosenthal, S. (2015). Politics and global warming, fall 2015. *New Haven, CT: Yale Program on Climate Change Communication*.
Lin, P. Y., Grewal, N. S., Morin, C., Johnson, W. D., & Zak, P. J. (2013). Oxytocin increases the influence of public service advertisements. *PLoS One, 8*(2), e56934. doi:10.1371/journal.pone.0056934
Loewenstein, G. (2010). Insufficient Emotion: Soul-searching by a Former Indicter of Strong Emotions. *Emotion Review, 2*(3), 234-239. doi:10.1177/1754073910362598

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as Feelings. *Psychological Bulletin, 127*(2), 267-286. doi:10.1037/0033-2909.127.2.267
Morris, B. S., Chrysochou, P., Christensen, J., Orquin, J., Barraza, J. A., Zak, P. J., & Mitkidis, P. (2018a). Stories Trump Facts: Triggering Visceral Response to Climate Change *Working Paper*.
Morrison, M., Duncan, R., & Parton, K. (2015). Religion Does Matter for Climate Change Attitudes and Behavior. *PLoS One, 10*(8), e0134868. doi:10.1371/journal.pone.0134868
Moyer-Gusé, E., & Nabi, R. L. (2010). Explaining the Effects of Narrative in an Entertainment Television Program: Overcoming Resistance to Persuasion. *Human Communication Research, 36*(1), 26-52. doi:10.1111/j.1468-2958.2009.01367.x
Nabi, R. L., Moyer-Gusé, E., & Byrne, S. (2007). All joking aside: A serious investigation into the persuasive effect of funny social issue messages. *Communication Monographs, 74*(1), 29-54.
Oatley, K. (1995). A taxonomy of the emotions of literary response and a theory of identification in fictional narrative. *Poetics, 23*(1-2), 53-74.
Oatley, K. (1999). Meetings of minds: Dialogue, sympathy, and identification, in reading fiction. *Poetics, 26*(5-6), 439-454.
Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. *Advances in experimental social psychology, 19*, 123-205.
Ringle, C. M., Wende, S., & Becker, J.-M. (2015). SmartPLS 3. *Boenningstedt: SmartPLS GmbH, http://www. smartpls. com*.
Schwartz, S. H., & Bilsky, W. (1987). Toward a universal psychological structure of human values. *Journal of Personality and Social Psychology, 53*(3), 550.
Siegrist, M., Cvetkovich, G., & Roth, C. (2000). Salient value similarity, social trust, and risk/benefit perception. *Risk Analysis, 20*(3), 353-362.
Silvia, P. J. (2006). Reactance and the dynamics of disagreement: Multiple paths from threatened freedom to resistance to persuasion. *European Journal of Social Psychology, 36*(5), 673-685.
Slater, M. D., & Rouner, D. (2002). Entertainment—education and elaboration likelihood: Understanding the processing of narrative persuasion. *Communication Theory, 12*(2), 173-191.
Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis, 19*(4), 689-701.
Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis, 24*(2), 311-322. doi:10.1111/j.0272-4332.2004.00433.x
Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research, 177*(3), 1333-1352. doi:10.1016/j.ejor.2005.04.006
Tal-Or, N., & Cohen, J. (2010). Understanding audience involvement: Conceptualizing and manipulating identification and transportation. *Poetics, 38*(4), 402-418. doi:10.1016/j.poetic.2010.05.004
Tranter, B., & Booth, K. (2015). Scepticism in a changing climate: a cross-national study. *Global Environmental Change, 33*, 154-164.
vanLaer, T., Ruyter, K. d., Visconti, L. M., & Wetzels, M. (2014). The Extended Transportation-Imagery Model: A Meta-Analysis of the Antecedents and Consequences of Consumers' Narrative Transportation. *Journal of Consumer Research, 40*(5), 797-817. doi:10.1086/673383

Vraga, E., Myers, T., Kotcher, J., Beall, L., & Maibach, E. (2018). Scientific risk communication about controversial issues influences public perceptions of scientists' political orientations and credibility. *Royal Society Open Science, 5*(2). doi:10.1098/rsos.170505

Wildavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why? *Daedalus*, 41-60.

Wollheim, R. (1974). Identification and imagination.

Appendix Y

Stimulus Materials, Study 1

Video A: International Conservatives

Produced by the New York Times

Source: https://www.youtube.com/watch?v=IGTVFTxBI1s

Video B: Scientist

Produced by John Cook (School of Psychology and Director of Global Change Institute, University of Queensland, Australia)

Source: https://www.youtube.com/watch?v=91WzsaahZYY

Appendix Z

Full Measures

a.) Religiosity. Participant religiosity was measured with the items: *'How important is religion in your life?'* ('Center of my Life,' 'Very Important,' 'Moderately Important,' 'Not important, though I consider myself religious,' 'I am not religious'), *'What is your present religion, if any?'* ('Protestant,' 'Roman Catholic,' 'Mormon,' 'Eastern Greek Orthodox,' 'Jewish,' 'Muslim,' 'Buddhist,' 'Hindu,' 'Atheist,' 'Agnostic,' 'Nothing in particular,' 'Something else', *'Would you consider yourself as a "born again," or evangelical Christian, or not?'* ('Yes,' 'No').

b.) Counterarguing. To measure the tendency to generate critical or negative thoughts about a speaker's arguments, we used self-reported response on a 3-item scale (Silvia, 2006): *'While reading the text (watching the video), were you thinking of arguments that went against the author's arguments?'*, *'Were you criticizing the text (video) while reading (watching) it?'*, and *'While reading the text (watching the video), were you skeptical of the author's arguments?'*. Items were measured using a 7-point Likert scale where each point was labeled ('strongly disagree,' 'disagree,' 'somewhat disagree,' 'neither agree nor disagree,' 'somewhat agree,' 'agree,' 'strongly disagree').

Table 32
Means, Standard Deviations, and Cronbach's Alpha for Counterarguing, Studies 2-4

	Mean	*SD*	*Cronbach's α*
Study 2	3.214	1.377	.798
Study 3	3.743	1.403	.811
Study 4	4.065	1.774	.892

c.) Character identification. To measure the participant's experience of identification with the messenger, we used a 5-item scale (Cohen, 2001a; Tal-Or & Cohen, 2010) with the

following questions: *'I think I understood John well,' 'I understood the events in the story the way John understood them,' ' While reading (watching the video), I felt what John felt,' 'While reading (watching the video), I could really "get inside" John's head,' 'I understand why John did what he did.* Items were measured using a 7-point Likert scale where each point was labeled ('strongly disagree,' 'disagree,' 'somewhat disagree,' 'neither agree nor disagree,' 'somewhat agree,' 'agree,' 'strongly disagree'). Character identification was weakly correlated with counterarguing ($\alpha = 0.20$).

Table 33
Means, Standard Deviations, and Cronbach's Alpha for Character Identification, Studies 2-4

	Mean	*SD*	*Cronbach's α*
Study 2	4.486	1.148	.860
Study 3	4.790	1.119	.875
Study 4	4.596	1.354	.890

d.) Climate change risk perception. To cross-validate the one-item risk perception measure used as our main dependent variable, two belief items (2012a; Kahan, 2017) coded as dichotomous 'agree/disagree' measures were also included *'There is solid evidence that the average temperature on earth has been getting warmer over the past two decades'* and *'The earth is getting warmer mostly because of human activity such as burning of fossil fuels.'*

e. Political Measures. Two measures of political affiliation were presented, following the dependent variables, in order to prevent priming effects: *'Generally speaking, how do you think of yourself politically?'* (5-point Likert scale: 'very liberal,' 'liberal,' 'moderate,' 'conservative,' 'very conservative') and, *'Generally speaking, do you consider yourself as a…'* (7-point Likert scale: 'Strong Democrat,' 'Weak Democrat,' 'Independent Democrat,' 'Independent Independent,' 'Independent Republican,' 'Weak Republican,' 'Strong Republican.').

Appendix AA

Additional Results, Study 1

Table 34

Study 1 - Regression Coefficients, Standard Errors, and Model Summary Information for the Presumed Messenger Influence Serial Multiple Mediation Model Depicted in Figure 12

		Consequent									
		M_1 (CA)				M_2 (ID)				Y (RISK)	
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
X(MESSENGER)	a_1	- 0.314	0.090	.001	a_2	0.258	0.064	0.000	c'	- 0.301	0.075	0.000
M_1 (CA)		---	---	---	d_{21}	- 0.310	0.022	0.000	b_1	- 0.341	0.028	0.000
M_2 (ID)		---	---	---		---	---	---	b_2	0.572	0.036	0.000
Constant	i_{m1}	3.011	0.157	0.000	i_{m2}	6.271	0.131	0.000	i_y	3.999	0.273	0.000
		$R^2 = 0.211$				$R^2 = 0.227$				$R^2 = 0.482$		
		$F(5,1009) = 53.794$,				$F(6,1008) = 49.446$,				$F(7,1007) = 133.826$,		
		$p = 0.000$				$p = 0.000$				$p = 0.000$		

Note. Education and political ideology are included as covariates in the model.

Table 35

Means and Standard Errors, Counterarguing, Character Identification and Risk Perception, Study 1

Condition	Means (Standard Error)		
	Counterarguing	Character Identification	Risk Perception
Scientist	3.16** (.07)	5.12** (.05)	5.51 (.07)
Conservative	2.84 (.070)	5.48 (.05)	1.53 (.07)

Note. ** $p < .001$; ***$p < 0.001$

Table 36

Descriptive statistics and correlations

	M	SD	1	2
1. Counterarguing	3.00	1.60		
2. Character Identification	5.30	1.15	- .46**	
3. Risk Perception	5.52	1.62	-.57**	.58**

Note. ** $p < .001$; ***$p < 0.001$

Appendix BB

Stimuli Study 2

Religious Condition

My name is John and I am a proud American. I'm very involved in my church, and faith is an important part of my life. I have always been skeptical that human activity can affect the climate - until our pastor presented the evidence that changed his mind, and which eventually caused me to change my mind too.

Non-Religious Condition

My name is John and I am a proud American. I'm not religious but being a good person is an important part my life. I have always been skeptical that human activity can affect the climate - until someone I respect presented the evidence that changed his mind, and which eventually caused me to change my mind too.

Appendix CC

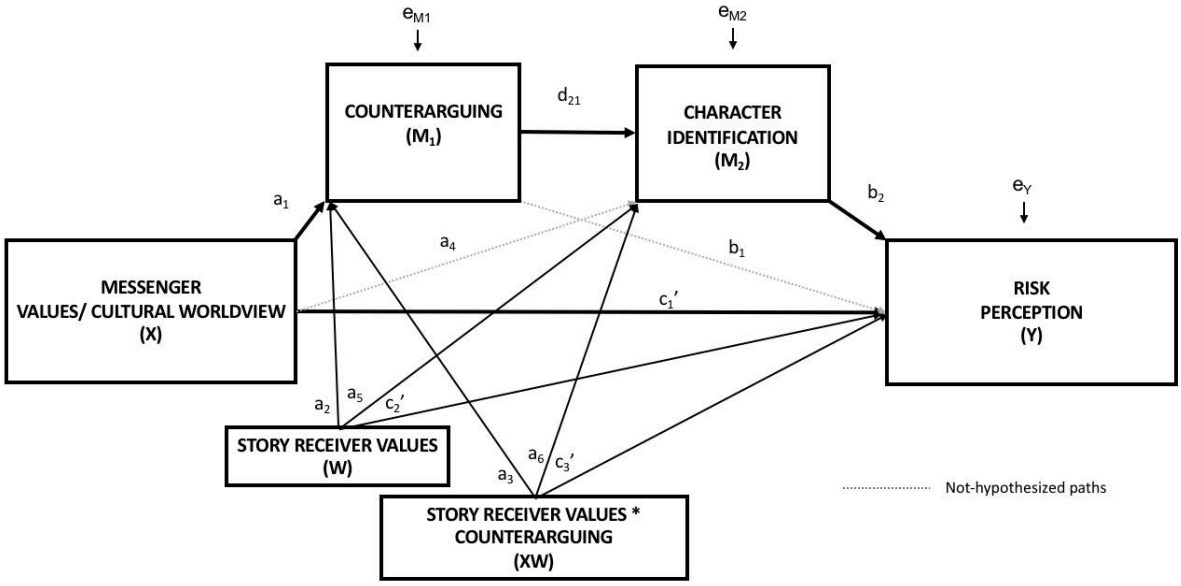


Figure 19. Statistical representation of the conditional process model depicting moderated serial mediation of an indirect effect of messenger values on risk perception

Appendix DD

Table 37

Study 2 - Path Coefficients, Standard Errors, and Model Summary Information for the Presumed Messenger Influence Moderated Serial Multiple Mediation Model Depicted in Figure 12.

		Consequent									
		Counterarguing (M_1)				Character Identification (M_2)				Risk Perception (Y)	
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Messenger (X)	a_1	.982	.262	.000	a_4	-.512	.211	.016	c_1'	.508	.346	.145
Counterarguing (M_1)		---	---	---	d_{21}	-.295	.053	.000	b_1	.026	.093	.783
Character ID (M_2)		---	---	---		---	---	---	b_2	.331	.111	.003
Story Receiver Values (W)	a_2	.653	.258	.012	a_5	-.142	.205	.488	c_2'	-.401	.332	.228
Interaction												
Story Receiver Values x Counterarguing (M_1 * W)	a_3	-1.175	.366	.002	a_6	.714	.292	.015	c_3'	-.284	.481	.555
Covariate 1 - Age	V_{m1}	.003	.009	.734	V_{m2}	-.006	.007	.374	V_y	-.022	.011	.038
Covariate 2 - Gender	Z_{m1}	-.223	.183	.225	Z_{m2}	-.015	.143	.919	Z_y	.449	.233	.055
Constant	i_{m1}	2.692	.371	.000	i_{m2}	5.806	.323	.000	i_y	4.294	.831	.000
		$R^2 = .071$				$R^2 = .190$				$R^2 = .103$		
		$F(5,214) = 3.273$				$F(6,213) = 8.316$				$F(7,212) = 3.469$		
		$p = .007$				$p = .000$				$p = .002$		

Appendix EE

Stimuli Study 3

Individualist Condition

My name is John and I am a proud American who believes we need a small government that protects individual freedoms and promotes personal responsibility. It's not the government's job to interfere or tell people how to live their lives. I have always been skeptical that human activity can affect the climate - until a close friend told me that he'd seen enough evidence to change his mind. He also told me about some of the smart, free-market solutions that would allow America to lead the way in addressing climate change without killing economic growth. In the end, I have to admit that I was convinced and actually ended up changing my mind on this issue.

Communitarian Condition

My name is John and I'm a proud American who believes we need a progressive government that protects the public interest and promotes fairness. It's the government's job to put limits on individual freedoms when they get in the way of what's good for everyone in society. I have always been skeptical that human activity can affect the climate - until a close friend told me that he'd seen enough evidence to change his mind. He also told me about some of the smart regulations that would address climate change in cooperation with other nations. In the end, I have to admit that I was convinced and actually ended up changing my mind on this issue.

Appendix FF

Cultural Worldview Measures, Studies 3 and 4

We measure dispositions towards Individualism/Communitarianism and Hierarchy/Egalitarianism using the short-form versions of two 6-item scales developed by (Kahan, Braman, Slovic, et al., 2007)

Table 38
Cultural Worldview Items, Short-Form

Individualism – Communitarianism (Individualism)	
IINTRSTS	The government interferes far too much in our daily lives.
CHARM	Sometimes the government needs to make laws that keep people from hurting themselves.
IPROTECT	It's not the government's job to try to protect people from themselves.
IPRIVACY	The government should stop telling people how to live their lives.
CPROTECT	The government should do more to advance society's goals, even if that means limiting the freedom and choices of individuals.
CLIMCHOI	Government should put limits on the choices individuals can make so they don't get in the way of what's good for society.

Hierarchy - Egalitarianism (Hierarchy)	
HEQUAL	We have gone too far in pushing equal rights in this country.
EWEALTH	Our society would be better off if the distribution of wealth was more equal.
ERADEQ	We need to dramatically reduce inequalities between the rich and poor, whites and people of color, and men and women.

Hierarchy - Egalitarianism (Hierarchy)	
EDISCRIM	Discrimination against minorities is still a very serious problem in our society.
HREVDIS2	It seems like blacks, women, homosexuals and other groups don't want equal rights, they want special rights just for them.
HFEMIN	Society as a whole has become too soft and feminine.

Appendix GG

Table 39

Study 3 - Path Coefficients, Standard Errors, and Model Summary Information for the Presumed Messenger Influence Moderated Serial Multiple Mediation Model Depicted in Figure 12.

		Consequent									
		Counterarguing (M_1)				Character Identification (M_2)				Risk Perception (Y)	
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Messenger (X)	a_1	.259	.239	.278	a_4	-.065	.168	.698	c_1'	.488	.302	.107
Counterarguing (M_1)		---	---	---	d_{21}	-.414	.044	.000	b_1	-.141	.091	.121
Character ID (M_2)		---	---	---		---	---	---	b_2	.301	.111	.007
Story Receiver Values (W)	a_2	.618	.242	.011	a_5	-.092	.172	.594	c_2'	-.013	.310	.968
Interaction												
Story Receiver Values x Counterarguing (M_1 * W)	a_3	-1.212	.335	.000	a_6	.163	.242	.450	c_3'	-.678	.434	.120
Covariate 1 - Age	V_{m1}	-.011	.007	.154	V_{m2}	-.010	.005	.055	V_y	-.009	.009	.334
Covariate 2 - Gender	Z_{m1}	.023	.173	.883	Z_{m2}	-.023	.122	.852	Z_y	.102	.218	.642
Constant	i_{m1}	3.962	.311	.000	i_{m2}	6.753	.279	.000	i_y	4.130	.902	.000
		$R^2 = .073$				$R^2 = .280$				$R^2 = .088$		
		$F(5,261) = 4.113$				$F(6,260) = 16.866$				$F(7,259) = 3.568$		
		$p = .001$				$p = .000$				$p = .001$		

Appendix HH

Stimuli, Study 4

Hierarchical Condition

My name is John. I am a proud American but our society has gone soft! Trying to give everyone equal rights and distribute wealth more equally isn't right. The world isn't fair and trying to make it that way is unrealistic. I have always been skeptical that human activity can affect the climate, until a close friend with similar views told me that he'd seen enough evidence to change his mind. He also told me about leaders with traditional values who are proposing smart ideas for addressing climate change. I have to admit that I was convinced and actually ended up changing my mind on this issue.

Egalitarian Condition

My name is John. I am a proud American but we have a long way to go to promote fairness in our society! It's our duty to protect against discrimination and the world would be a much better place if wealth was distributed more equally. I have always been skeptical that human activity can affect the climate, until a close friend with similar views told me that he'd seen enough evidence to change his mind. He also told me about progressive leaders who are proposing smart ideas for addressing climate change. I have to admit that I was convinced and actually ended up changing my mind on this issue.

Appendix II

Table 40

Study 4 - Path Coefficients, Standard Errors, and Model Summary Information for the Presumed Messenger Influence Moderated Serial Multiple Mediation Model Depicted in Figure 12

		Consequent									
		Counterarguing (M_1)				Character Identification (M_2)				Risk Perception (Y)		
Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Messenger (X)	a_1	2.578	.211	.000	a_4	-.289	.217	.185	c_1'	.662	.273	.016
Counterarguing (M_1)		---	---	---	d_{21}	-.430	.053	.000	b_1	-.032	.075	.667
Character ID (M_2)		---	---	---		---	---	---	b_2	.296	.081	.000
Story Receiver Values (W)	a_2	2.640	.257	.000	a_5	-.403	.249	.107	c_2'	-2.761	.314	.000
Interaction												
Story Receiver Values x Counterarguing (M_1 * W)	a_3	-4.417	.357	.000	a_6	.551	.369	.137	c_3'	-.392	.464	.398
Covariate 1 - Age	V_{m1}	-.002	.008	.848	V_{m2}	-.005	.006	.456	V_y	-.008	.008	.277
Covariate 2 - Gender	Z_{m1}	-.345	.175	.050	Z_{m2}	-.406	.142	.005	Z_y	-.193	.181	.286
Constant	i_{m1}	2.845	.328	.000	i_{m2}	6.930	.303	.000	i_y	4.886	.683	.000
		R^2 = .464				R^2 = .41				R^2 = .580		
		$F(5,234) = 40.533$				$F(6,233) = 26.909$				$F(7,232) =$		
		$p = .000$				$p = .000$				$p = .000$		

Appendix JJ

Table 41

Means and Standard Errors for Counterarguing, Character Identification, and Risk Perception, Studies 2-4

Study/Messenger **Condition**	Means (Standard Error)		
	Counterarguing	Character Identification	Risk Perception
Study 2			
Religious	3.402 (.135)	4.359 (.117)	5.405 (.164)
Non-Religious	3.021 (.125)	4.615 (.100)	5.101 (.171)
Study 3			
Individualist	3.825 (.130)	4.658 (.106)	4.848 (.184)
Communitarian	4.261 (.138)	4.286 (.113)	4.474 (.189)
Study 4			
Hierarchist	4.551 (.142)	4.333 (.111)	5.152 (.171)
Egalitarian	3.546 (.169)	4.879 (.132)	4.819 (.195)

Appendix KK

Table 42

Means, alpha's, Standard Deviations for Counterarguing, Character Identification, Risk Perception, Studies 1-4

	Counterarguing			Character Identification			Risk Perception		
	α	Mean	*SD*	α	Mean	*SD*	α	Mean	*SD*
Study 1	.85	3.00	1.60	.88	5.30	1.15	1	5.52	1.62
Study 2	.80	3.21	1.38	.86	4.89	1.15	1	5.25	1.76
Study 3	.81	3.74	1.40	.88	4.79	1.12	1	4.86	1.78
Study 4	.89	4.07	1.77	.89	4.60	1.35	1	4.99	2.00

Table 43

Bivariate Correlations for Risk Perception, Composite Measures of Counterarguing & Character Identification – Study 2

	Counterarguing	Character Identification	Risk Perception
Counterarguing	1	-.393**	-0.052
Character Identification		1	.180**
Risk Perception			1

Note. $^{**}p < .01$; $^{*}p > .05$

Table 44

Bivariate Correlations for Risk Perception, Composite Measures of Counterarguing & Character Identification – Study 3

	Counterarguing	Character Identification	Risk Perception
Counterarguing	1	-.517**	-0.187**
Character Identification		1	0.239**
Risk Perception			1

Note. $^{**}p < .01$; $^{*}p > .05$

Table 45

Bivariate Correlations for Risk Perception, Composite Measures of Counterarguing & Character Identification – Study 4

	Counterarguing	Character Identification	Risk Perception
Counterarguing	1	-6.13**	-0.152*
Character Identification		1	0.239**
Risk Perception			1

Note. $^{**}p < .01$; $^{*}p > .05$

Chapter 4
Discussion & Conclusion

Climate change is one of the most urgent threats facing humanity yet public engagement is weak, and science communicators struggle to craft appeals that actually influence individual beliefs, attitudes and behavior. While much is known about how individuals process risk and assimilate information on this issue, there is also a gap in our understanding of how these intersect and interact to influence engagement through real-world communication campaigns. There is a rich body of research studying the biased assimilation of climate change information; however, there is very little work examining how structuring these narratives as stories might help to improve engagement. This thesis takes a step towards filling that gap by answering the following research questions:

- Are climate change narratives structured as stories better than analytical frames for promoting pro-environmental behavior and engagement with climate change?

- Do stories with negative affective end valence increase climate change risk perception and outcome efficacy more than those with positive affective end valence?

- Does perceived value congeniality between a story character and receiver heighten climate change risk perception?

Explicating the findings of 11 experiments, the overarching purpose of this dissertation was to contribute to a better understanding of how climate change communications structured as stories might impact key measures of engagement such as risk perception, efficacy, and pro-

environmental behavior. Each experiment I conducted supports this purpose by examining the underlying mechanisms of story from a different angle.

More specifically, the dissertation makes three contributions to the existing literature. First, it advances our understanding of how narrative structure influences pro-environmental behavior in the context of climate change. Second, it brings new insights into the role of affective valence at the end of stories in fostering risk perception and a sense of individual outcome efficacy. Third, the work deepens our understanding of how value congeniality between story characters in climate change narratives influence risk perception in ideologically diverse audience segments. Here, I elaborate on each contribution and how they might inform practitioner work. The dissertation finishes with outlining some limitations of this work and offers suggestions for future research.

4.1 Narrative Structure & Action on Climate Change

The majority of climate change communications are structured as informational narratives. Climate change is a cognitively complex and psychologically distant threat and, while there is no doubt that knowledge and problem awareness are important precursors to engagement (van der Linden, Leiserowitz, Feinberg, & Maibach, 2014, 2015), they are insufficient to motivate affect and action taking - especially in the face of motivated- and identity-protective cognition (Kahan, 2013c). A central proposition of this work is that stories will be more effective at overcoming these barriers than informational narratives because, through narrative transportation, they facilitate affective engagement and experiential processing rather than cognitive elaboration.

In two laboratory studies, I found that climate change narratives structured as stories outperformed analytical frames for motivating pro-environmental behavior (e.g., make a donation to a charity fighting climate change, recycle, and subscribe to a Greenpeace

newsletter). Furthermore, the results of a follow-up study revealed that the treatment effect of stories persisted for at least six weeks, post-experiment. These findings stand in contrast to work by Jones (2014) which observed no effect of structure in climate change 'narratives' (the term they use for stories) versus 'non-narratives' (lists of facts) on narrative transportation or acceptance of policy solutions. Critically, however, the experimental treatment (i.e., stories) used by Jones would not fulfill the definition of story used in this work. Jones reflects on the likelihood that his non-findings are due to a lack of "artistry" in the stimuli but in reviewing these treatments, it was clear to this author that their 'story' narratives would have been categorized as informational frames according to the definition and criteria set within this work: "a detailed, character-based narration of a character's struggles to overcome obstacles and reach an important goal" (Haven, 2007, p. 79). Essential story features include an identifiable character, plot (temporal dimension, goal), and setting. Among other things, the 'stories' used by Jones lack a clearly identifiable character – one of the key mechanisms whereby stories are thought to exert their influence.

Another important outcome from this research pertains to the finding that participants exposed to informational narratives about climate change actually performed *fewer* pro-environmental behaviors than those in a control group. This is thought-provoking and may indicate that cognitive elaboration without affective engagement causes a form of psychic numbing that stunts risk perception and action taking.

It should be noted that while narrative structure did influence self-reported narrative transportation in an online environment, it did not predict an increased willingness to donate time to help fight climate change. One probable explanation is the online setting in which the study was conducted. A high percentage of Mturk workers are professional survey takers (Stewart et al., 2015) and likely to be cynical about requests for participation outside the Mturk environment. Unlike prior work (Chen, 2015; Green, 1996; Green & Brock, 2000), I found no

evidence that self-reported narrative transportation predicted post-treatment influence. This is not to say that participants were not transported. Rather, it confirms that self-report is an unreliable measure of an immersive psychological experience. Instead, the results of this work suggest that measures of autonomic reactivity indicative of affective engagement are stronger, more objective measures of narrative transportation and experiential processing. The implications for practitioners who want to practice an evidence-based approach to climate change communication are clear: stories are more effective than informational narratives for fostering experiential processing and affective engagement which predict action taking in the face of risk.

4.2 Affective Engagement & Risk Perception

The results of this work suggest that climate change stories stand a better chance than analytical narratives at influencing pro-environmental behavior, risk perception, and outcome efficacy because they trigger affective engagement, as indicated by activation of the autonomic nervous system (ANS). The use of emotion in climate change appeals is currently a hot topic among science communicators (Chapman, Lickel, & Markowitz, 2017), with some claiming that negative affect fosters public paralysis. Negative affect is a form of cognitive discomfort and serves as a warning sign that bodily action may be necessary to optimize metabolic resources. People are positive affect maximizers and will willingly choose situations with objectively more overall pain as long as the event ends with relatively less pain (Do, Rupert, & Wolford, 2008; Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993).

More specifically, in one study I found that climate change stories with negatively valenced *endings* influence pro-environmental behavior by increasing inter-beat (RR) intervals. This finding aligns with prior work proposing a relationship between negative emotional valence and heart rate deceleration (Bolls, Lang, & Potter, 2001; Lang, Newhagen,

& Reeves, 1996) as well as increased autonomic arousal (Potter & Bolls, 2012). Negative valence has been shown to have a more enduring effect on heart rate response compared with positive emotion (Brosschot & Thayer, 2003), which may help explain why participants who experienced cardiac deceleration also exhibited increased pro-environmental behavior. They are also in line with research suggesting that fluctuations in cardiac activity are associated with attentional allocation (Potter & Bolls, 2012) and emotional arousal (Mitkidis, McGraw, Roepstorff, & Wallot, 2015), key determinants of empathic and sympathetic responses (Dickert & Slovic, 2009). The finding that heart rate deceleration leads to increased pro-environmental behavior likely reflects emotional arousal *in tandem with* cognitive processing, culminating in a calculated form of autonomic response to a distal threat. It is noteworthy that analytical narratives did not evoke this same autonomic response.

The results of the three survey experiments presented in Paper B indicate that negative affective endings in climate change stories yielded higher emotional arousal and risk perception for all audiences, but particularly among those segments typically disengaged with this issue (i.e., conservatives and those holding individualist and hierarchical worldviews). Moreover, there is a strong association between risk perception and efficacy where high threat appraisal and low efficacy have the potential to discourage action taking. When people have a sense of low efficacy, they will avoid further information to reduce negative affect (Witte & Allen, 2000).

In study 4 of Paper B, I found that negative- and extremely negative affective endings fostered a greater sense of outcome efficacy (i.e., the sense that their own behavior influences climate change) in all ideological groups, than did positive affective endings. However, there were significant differences in how *degrees of affective negativity* influenced emotional arousal and outcome efficacy in ideologically diverse groups. Political moderates, communitarians, and egalitarians were more inclined to believe their own behavior made a difference to climate

change when exposed to messages with 'apocalyptic' end valence. Most other audiences, however, had a higher sense of outcome efficacy when treated with the non-apocalyptic, but still negative, affective endings. Liberal audiences were the only group who reported their highest efficacy levels in the face of positive affective endings.

As was true for the studies on emotional arousal and risk perception, the effects of negative affect on emotional arousal and efficacy were particularly pronounced in conservative audiences. Self-reported emotional arousal was highest in the doom condition (followed by negative) for moderates, liberals, communitarians, and egalitarians while conservatives, individualists and hierarchists reported the negative condition more arousing. These results undermine the hypothesis that "fear appeals" necessarily hinder efficacy (e.g., O'Neill & Nicholson-Cole, 2009) but also raise additional questions about the relationship between the two. These findings are in line with prior work positing that receptivity to new information as a result of negative affect is a form of danger-control mechanism (Witte & Allen, 2000) and suggest that human reliance on negative affect as the impetus for action is not a mere vestige of our evolutionary past, but an influential mechanism for how we process information and risk to this day. Unfortunately, it appears that positive and hopeful messages make us dangerously content with the status quo, impervious to the risks we face.

Taken together, these findings hold numerous implications for policymakers and climate change communicators. Climate change messaging with positive affective endings may encourage a sense of hope in the public but will not likely cause the levels of concern that lead to engagement and action. The optimal levels of negative affect vary across ideologically diverse audiences as values influence what we fear and why (Slovic, Finucane, Peters, & MacGregor, 2004). Appeals with apocalyptic endings may create engagement in moderate- and left-of-moderate audiences, but they are likely to backfire in audiences with conservative values.

An interesting finding, unrelated to the expectations outlined in the conceptual model presented in paper B, pertains to the understanding of how various media interact with affective valence to influence arousal and risk perception. The results of study 2 in Paper B suggest that communicators would do well to carefully reflect on trade-offs between the vividness of video and how the noise of a multi-sensory medium may boost baseline levels of emotional arousal and undermine the treatment effect.

Taken together, these findings are in line with prior work suggesting that the human propensity to attend more to negative affect is an evolutionarily adaptive response to attentional prioritization (Griffin et al., 2008; Kahlor, 2010).

4.3 Value Congeniality & Character Identification

Another contribution of this work is that it has advanced our understanding of how value congeniality between a climate change story messenger and story receiver influences risk perception. In many countries, an individual's stance on climate change has become an important identity cue (Kahan, Braman, Slovic, Gastil, & Cohen, 2007) and people are therefore apt to process information in a biased way that confirms their values and social affiliation (Kahan, 2013c, 2015, 2017; Kahan, Jenkins-Smith, & Braman, 2011; Kahan et al., 2012; Kahan, Wittlin, et al., 2011).

As discussed throughout this dissertation, stories are more effective at overcoming resistance because they help integrate experiential and analytical processing through affective engagement shown in prior work to be critical for the rational assimilation of information and risk assessment (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic et al., 2004). This experiential processing is qualitatively different to cognitive elaboration that encourages scrutiny to arguments. Instead, stories trigger emotional engagement through identification

with story characters (Cin, Gibson, Zanna, Shumate, & Fong, 2007; Cohen, 2001; Green, 1996, 2004; vanLaer, Ruyter, Visconti, & Wetzels, 2014).

The findings of study 1 in Paper C suggest that scientists are not ideal climate change messengers. Even after controlling for age, gender, education and political ideology, the public counterargued more, and identified less with scientists than with conservative international politicians. Given the frequency with which scientific credentials are invoked within the domain of climate change, the practical implications of these findings are sobering. This is not to claim that scientists will never be effective messengers, only that perceived value congeniality likely matters more on issues characterized by ideological polarization. While scientists are among the most trusted societal groups in a broader sense, research suggests that they are automatically associated with the political leanings of polarized issues. Climate change is strongly associated with liberal ideology and by extension, climate scientists (Funk & Rainy, 2015). When it comes to the effectiveness of messengers in climate change, it appears that value congeniality may trump academic pedigree.

Studies 2-4 in Paper C found that audience segments not typically concerned about the risk of climate change (i.e., religious, individualist and hierarchical worldviews) had higher risk perception when they encountered characters who shared their own ideological commitments, whereas the opposite held true for people from liberal audience segments (i.e., non-religious, communitarian and egalitarian worldviews). The finding that value alignment influences assimilation of information replicates work by Kahan and colleagues (e.g., Kahan, 2013c; Kahan, 2017) but the present studies advance our understanding of this mechanism by demonstrating the value of misalignment as well. In every case, my data suggests that all audiences counterargued more, and identified less, with those who did not share their values and worldview. However, for skeptical and disengaged segments, this translated into lower risk perception. Across four studies I found that the most ideologically conservative messengers

heightened risk perception, not only among those who share these values, but also among those who did not.

The main practical implication for climate change communicators and policymakers is that there is no magical one-size-fits-all story character that works for all people and audiences. With that said, climate change story characters who project value congeniality with the most skeptical and disengaged audience segments will likely be the most effective across diverse ideological audiences. In the United States, roughly 30 percent of the population (Leiserowitz, 2017) are skeptical that climate change is human-caused and it is crucial to gain the support of these disengaged groups in order to sustain international mitigation efforts. Religious messengers, as well as those holding individualist and hierarchical worldviews about how society should be ordered stand the best chance at convincing people about the urgency of climate change – even with audiences with whom their values are misaligned. It appears that there is little benefit to using climate change messengers who embody an ideologically liberal worldview as this only increases reactance among the disengaged segments. Messengers who affirm conservative values and worldviews, however, create a greater sense of urgency in all audiences. This strategy offers disengaged audiences the opportunity for observational learning and cognitive rehearsal through connections with in-group messengers whom they can trust to uphold their own ideological commitments and goals.

4.4 Limitations and Future Research

Despite immense attention given to the rigor and reliability of the design, execution, and analysis of this research, there are certainly limitations to this work. Some of the most important constraints pertain to study design, and are the downside of a methodological strength. Many of these are discussed in Chapter 2 but I will point out a few specifics here as they are important to the validity of these conclusions.

The experiments presented in this thesis were all conducted in the controlled environments of laboratory or online settings. Online panels were used extensively throughout this research as an attempt to recruit ideologically diverse samples that include climate change skeptics and those with low levels of engagement. Mturk is a valuable and cost-effective tool that allowed me to gain greater variation in my samples than would typically be afforded by university student convenience samples. However, the environment also presents challenges. For one thing, the panel tends to skew liberal (Huff & Tingley, 2015; Kahan, 2013a, 2013b). For another, there is mixed evidence about the quality of data derived from Mturk samples. Some empirical work suggests that Mturk workers are more attentive than undergraduate students irrespective of remuneration levels (Andersen & Lau, 2018), while other others indicate high rates of dishonesty and cheating (Peer, Brandimarte, Samat, & Acquisti, 2017). Wherever possible, I attempted to mitigate these potential drawbacks by 1) scattering attention checks throughout, 2) recruiting an ideologically balanced sample (e.g., studies B3, C2-4), 3) replicating the study within the same environment, and 4) replicating the study in a different environment using a nationally representative panel such as YouGov (e.g., study B4). Given the important implications for practitioners, further research could replicate these experiments in field studies, adding external validity to the findings.

Another limitation is that most of the data presented in the dissertation is cross-sectional. As such, we cannot draw inferences about the duration of the treatment effects. The one exception is study A1, where we observed an effect of story treatment in a follow-up survey six weeks after the main experiment. Nevertheless, it is doubtful that the treatment effect persists after a single message exposure. Future work should investigate the temporal aspects of how narrative structure, end valence and value congeniality influence risk perception and behavior in the long run.

A further shortcoming relates to the use of dichotomous variables to describe nuanced constructs such as affective valence, values or worldviews. The findings of studies B1-B4 suggest that negative affect was more influential on risk perception and efficacy than positive affect. This binary view of affect is an oversimplification of a complex reality and future research should investigate how various combinations of affective valence at different points throughout stories, influences engagement. Likewise, binary characterizations of participant values as either religious or non-religious, individualists or communitarians, hierarchists or egalitarians in studies B1-B4 and C2-C4, represents on oversimplification. In reality, the values and worldviews people hold vary along a continuum that is rarely conducive to dichotomous categorization. Future work could investigate levels and combinations of, for example, religiosity or a preference for hierarchy in societal ordering.

Finally, a number of the experiments presented in the dissertation used self-report measures. These have important limitations when it comes to providing insights into highly complex, immersive, largely sub-conscious, psychological processes such as narrative transportation, emotional arousal and risk perception. Whenever possible I triangulated measures but future research should consider doing this with additional objective measures such as psychophysiology and behavior.

4.5 Conclusion

I have argued that the conventional approach to fostering engagement with climate change using informational appeals does not sufficiently acknowledge what science tells us about how humans process information and assess risk. This implies a need for a change in paradigm in terms of how communicators and policymakers approach fostering public engagement. In line with (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007), this work has utilized a definition of engagement which includes cognitive, affective, and behavioral involvement with the issue.

The eleven studies contained in this dissertation have identified three main mechanisms that could be used to improve the development of public appeals. In conclusion, this research advances our understanding of how narrative structure influences engagement with climate change through emotional arousal, which likely incites pro-environmental behavior as the brain's way of optimizing bodily budgets. These findings have important implications for science communication scholars and practitioners alike. In a twist of irony, structuring narratives as factual presentations ignores what science tells us about the important role of affective and emotional engagement for optimizing communication and decision-making. To maximize the likelihood of action taking, our results suggest that science communicators should consider enrobing the presentation of information in story structure instead. Further, the research presented in this dissertation strongly urges climate change communicators not to shy away from the use of negative affective endings in their appeals, as most audiences are (apparently) unmotivated to take the threat seriously when faced with optimistic endings.

At the same time, this work highlights the need for sophisticated audience segmentation and customized messaging which frames climate change appeals in ways that acknowledge ideological differences in how risk is processed. Communicators should be aware of potential backfire from the use of apocalyptic affective endings with certain audiences. More specifically, to heighten risk perception in disengaged audiences, these results suggest using messengers that affirm the closely held values and cultural worldviews of conservative, individualist and hierarchical audiences. These messengers, it turns out, not only increase risk perception in audiences who share their values, but also in liberal audiences with high baseline levels of concern about the threat of climate change. In summary, the findings presented in this dissertation urge science communicators to embed climate change information into narratives structured as stories with negative endings and characters espousing conservative ideological commitments.

References

Andersen, D. J., & Lau, R. R. (2018). Pay Rates and Subject Performance in Social Science Experiments Using Crowdsourced Online Samples. *Journal of Experimental Political Science*, 1-13. doi:10.1017/XPS.2018.7

Bolls, P. D., Lang, A., & Potter, R. F. (2001). The Effects of Message Valence and Listener Arousal on Attention, Memory, and Facial Muscular Responses to Radio Advertisements. *Communication Research, 28*(5), 627-651. doi:10.1177/009365001028005003

Brosschot, J. F., & Thayer, J. F. (2003). Heart rate response is longer after negative emotions than after positive emotions. *International Journal of Psychophysiology, 50*(3), 181-187. doi:10.1016/S0167-8760(03)00146-6

Chapman, D. A., Lickel, B., & Markowitz, E. M. (2017). Reassessing emotion in climate change communication. *Nature Climate Change, 7*(12), 850-852. doi:10.1038/s41558-017-0021-9

Chen, T. (2015). The persuasive effectiveness of mini-films: Narrative transportation and fantasy proneness. *Journal of Consumer Behaviour, 14*(1), 21-27. doi:10.1002/cb.1494

Cin, S. D., Gibson, B., Zanna, M. P., Shumate, R., & Fong, G. T. (2007). Smoking in Movies, Implicit Associations of Smoking with the Self, and Intentions to Smoke. *Psychological Science, 18*(7), 559-563. doi:10.1111/j.1467-9280.2007.01939.x

Cohen, J. (2001). Defining Identification: A Theoretical Look at the Identification of Audiences With Media Characters. *Mass Communication and Society, 4*(3), 245-264. doi:10.1207/S15327825MCS0403_01

Dickert, S., & Slovic, P. (2009). Attentional mechanisms in the generation of sympathy. *Judgment and Decision Making, 4*(4), 297-306.

Do, A. M., Rupert, A. V., & Wolford, G. (2008). Evaluations of pleasurable experiences: The peak-end rule. *Psychonomic Bulletin & Review, 15*(1), 96-98.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of behavioral decision making, 13*(1), 1-17.

Funk, C., & Rainy, L. (2015). Public and Scientists' Views on Science and Society. Retrieved from doi:http://www.pewinternet.org/2015/01/29/public-and-scientists-views-on-science-and-society/

Green, M. C. (1996). *Mechanisms of narrative-based belief change.* The Ohio State University. Retrieved from http://rave.ohiolink.edu/etdc/view?acc_num=osu1235579429

Green, M. C. (2004). Transportation Into Narrative Worlds: The Role of Prior Knowledge and Perceived Realism. *Discourse Processes, 38*(2), 247-266. doi:10.1207/s15326950dp3802_5

Green, M. C., & Brock, T. C. (2000). The Role of Transportation in the Persuasiveness of Public Narratives. *Journal of Personality and Social Psychology, 79*(5), 701-721. doi:10.1037/0022-3514.79.5.701

Griffin, R. J., Yang, Z., Ter Huurne, E., Boerner, F., Ortiz, S., & Dunwoody, S. (2008). After the flood: Anger, attribution, and the seeking of information. *Science Communication, 29*(3), 285-315.

Haven, K. F. (2007). *Story Proof: the science behind the startling power of story*. Westport, CT: Libraries Unlimited.

Huff, C., & Tingley, D. (2015). "Who are these people?" Evaluating the demographic characteristics and political preferences of MTurk survey respondents. *Research & Politics, 2*(3), 2053168015604648.
Jones, M. D. (2014). Communicating Climate Change: Are Stories Better than "Just the Facts"? *Policy Studies Journal, 42*(4), 644-673. doi:10.1111/psj.12072
Kahan, D. (2013a). Fooled twice, shame on who? Problems with Mechanical Turk samples, Part 2.
Kahan, D. (2013b). What's a valid sample? Problems with Mechanical Turk Samples, Part 1.
Kahan, D. M. (2013c). Ideology, motivated reasoning, and cognitive reflection. *Judgment and Decision Making, 8*(4), 407-424.
Kahan, D. M. (2015). Climate-Science Communication and the Measurement Problem. *Political Psychology, 36*(S1), 1-43. doi:10.1111/pops.12244
Kahan, D. M. (2017). 'Ordinary science intelligence': a science-comprehension measure for study of risk and science communication, with notes on evolution and climate change. *Journal of Risk Research, 20*(8), 995-1016. doi:10.1080/13669877.2016.1148067
Kahan, D. M., Braman, D., Slovic, P., Gastil, J., & Cohen, G. L. (2007). The second national risk and culture study: Making sense of-and making progress in-the american culture war of fact.
Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research, 14*(2), 147-174. doi:10.1080/13669877.2010.511246
Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nature Climate Change, 2*(10), 732-735.
Kahan, D. M., Wittlin, M., Peters, E., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. N. (2011). The Tragedy of the Risk-Perception Commons: Culture Conflict, Rationality Conflict, and Climate Change *Temple University Legal Studies Research Paper No. 2011-26; Cultural Cognition Project Working Paper No. 89; Yale Law & Economics Research Paper No. 435; Yale Law School, Public Law Working Paper No. 230.*
Kahlor, L. (2010). PRISM: A planned risk information seeking model. *Health Communication, 25*(4), 345-356.
Kahneman, D., Fredrickson, B. L., Schreiber, C. A., & Redelmeier, D. A. (1993). When More Pain Is Preferred to Less: Adding a Better End. *Psychological Science, 4*(6), 401-405. doi:10.1111/j.1467-9280.1993.tb00589.x
Lang, A., Newhagen, J., & Reeves, B. (1996). Negative video as structure: Emotion, attention, capacity, and memory. *Journal of Broadcasting & Electronic Media, 40*(4), 460-477.
Leiserowitz, A., Maibach, E., Roser-Renouf, C., Rosenthal, S., Cutler, M., & Kotcher, J. (2017). *Climate change in the American mind: October 2017*. Retrieved from New Haven, CT:
Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change, 17*(3–4), 445-459. doi:http://dx.doi.org/10.1016/j.gloenvcha.2007.01.004
Mitkidis, P., McGraw, J. J., Roepstorff, A., & Wallot, S. (2015). Building trust: Heart rate synchrony and arousal during joint action increased by public goods game. *Physiology & behavior, 149*, 101-106. doi:10.1016/j.physbeh.2015.05.033

O'Neill, S., & Nicholson-Cole, S. (2009). “Fear won't do it” promoting positive engagement with climate change through visual and iconic representations. *Science Communication, 30*(3), 355-379.

Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology, 70*, 153-163.

Potter, R. F., & Bolls, P. (2012). *Psychophysiological measurement and meaning: Cognitive and emotional processing of media*: Routledge.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality. *Risk Analysis, 24*(2), 311-322. doi:10.1111/j.0272-4332.2004.00433.x

Stewart, N., Ungemach, C., Harris, A. J., Bartels, D. M., Newell, B. R., Paolacci, G., & Chandler, J. (2015). The average laboratory samples a population of 7,300 Amazon Mechanical Turk workers. *Judgment and Decision Making, 10*(5), 479.

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2014). How to communicate the scientific consensus on climate change: plain facts, pie charts or metaphors? *An Interdisciplinary, International Journal Devoted to the Description, Causes and Implications of Climatic Change, 126*(1), 255-262. doi:10.1007/s10584-014-1190-4

van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D., & Maibach, E. W. (2015). The scientific consensus on climate change as a gateway belief: experimental evidence. *PLoS One, 10*(2), e0118489.

vanLaer, T., Ruyter, K. d., Visconti, L. M., & Wetzels, M. (2014). The Extended Transportation-Imagery Model: A Meta-Analysis of the Antecedents and Consequences of Consumers’ Narrative Transportation. *Journal of Consumer Research, 40*(5), 797-817. doi:10.1086/673383

Witte, K., & Allen, M. (2000). A Meta-Analysis of Fear Appeals: Implications for Effective Public Health Campaigns. *Health Education & Behavior, 27*(5), 591-615. doi:10.1177/109019810002700506

Appendix
Declarations of Co-Authorship

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Brandi Shaw Morris

This declaration concerns the following article/manuscript:

Title:	Stories Trump Facts: Triggering Emotion and Action-Taking on Climate Change
Authors:	Brandi S. Morris, Polymeros Chrysochou, Jacob Christensen, Jacob L. Orquin, Jorge Barraza, Paul J. Zak, Panagiotis Mitkidis

The article/manuscript is: Published ☐ Accepted ☐ Submitted X ☐ In preparation ☐

If published, state full reference:

If accepted or submitted, state journal: Climatic Change

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No X ☐ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	B
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	A

Signatures of the co-authors

Date	Name	Signature
1/10/2018	Polymeros Chrysochou	
8/10/2018	Jacob Christensen	
7/10/2018	Jacob L. Orquin	
6/10/2018	Jorge Barraza	
11/10/2018	Paul J. Zak	
1/10/2018	Panagiotis Mitkidis	

In case of further co-authors please attach appendix

Date:

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.

AARHUS BSS SCHOOL OF BUSINESS AND SOCIAL SCIENCES
AARHUS UNIVERSITY

Declaration of co-authorship*

Full name of the PhD student: Brandi Shaw Morris

This declaration concerns the following article/manuscript:

Title:	The Messenger IS the Message: Identification with Story Characters Influences Climate Change Risk Perception
Authors:	Brandi S. Morris, Panagotis Mitkidis, Polymeros Chrysochou, Anthony Leiserowitz

The article/manuscript is: Published ☐ Accepted ☐ Submitted ☐ In preparation **X**

If published, state full reference:

If accepted or submitted, state journal:

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

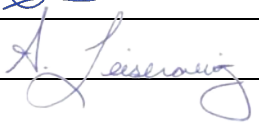
No **X**☐ Yes ☐ If yes, give details:

The PhD student has contributed to the elements of this article/manuscript as follows:

A. Has essentially done all the work
B. Major contribution
C. Equal contribution
D. Minor contribution
E. Not relevant

Element	Extent (A-E)
1. Formulation/identification of the scientific problem	A
2. Planning of the experiments/methodology design and development	B
3. Involvement in the experimental work/clinical studies/data collection	A
4. Interpretation of the results	B
5. Writing of the first draft of the manuscript	A
6. Finalization of the manuscript and submission	A

Signatures of the co-authors

Date	Name	Signature
1/10/2018	Panagotis Mitkidis	
1/10/2018	Polymeros Chrysochou	
8/10/18	Anthony Leiserowitz	

In case of further co-authors please attach appendix

Date:

Signature of the PhD student

*As per policy the co-author statement will be published with the dissertation.