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Measuring the Effectiveness of Cognitive Biases on Climate-Oriented Decision Making: A Novel Consideration for Policy Ideation and Enforcement

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Abstract

Public policies are an imperative population intervention to guide human decision-making towards the intended goal in order to achieve both the public good and improvements in society. However, recent years have witnessed increased noncompliance to public policies and their general failures to influence target population's decision-making in dire areas of issues. One primary example is climate policy. While traditional methods of policy framing are currently met with nonoptimal population responses, incorporating common cognitive biasing strategies may provide a solution. Thus, this research study aims to investigate the impact of cognitive bias on responses towards climate policy. The study compared the responses of two independent groups to a survey that differed in the statement tone: one survey was neutral, while the other incorporated various forms of cognitive bias related to climate policy. The study recruited 149 participants who were randomly assigned to either the neutral or pro-climate conditioned survey. Each question in the pro-climate conditioned survey contains framing in the form of both pro-climate language and specific cognitive biases such as base rates, temporal construal, emotional arousal, etc. The results, which are based on the difference in participant responses between the neutral and pro-climate survey, showed that the participants in the pro-climate condition had significantly different responses towards climate policy compared to those in the neutral condition. Namely, questions 16, 23, 26, and 37 showed statistically significant differences between the two conditions. While questions 16 and 26 are general priming questions where the only difference between the two conditions is the pro-climate language, questions 23 and 37 tested the effect and cumulative priming influence of specific cognitive biases. All four questions' results'

implications are then thoroughly discussed, along with a more general discussion of the overall priming influence of the pro-climate survey. Overall, these findings indicate that the inclusion of cognitive bias in survey questions can prime individuals and influence their identification and implementation of climate-based policy initiatives. These results highlight the importance of understanding how cognitive biases can affect responses to surveys and, in turn, influence policy decisions. Along with discussions of the qualitative implications of this study's quantitative results, potential limitations associated with this study's methods, and broader conclusions of this study's practical application are discussed.

Keywords

Climate Policy, Cognitive Biases, Decision Making, Priming, Pro-Climate, Consideration Set

1. Introduction

The purpose of this original research paper is to empirically compare the effects of different implementations of cognitive biases on climate-oriented recall and opinion. Specifically, we investigate how different bias types, such as framing effects, base rate changes, and other commonly studied cognitive biases, affect individuals' recall of climate-related information and their opinions and perceptions of recalled behaviors on climate change. We implement these biases in two different ways: through the presentation of biased information and through the framing of information in a biased manner. By comparing the effects of these different implementations of cognitive biases on climate-oriented recall and opinion, we aim to provide insights into how cognitive biases can shape individuals' beliefs and attitudes towards climate change, which has important implications for communication and policy efforts aimed at addressing this critical global issue.

Defining the Term Policy: Collins Dictionary defines policy as a set of ideas or plans used as a basis for making decisions, especially in politics, economics, or business. Ruggeri considers policies "actions of the public," ideological in that they guide optimal behaviors of certain groups towards outcomes that are in the best interest of the majority. The term policy as defined by Kai Ruggeri, Assistant Professor Health Policy and Management at the Columbia University Medical Center, is "unwritten codes of practice that result in consistent actions or series of steps when a small group or individual faces a common choice or obstacle" (Ruggeri, 2018). While they are not enforceable or considered in a litigious sense, they are thought of as strategic approaches to achieving an outcome that is desirable for most citizens (See **Figure 1**).

2. National Issue Where Policy Failure Has Had a Strong Impact

Policy, while an integral pillar stone in governing prosocial human behavior, can

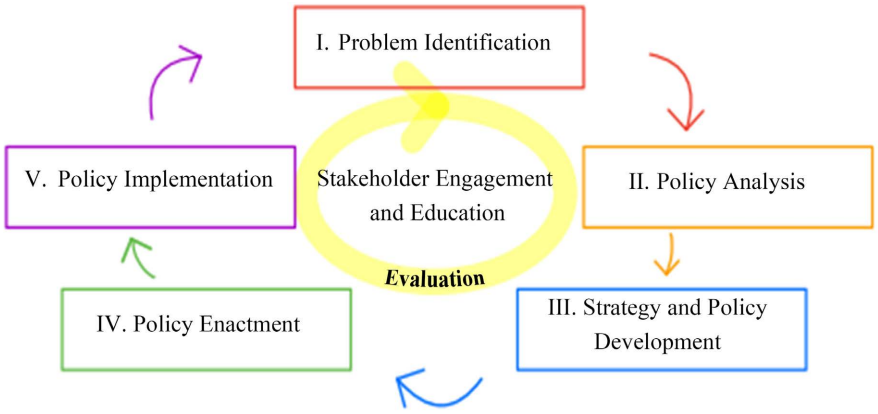

Figure 1. The policy-law cycle.

be fraught with shortcomings that lead to policy failures. Below are some specific examples of issue-specific policy shortcomings to serve as examples that justify the need to adopt a different, science-backed approach to the ideation, creation, and adherence of policy that is rigid in its goal to assert positive change for the greater societal good. Policy failures can be seen in global warming statistics, which relate directly to adequate creation of climate policy and adherence of those policies by constituents, governments, and industry.

Global Warming: According to a recent news article, 2023 was the eighth straight warmest year on record, based on evidence from climate scientists. The article cites data from the World Meteorological Organization, which found that the global average temperature in 2023 was 1.1 degrees Celsius above pre-industrial levels. This continued warming trend is attributed to the increase in greenhouse gas emissions, primarily from human activities such as burning fossil fuels and deforestation. The consequences of this warming trend include more frequent and intense heatwaves, droughts, and other extreme weather events, as well as rising sea levels and melting glaciers. The article notes that urgent action is needed to reduce greenhouse gas emissions and mitigate the impacts of climate change.

While the earth's temperature is rising every decade since 1880, the rate of global warming since 1981 has more than doubled. Furthermore, the year 2021 is the sixth warmest year on record, with the surface temperature being 1.51˚F than the 20th-century average. While shocking, this trend has continued since 2013, as all years from 2013 through 2021 made 9 out of the 10 warmest years on record. This extra heat is driving regional and seasonal temperature extremes, reducing snow and ice covers, intensifying acid rainfall, and altering habitats for plants and animals. Current policies for temperature preservation are ineffective; they do not meaningfully regulate carbon dioxide and greenhouse gas emissions, nor do they put defined limits on anthropogenic activities such as burning fossil fuels and clearing forests. If the current system does not change, the U.S. Climate Science Special Report predicts that the global temperature can increase up to 10.2˚F warmer than the average from the previous decades[1].

[1] *Climate change: global temperature*. (2023, January 18). NOAA Climate.gov. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature

Climate Change & Global Warming: The Environmental Protection Agency is committed to advancing the goals of environmental justice for all Americans. Understanding and addressing climate change is critical to EPA's mission of protecting human health and the environment. EPA tracks and reports greenhouse gas emissions, leverages sound science, and works to reduce emissions to combat climate change. The EPA is a critical policy maker for climate-oriented issues. One such issue frequently handled by the EPA is the identification of issues regarding the negative impact on certain endangered species as a result of failed climate policy.

The environment is declining at unprecedented rates, and the rate of species extinctions is accelerating. The health of ecosystems on which humans and millions of other species are deteriorating more rapidly than ever, eroding the foundation of economies, livelihoods, food security, health, and quality life worldwide. The average abundance of native species in most major land-based habitats has fallen by at least 20% since 1900. More than 40% of amphibian species, almost 33% of reef-forming corals, and over 33% of all marine mammals are threatened. The essential, interconnected web of life on Earth is getting smaller as a direct result of anthropogenic activity in all regions of the world. Land degradation has reduced the productivity of 23% of the global land surface, up to $577 billion in annual global crops are at risk from pollinator loss and 100 - 300 million people are at increased risk of floods and hurricanes because of loss of coastal habitats and protection[2]. Urban areas have more than doubled since 1992. Additionally, plastic pollution has increased tenfold since 1980 as policies failed to regulate the million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities. The average abundance of native species in most major land-based habitats has fallen by at least 20%, mostly since 1900. The numbers of invasive alien species per country have risen by about 70% since 1970, across the 21 countries having detailed records of the issue[3].

Although progress has been made in implementing policies to conserve nature, current trajectories are not sufficient to achieve global goals for sustainability and conservation. Human actions have significantly altered over 75% of the land-based environment and 66% of the marine environment. However, areas held or managed by Indigenous peoples and local communities have demonstrated less severe or avoided trends, indicating the importance of considering crucial stakeholders in policymaking. The EPA report suggests policy options and actions for improving environmental policies in various sectors. In agriculture, promoting good agricultural and agroecological practices, multifunctional landscape planning, and cross-sectoral integrated management are emphasized. Additionally, conservation of genetic diversity and empowerment of consumers and producers through market transparency, improved distribution and locali-

[2]The United Nations. (2019). UN Report: Nature's Dangerous Decline "Unprecedented"; Species Extinction Rates "Accelerating" *United Nations Sustainable Development*. https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

[3]*Invasive alien species on the rise worldwide*. (2022, June 27). IUCN. https://www.iucn.org/news/secretariat/201702/invasive-alien-species-rise-worldwide

zation, and reformed supply chains are important. In marine systems, ecosystem-based approaches to fisheries management, spatial planning, effective quotas, and marine protected areas are highlighted, along with reducing run-off pollution and working with producers and consumers. In freshwater systems, policy options include more inclusive water governance, better integration of water resource management and landscape planning, and promoting practices to reduce pollution and increase water storage. In urban areas, the report recommends promoting nature-based solutions, improving access to green spaces and a healthy urban environment for low-income communities, sustainable production and consumption, and ecological connectivity within urban spaces.

Climate change will influence the continued rising sea levels, changing temperature and precipitation patterns, and more severe weather events. The declines in sea ice thickness and extent, along with changes in the timing of ice melt, are putting animals that are particularly ice-dependent at risk. Beyond the livelihood of animal species, the rapidly declining arctic ice means danger for humans as well. The rapidly diminishing Arctic Sea ice is accelerating warming for the entire Earth[4]. As more sea ice disappears, the underlying ocean surface is exposed. This much darker ocean surface absorbs sunlight instead of reflecting it, allowing much more heat to enter the Arctic system. As a result, the state specific issues related to negative impact on arctic ice-melt or rising tides as a result of failed climate policy[5].

Policy failures including weak regulations on CO_2 emissions and weak overall goals what happens in the Arctic will influence the rest of the planet. Without urgent action to slash greenhouse gas emissions, the world will continue to feel the effects of a warming Arctic. For areas around the world—even thousands of kilometers south of the Arctic—this negative cycle is fostered if policies continue to remain ineffective in its regulations. Furthermore, While Arctic glaciers and ice caps represent only 25% of the world's land ice area, meltwater from these sources' accounts for 35% of the current global sea-level rise. This negative trend will continue in many other aspects. Shipping in the Arctic is on the rise as sea ice recedes and the pressure to access Arctic resources intensifies. More vessels mean increased risks to Arctic ecosystems and wildlife, from heavy fuel oil spills to air and underwater noise pollution and the break-up of the remaining ice. Consequences include food shortages and risks to people's livelihoods, cultures and health, especially in Indigenous communities. Surging wildfires, thawing permafrost, eroding coastlines, food/livelihood/transportation threats for human arctic communities—all are specific issues rooted in climate change; for governments regarding global warming are stagnating process for change while "time is running out." Rapidly unfolding events will soon overwhelm the ability

[4]Hersher, R. (2022, August 11). The Arctic is heating up nearly four times faster than the whole planet, study finds. *NPR*.
https://www.npr.org/2022/08/11/1116608415/the-arctic-is-heating-up-nearly-four-times-faster-than-the-rest-of-earth-study-f

[5]*Climate change—WWF Arctic*. (2023, January 26). WWF Arctic.
https://www.arcticwwf.org/threats/climate-change/

of decision-makers to respond meaningfully to coastal erosion, wildfires, thawing permafrost and powerful storms. The current lack of local and regional plans to reduce vulnerabilities and build resilience also contributes to the many irreversible changes in the Arctic currently underway. And the fundamental way to tackle this issue is through stopping global warming. Some policy suggestions include:

Switch to renewable energy: Transition towards a 100 percent renewable future by developing clean energy sources. Governments need to finance renewable resources for Arctic communities through programs and incentives, including by redirecting existing subsidies for fossil fuel production and consumption and by promoting international cooperation to advance renewable energy provision.

Support the conservation and restoration of wetlands: To avoid large emissions from wetland greenhouse gases will require a slowing of human emissions globally. Restoring damaged and degraded wetlands, once the reservoirs of wildlife habitats and biodiversity in general, can substantially reduce emissions.

Advocating for the complete phase-out of fossil fuels: Advocating against new exploration, investments, and the development of fossil fuel reserves in the Arctic, as well as the construction of associated infrastructure that would support or stimulate the opening of new extraction sites; opposing oil production in the Arctic overall along with the United States plan to open drilling in the Arctic Refuge.

Communicating issues about a warmer arctic: One of the policies' most effective qualities is their ability to communicate a message and persuade for the public good. Thus, providing consolidated science-based reports, content, and focused media tools, telling compelling stories that transport audiences to Arctic communities and landscapes impacted by climate change, and sharing stories about the issues faced by the people and wildlife who call the Arctic home will show the target population of the policy just how important and urgent it is to halt the climate crisis immediately.

The most effective way to achieve these large-scale goals is to change the hearts and minds of citizens to agree to these planet saving initiatives this issue is through stopping global warming. The issue is that such policy suggestions are often met with pushback, disagreement, or non-compliance. While the evidence continues to amass regarding climate degradation, there exists a fundamental disconnect between what is objectively the best practices to prolong the planet and our species, and how citizen perceive the issue and how it impacts them at a personal level.

3. A Need to Bridge the Gap between Science and Policy

There exists a gap in the optimal delivery of public policy communications that consider the gap between theoretical constructs of decision-making based in rational judgment and individuals' emotional and often non-rational, automatic

decision processes derived from efficient heuristics. This research study aims to understand better decision-making processes centered on policymaking. Through systematic manipulations of policy-centered communications, the author demonstrates how information communicated to the constituent on important decisions to be made can systematically shift the outcomes of such decisions. Within several communication manipulations that harness known cognitive constructs such as the positioning of dilemmas, use of framing effect, in-group biases, and temporal construal, a better-informed model of policymaking is outlined. This model is founded in applied theory from the behavioral, affective and neural sciences.

Predispositions Inherent in Human Judgment and Decision Making: Since the seminal work of Daniel Kahneman and Amos Tversky, it has been long understood that human decision making is far from rational. Rather than making judgments and decisions from rational utilities, humans tend to focus on emotional information and weight decision utilities, or the pieces of information used to decide, utilizing these emotional drivers (Tversky & Kahneman, 1986). Kahneman and Tversky's groundbreaking research on decision-making revealed that humans tend to make irrational decisions, often based on biases and heuristics rather than logic and rationality. According to their work, people tend to overestimate their abilities, rely too heavily on past experiences, and give disproportionate weight to unlikely events. This leads to several cognitive errors and biases, such as the availability heuristic and the framing effect, that can result in flawed decision-making. Despite these limitations, Kahneman and Tversky's work has greatly informed our understanding of the human mind and provided valuable insights into how we can improve our decision-making processes.

Social and Political Outcomes Resulting from Predispositions in Human Judgment and Decision Making: An example of Kahneman and Tversky's research on irrational decision making relates to the change often seen in the use of decision-making utilities used when making choices related to self and others. "Power tends to corrupt; absolute power corrupts absolutely" was an observation made by Lord Acton, a British historian of the late nineteenth and early twentieth centuries[6]. In this quote, he meant that a person's sense of morality becomes less as his or her power becomes greater. Understanding that issue occurs on a systematic level has for centuries called into question how power shifts an individuals' psychological constructs during decisions regarding the citizens that they are charged to oversee. A better understanding of the means in which egocentric decision outcomes arise can be used to better communicate important issues to a constituent that lessen the power of an individual or governing groups to make decisions that are not representative of the greater good.

Defining Corruption: One such issue stemming from irrational human decision-making tendencies is the introduction of corruption into governance. Cor-

[6]*Separation of Powers with Checks and Balance* (n.d.). Bill of Rights Institute. https://billofrightsinstitute.org/essays/separation-of-powers-with-checks-and-balances

ruption, commonly defined as "an abuse of entrusted power for private gain[7]" is a buzzword in political debates, popular media, and dinner table conversations. The catchall term for self-interested behavior that comes at the expense of public wellbeing, corruption is blamed for a range of social ills, from the waste of public funds to non-democratic capture of political power, high rates of unemployment, growing income inequality, and large political clout of corporations[8].

Policies are traditionally put in place by those in positions of power over their constituents. Several studies have suggested that those that rise to positions of power shift their focus from an allocentric or outward view to an egocentric or self-focused view. When this shift occurs, the decision they choose to make may not be in the best interest of the majority.

The Cognitive Psychology of Corruption: Research suggests that individuals holding power are more likely to act corruptly. Factors that contribute to corrupt behavior include personal gain, lower self-control, perceived indirect harm, and working in organizations where unethical behavior is not punished (Dupuy & Neset, 2018). Risk acceptance and aversion also play a role, with uncertainty increasing the likelihood of corruption. Rationalization narratives can make corruption more acceptable, while emotions such as guilt can make it less likely. To counter these cognitive influences, practitioners should encourage measures that improve information flow about the costs of corruption, reward ethical behavior, establish integrity standards, and improve organizational decision-making.

4. Constructs in Cognition That Influence Human Decision Making

Cognitive Biases: Along with the changing cognitive processes related to corruption and power, there exist several constructs, known as "Cognitive Biases," that are known influencers of human judgment. Kahneman and Tversky conducted decades of research on the irrationality of human decision-making. Before their work, human judgment was considered to arise from rational considerations of decision utilities and removed from affective influences, such as emotion.

Cognitive bias is a systematic inaccuracy in thinking that arises as people receive and interpret information in the environment around them, influencing their decisions and judgments. This misinterpretation stems from utilizing decision utilities that are made to be more salient than others to make a choice. The following presents a brief summary of some cognitive biases that have been shown to exist systematically in human decision-making processes that are addressed in this paper's original research.

Temporal *Construal Theory*: When a decision is far out, people focus on abstract utilities, and when decision is near, they focus on concrete utilities (Trope

[7]Transparency International. (2022, January 22). 2013 *Corruptions Perceptions Index—Explore the results*. Transparency.org. https://www.transparency.org/en/cpi/2013

[8]Zaloznaya, M. (2014). The Social Psychology of corruption: why it does not exist and why it should. *Sociology Compass*, *8*(2), 187–202. https://doi.org/10.1111/soc4.12120

& Liberman, 2003).

NIMBY Not in My Backyard: The study aimed to understand why people are hesitant to engage in intergroup contact by asking participants to imagine having neighbors from different social groups. Five social groups with varying emotion-arousing potential were included in the study, and acceptance levels were found to be linked to the emotions evoked when anticipating contact rather than prior contact with the groups. Emotions were also found to be connected to preferred interpersonal relationships. The study suggests that further research is needed to understand the reasons behind reluctance to engage in intergroup contact to effectively reduce prejudice (van Alphen, Dijker, Bos, van den Borne, & Curfs, 2011).

Anchoring Effects: The common human tendency to rely too heavily on the first piece of information offered, referred to as an "anchor," when making decisions[9]. Once an anchor is set, a bias is created for interpreting information around that anchor. Anchors push public policy by operating as an answer that shifts the focus of the public's attention on agreement/disagreement with the policy and, in turn, ignore whether they are even addressing the fundamental questions.

The impact of biases on decision-making prevents the yielding of rational and informed decisions from a desired population. Empirical data are distorted by different cognitive biases, resulting in the construction of inaccurate decision-making models that undermines the psychologists' original purpose. Thus, consideration of one of the most influential biases, the anchoring effect, or the tendency to fix on the initial information as the starting point for making a decision, and the failure to adjust for subsequent information, is a critical aspect in understanding decision biases (Gu, Zhu, & Li, 2020). The anchoring effect is a classical judgment deviation. After many years of research, scientists have derived several likely mechanisms that explain the anchoring effect. Some models include the Selective Access Model, the Attitude Change Model, and the Scale Distortion Model.

The Selective Access Model: The selective access theory proposes that context influences the interpretation of ambiguous words, so that only the intended meaning is accessed. In essence, this perspective holds that context provides sufficient information to activate just the most pertinent interpretation of an ambiguous term. A simple example of the Selective Access Model is the ambiguity of context. For example, "Bill is running" would be an ambiguous statement that can be swayed by contextual information. To interpret the sentence as "Bill running as in exercising" or "Bill running for office" relies on additional information. If this statement is paired with an image of a finish line or an image of a ballot box, selective access has occurred for the interpretation of this word "running."

The Attitude Change Model: There are three bases considered important for

[9]Staff, P. (2023). The Anchoring Effect and How it Can Impact Your Negotiation. *PON—Program on Negotiation at Harvard Law School*. https://www.pon.harvard.edu/daily/negotiation-skills-daily/the-drawbacks-of-goals/

attitude change: compliance, identification, and internalization. These three psychological processes represent the different levels of attitude change (Kelman, 1958).

Compliance: Compliance refers to a change in conduct motivated by consequences, such as an individual's desire to receive rewards or avoid punishment from another group. Individuals are impacted by the social consequences of adopting a new action, and not necessarily by changes in their views or judgments of an attitude object. Frequently, the individual is also aware of the pressure to respond in a particular manner.

A set of laboratory studies known as the Asch experiments revealed compliance. In experiments conducted by Solomon Asch of Swarthmore College, student groups were required to take a "vision test." All but one of the participants were the experimenter's confederates, and the purpose of the experiment was to determine how the remaining student would respond to the confederates' actions. Participants were instructed to choose from three possibilities, the line with the same length as a sample and to state their selection aloud. Unbeknownst to the participants, Asch had put several confederates in front of them to purposely provide the incorrect answer. The results indicated that 75% of replies were in accordance with the influence of the majority and were the identical answers chosen by the confederates (Asch, 1956).

Identification: Identification discusses the modification of one's views and behavior in order to resemble someone one admires or appreciates. In this situation, the individual adopts the new attitude not because of the substance of the attitude object, but because it relates to the desired connection. Frequently, children's views on race and political party affiliations are influenced by their parents' views and beliefs (Hughes, Rodriguez, Smith, Johnson, Stevenson, & Spicer, 2006).

Internalization: Internalization refers to the change in beliefs and emotions that occurs when an individual considers the content of an attitude to be intrinsically satisfying and, as a result, results in an actual shift in beliefs or assessments of an attitude object. The new attitude or conduct is compatible with the individual's value system and tends to be integrated with the individual's current values and beliefs. Therefore, internalized behaviors are a result of the content of the attitude object (Kelman, 1958).

The Scale Distortion Model: The scale distortion model is a concept that refers to the phenomenon of exaggerating or minimizing the relative size of an object or distance in a representation or image. This distortion can be intentional or unintentional and can occur for various reasons such as the use of different scales or perspectives, lens distortion, or human perception biases. The scale distortion model can have significant effects on the interpretation and communication of visual information, as it can alter the perception of size, distance, and relationships between objects. Therefore, it is crucial to be aware of and account for scale distortion when creating or analyzing visual representations.

An example of the Scale Distortion Model can be found in self-reported behaviors that shift in relation to changes in the amount of time presented in a visual scale of choices (Thomas & Kyung, 2019). The model can lead consumer payments elicited using slider scales to be consistently different from those elicited using text boxes. People who utilize text boxes to make payments assess monetary values in relation to the answer range's beginning point. In contrast, when using slider scales, individuals assess the monetary values in relation to both the beginning and the end of the answer range. As a result, payments triggered by slider scales typically fall near the response range's extreme. Both ascending and descending payment forms have different effects on this slider scale end point assimilation. Slider scales elicit greater payments than text boxes for ascending payment methods (e.g., eBay bids). But slider scales elicit smaller payments than text boxes for descending payment structures (e.g., Priceline bidding). This research illustrates how the mental number line impacts financial decisions in addition to showing how slider scales change consumer payments.

Changing Memories: Not only does the anchoring effect impact one's decision-making, it also modifies one's memory associated with the event by producing false memory. After ensuring that anchoring effect is at work (participants who were confronted by an irrelevant high anchor overestimated the speed of the car compared with participants from the low anchor group), Navarre et al. found that when confronted with an anchor, participants activate representations related to this value and integrate it into their perceptions of their memories (Navarre, Didierjean, & Thomas, 2022).

Base Rates: Base rates are the naturally occurring frequency of a phenomenon in a population. One example is the percentage of students at a particular university who have a major eating disorder. Many psychologists consider base rate assumptions as intuitive predictions that adhere to a heuristic-representativeness of judgment. Using such a heuristic, individuals predict the conclusion which appears to be the most reflective of the evidence. Base rate assumptions often violate the logic of statistical prediction because intuitive forecasts are insensitive to the reliability of the evidence and the prior likelihood of the result.

In a series of classic tests including both naïve and savvy university students (N = 871), the notion that individuals forecast by representativeness was supported. The ordering of outcomes by probability coincided with the ranking by representativeness, and participants in this series of studies incorrectly predicted uncommon events and extreme values if they were representative. The representativeness heuristic is responsible for the occurrence of unjustifiable trust in forecasts and the prevalence of erroneous intuitions regarding statistical regression (Tversky & Kahneman, 1986).

Misuse of Base Rate in Law: Base rate neglect is the tendency for people to disregard or underestimate certain relevant statistical information (the base rate). In each hypothetical situation, the majority ignored the stated information about the low prevalence of blue cars and chose the blue car when decid-

ing whether a car causing an accident was blue or not blue. The students fully trusted an eyewitness saying that the car was blue and disregarded the initial base rate despite being informed that the witness could be mistaken in some cases.

One article describes an experiment meant to evaluate law students' ability to use probabilistic reasoning to determine the likelihood of a defendant's guilt. As anticipated, most students are victims of base rate neglect, which may be associated with a representative heuristic, the testimony of an eyewitness. The results might be seen as a caution against the use of probabilistic reasoning in the courtroom; judges' intuition could easily lead to erroneous rulings. However, it is suggested that the issue is not with the formal modeling of probabilities, but rather with human intuition when dealing with unclear data. Future judges should be familiar with Bayesian thinking in order to prevent errors in judgment.

5. Issues with Self-Report

Self-reported information is prone to be affected by cognitive biases, such as the varying aspects of anchoring effects. Moreover, individuals are prone to respond to self-reported questions in a biased way due to several inherent cognitive and affective processes, such as Interviewer Bias, Social Desirability, and Recall Bias, briefly summarized below.

Interviewer Bias: Interviewer bias occurs when the personal qualities of the interviewer introduce a bias and becomes a key determinant of the outcome of an interview. The longer the period between the actual experiment and the interview, the greater the inaccuracy of the data. In certain interviews (especially those discussing embarrassing and/or sensitive subjects), respondents may distort information to present what they perceived as a more favorable impression (Salazar, 1990).

Social Desirability: Social desirability is the need for social approval and acceptance, as well as the belief that this can be attained by acceptable and appropriate behaviors. Social desirability response bias is the tendency for subjects to overestimate the importance of socially desirable job and organizational characteristics (challenge and responsibility) to them and to underestimate the importance of less socially desirable characteristics (pay). This leads individuals to attribute themselves with culturally approved statements and deny culturally unacceptable traits. Explicitly stated methodologies are most likely to evoke a social desirability response bias, causing measurements in self-report studies of choice situations to be less valid.

Social desirability response bias accounts for the discrepancies in results of self-report methodologies in choice situations. In a study, the low social desirability group had no significant differences between the direct self-report measures and the relative value weights. But for the high social desirability group, two out of six differences are significant and, in the direction, consistent with a social desirability bias, or overreport the importance of socially acceptable traits and

underreport the importance of less socially desirable traits. For people with low social desirability, this bias is not evident in the data; however, this bias is a significant factor for groups with high social desirability (Arnold & Feldman, 1981).

Recall Bias: Recall bias occurs when participants do not accurately recall a past event or experience and/or leave out details when reporting them (Raphael, 1987). As a result, this bias exaggerates the magnitude of the difference between cases and controls. This is not to be confused with memory loss. To assess whether recall bias is having an effect on the data, researchers can verify the actual exposure status with unbiased records. When records are not available, researchers can directly ask the participant to identify the exposures.

To mitigate this bias, a validity scale is recommended to adjust and correct differential recall patterns among respondents. Each item on the scale will question the respondent on his/her exposure to a fake "risk" factor. When the respondent endorses an excessively large number of validity scale items, then they possess recall bias. The inclusion of irrelevant exposures in the research protocol helps reduce recall bias by reducing the likelihood of hypothesis-guessing within the research by either the interviewer or the respondent. The discrepancy scores generated from the scale can be used in the final statistical analysis as a control for recall bias effects.

5.1. Benefits of Integrating Psychologists, Neuroscientists, and Behavioral Scientists into Policy Making

Understanding psychological and neuroscientific underpinnings of human decision making is a crucial component in evaluating the results, success, and consistency of public policies and understanding such phenomena beyond sheer numbers provided by mass collections of data. Ruggeri points out the potential psychological approaches to policy must generate effective insights in challenging areas of public interest. While the impact of the field of psychology, behavioral science, and neuroscience on policy is already well-established, more empirical research will continue pushing the prominence of such sciences in contributing to effective policies as well as increasing the perceived benefit of optimizing communication between these fields and policymakers. Below are a series of mechanisms at play that can and do shift policy makers and the constituent being queried when considering how public policy construction and compliance.

5.2. Psychology of Persuasion

Choice Architecture: Choice architecture is the design of many methods in which options can be presented to decision-makers, as well as the effect of these presentations on the decision-making process (Thaler, Sunstein, & Balz, 2013). Architecting an individual's decision-making process changes the salience of which "decision utilities" are used (Robson, & Samuelson, 2011). Decision utili-

ties are the constructs that determine the choice outcomes that are made.

Choice architecture refers to the design of the context in which people make decisions, and it can have a powerful influence on the choices people make. Research has shown that small changes to the way options are presented can have a big impact on the choices people make. For example, simply changing the order in which options are presented can influence which option is chosen. A classic example of this is a study that found that when a cafeteria placed healthier food options at the beginning of the serving line, people were more likely to choose those options (Wansink & Hanks, 2013). Another example is default options, which have been shown to have a significant impact on behavior. For instance, when organ donation is presented as an opt-out choice rather than an opt-in choice, donation rates increase significantly. These findings have led to the implementation of policies aimed at using choice architecture to promote better outcomes, such as the use of default options to increase organ donation rates and the redesign of school cafeterias to encourage healthier eating habits. Overall, the research on choice architecture suggests that small changes to the way options are presented can have a big impact on behavior and can be used to promote positive outcomes.

The Nudge Unit, officially known as the Behavioral Insights Team, has been effective in implementing policies that encourage positive behavior change in the United Kingdom. By using behavioral science principles, they have successfully nudged people towards making better choices for their health, finances, and overall well-being. One notable example is their work on tax compliance, where they found that personalized and simple messages reminding people of their duty to pay taxes on time increased the number of on-time tax payments. The study titled demonstrated the effectiveness of their approach in improving tax compliance (Garofalo, Kuhns, Hotton, Johnson, Muldoon, & Rice, 2016).

Neuroscience of Biases: Cognitive biases are not a subjective construct that is voluntarily adhered to in shifting how decisions are made. There are neural underpinnings of some cognitive biases that are important to consider. Humans are hardwired to process information in specific ways that result in using different, suboptimal decision utilities. One example connecting the use of cognitive biases with brain processes is found in the adoption of in-group biases in interpreting utilities used in making decisions.

Racism and partiality of members of one's own group are pervasive in our culture and have long been the subject of social psychology research. Because it is now feasible to investigate the neurological processes that underlie these in-group biases, this research provides a summary of recent findings on the subject. It appears that how we categorize the world into 'us' and 'them' is not dependent on a single brain area or network, but rather on minute variations in neuronal activity across the brain, depending on the modalities involved. These findings have significant ramifications for our comprehension of the origins of in-group prejudices and may provide fresh perspectives on how to combat them (Molenberghs, 2013).

5.3. Rationale for Novel Research in Cognitive Biases on Climate Beliefs

It has never been more vital for psychologists and behavioral scientists to step in and offer their insights on human reception of policies to mitigate the theoretical gap and elevate the cooperation to and overall effectiveness of policies for the public good. Moreover, the need for inclusion of theory and applications from experts in psychology, neuroscience, and behavioral science becomes undeniably evident. In contribution to this need, this study not only not only aims to mitigate a scientific gap in research for responsiveness to and effectiveness of policies, but also to strengthen the pool of existing research in order to raise the prominence of the previously dormant informants of public policy: psychology, neuroscience, and behavioral science. Advancing the role of and feasibly translating such research will enhance communication between policymakers and scientists while, most importantly, fostering an improved picture of securing and ensuring public good in real life.

The following hypotheses were constructed based on the current understanding of the influence of cognitive biases on climate-oriented decision making:

5.4. Hypotheses

H0: There is no significant difference in reported responses to perceptions of climate change as a function of Pro-Climate question framing.

H1: There is a significant difference in reported responses to perceptions of climate change as a function of Pro-Climate question framing.

H1a: There will be specific changes in participant response to Pro-Climate question framing as a function of specific cognitive biases.

H1b: There will be a significant difference in the explicit choice of sentiment used (e.g. positive, neutral, negative) to describe climate change as a function of pro-climate question framing.

H1c: There will be a significant difference in the implicit judgment of facial affect as a function of pro-climate question framing.

6. Methods

The methods of this study adheres to all ethical guidelines. All human material are recruited with consent and debriefed accordingly. All Human data are deidentified post-study and have no way of linking back to the participant or the participant's family. This study is submitted to and approved by the KatyISD AP Research Campus Institutional Review Board (IRB), which evaluates the ethical adherence of all submissions to the Declaration of Helsinki. Full reference to the IRB form—including all approval information, required signatures, and participant consent form—can be found here (https://drive.google.com/file/d/1twMMsxeQU01mwLGw33EO6TNBQJ_RZljn/view?usp=sharing). This study is submitted as a part of a collective file of research paper from a KatyISD campus to the ethics committee, KatyISD Campus IRB.

There are no funds or external source of income supporting this study, as this study is a remote project.

6.1. Sample Size and Participants

The sampled respondents are people of any age and gender living in the East Coast, Midwest, or West Coast regions of the United States. A total number of 149 participants were recruited (n = 149). The respondents varied in age and gender, with each participant being assigned randomly to either a control or experimental online survey to ensure a random distribution of participants for each survey. While the sample for this research is not probabilistic, an initial demographic inventory did not show statistically significant differences.

6.2. Procedures

The respondents drawn from the researcher's networks received the Neutral or Pro-Climate survey through two ways: a direct message of participation request along with the link to the survey from the researcher or a shared link from the respondents who already participated in the survey. The full neutral survey is found in Appendix B, while the Pro-Climate survey is found in Appendix C. All appendices are located here (https://drive.google.com/file/d/1KoE5XcRzPbIlB9Wpz9dVifkEBzYILy0y/view?usp=sharing).

Upon opening the online survey, all respondents read the instructions regarding the approximate duration of the survey and necessary actions that they need to adhere to while taking the survey, namely the warning of "Please DO NOT go back to any question to change your answer." These instructions are included because providing the amount of time the survey will take ensures that less participants will give up filling out the surveys midway due to the length of time during which they take the survey not matching their expected length or the available time they allocated to taking the survey—both of which can result in the respondents leaving the survey for an unknown period of time before returning and thus a weakening of the staggered effect of priming within the questions for the Pro-Climate Survey. The verbal instruction to not return to a previous question to change the answer enhances this delimitation measure, ensuring that the cumulative effect of the cognitive biases is gradually built up in the order they are deliberately placed in the Pro-Climate Survey. The remaining instructions are like that of a generic survey: proceed through the questions and submit the survey when completed.

After the brief initial instructions and section of informed consent, the respondents completed an initial demographic inventory. Following this section, which was identical across participants, each was then exposed to one of two versions of a climate-centric survey. Participants in the Neutral condition were exposed to non-biasing language and content related to external weather events. Participants in the Pro-Climate condition were presented with language that discussed the negative state of the current environment, and then asked to com-

plete the survey. Prior to introducing further, structured, cognitive biases into the subsequent questions, following the paragraph are a set of self-reporting questions meant to assess the initial priming embedded in the instructions. The reason for asking the respondents a series of self-reported recalled behaviors is to have a manipulation check on base rate differences in reported recall, free of subsequent framing with respect to cognitive biases to ensure the construct validity of the bias framing sentiments. The remaining questions of the second section are questions that evaluate cognitive bias-specific priming, with the Neutral Survey using non-biasing questions with neutral wording as a control for the cognitive-bias primed Pro-Climate Survey. After the respondents complete the 38 experimental questions within the second section, they proceed to the final section, where a brief description ensuring anonymized responses was restated.

7. Results & Discussion

Demographic Information: Both groups of participants (n = 149) completed an identical intake survey to collect demographic and reported climate-oriented behaviors. 53 participants filled out the neutral survey (Control; n = 53) and 96 participants (Experiment; n = 96) filled out the pro-climate survey. Hence, despite the remote, rather than in-person, setting of this study, the sample size is not of concern. In terms of this sample's representative qualities, we offer this explanation: although the respondents were not probabilistically sampled, statistical analysis on demographic information suggest that there were no meaningful differences in participant respondents as a function of group selection. Please see Appendix G for demographic comparisons by survey group. All appendices are located here (https://drive.google.com/file/d/1KoE5XcRzPbIlB9Wpz9dVifkEBzYILy0y/view?usp=sharing).

Pre-Experimental Manipulation—Reported Behaviors: Prior to viewing survey questions that contained embedded cognitive bias framing, the participants were asked a series of self-reported recalled behaviors as a manipulation check on base rate differences in reported recall, free of subsequent framing with respect to cognitive biases to ensure the construct validity of the bias framing sentiments.

Vehicle Choice: Participants selected the type of vehicle they drive (e.g., SUV, bicycle, sedan, EV, etc.). Vehicles were then reclassified as positive or negative with respect to their environmental footprint. A Chi-Square Test of Independence was performed to assess the relationship between vehicle's climate footprint and survey condition. There was not a significant relationship between the two variables, X^2 (1, N = 148) = .278, p = .711. Respondents in both groups reported use of climate-friendly vehicles twice as frequently as those reported non-climate-friendly vehicles.

Mileage Driven Per Week: There was a significant difference in the reported average number of miles driven per week by respondent group, with those in the pro-climate condition reported a greater number of average miles traveled ($\overline{X}$ = 164.2, s.d. = 129.1) compared to those in the control condition ($\overline{X}$ = 105.88, s.d. = 107.6). This result is likely due to outlier responses of >2 standard devia-

tions above the average value. In addressing the distribution of both samples when this outlier is controlled for, no significant difference remained in the group's average reported miles driven per week.

Considering possible relationships that may exist within the continuous variables collected in this study, a comparison between participant's reported age and average number of miles per week was conducted. In a bivariate correlation analysis, age and reported miles driven per week were weakly positive correlation (r = .190, p = .048). Until the middle 50's, the older the driver, the more likely they were to report driving a greater distance in miles per week. This is logical as younger aged respondents tend to not be of the age to drive. Beyond this age, reported driving expectedly decreases within the older age cohort of participants. See Figure 2.

Interestingly, there was a negative correlation found between reported shower duration and reported miles driven per week, though this was not a significant difference across groups. See Figure 3.

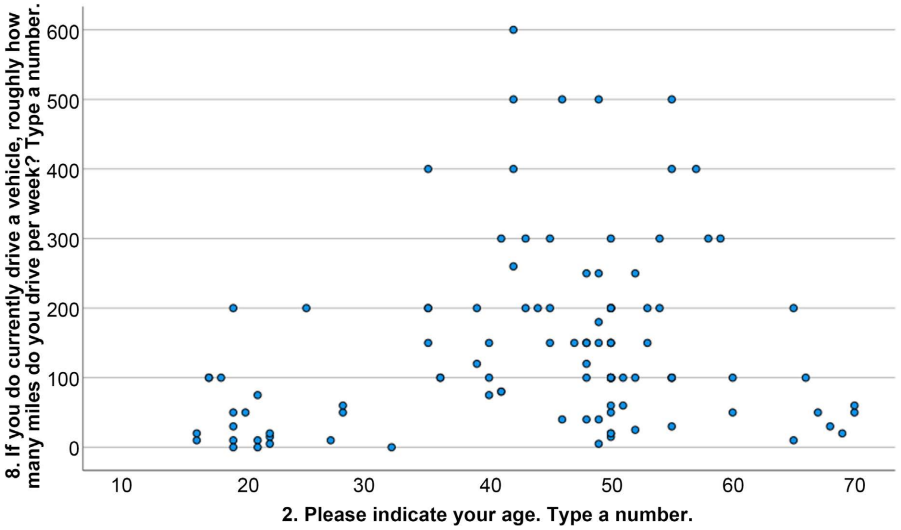

Figure 2. All participants reported age by miles driven per week.

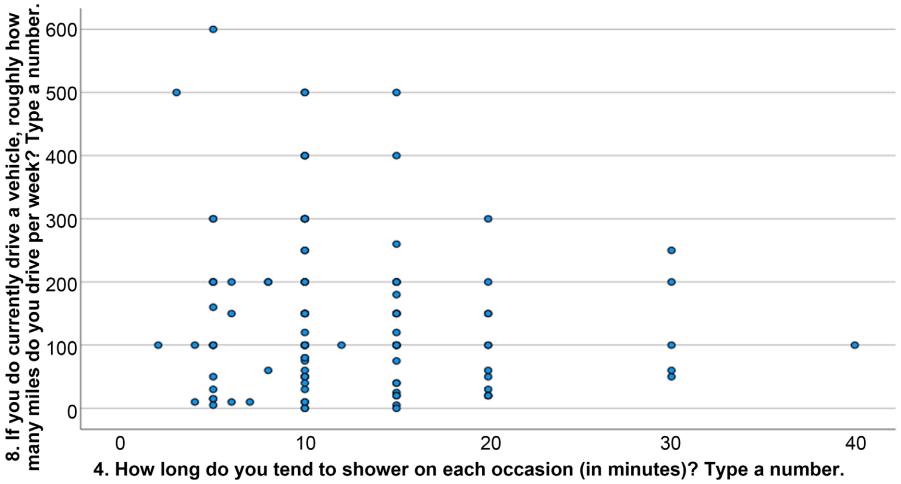

Figure 3. All participants reported shower length by miles driven per week.

Primary Source of News: There were no significant differences in survey groups in the proportion of new platforms selected as a main source of news. Half of respondents in each condition reported newspapers and magazines as their primary news source. A greater proportion of participants in the pro-climate condition reported consuming news via digital sources, such as the Associated Press and BBC, compared to respondents in the neutral condition.

Cognitive Bias Oriented Question Responses

Demographic and reported climate-oriented behaviors did not demonstrate significant differences across participants. The similar distribution of these responses across survey groups provides evidence that responses to subsequent bias-framed questions would unlikely be due to sampling and more likely due to the cognitive biasing embedded in the questions in the pro-climate survey version.

At this point, participants viewed an instruction paragraph that varied as a function of the survey they received. Participants in the neutral survey condition were exposed to non-biasing language and content related to external weather events. Participants in the pro-climate condition were presented with language that discussed the negative state of our current environment, and then asked participants to complete the survey. Prior to introducing further structured, cognitive biases into the subsequent questions, the following are a set of questions meant to assess the initial priming embedded in the instructions.

Frequency of Reported Driving for Personal Pleasure: Though the question was preceded by a neutral climate image in the control group and a negatively-framed image in the pro-climate group, there was no significant effect for the frequency of driving for pleasure, ($t(1) = -1.855$, $p = .066$) as a function of survey group; however, the frequency of driving for pleasure in pro-climate respondents was slightly higher ($X = 2.87$, SD = 1.369) than reported by Neutral respondents ($X = 2.44$, SD = 1.298) approach significance difference. This suggests that there were minimal biases from the initial framing provided in the instructions, and that a cumulative impact of the cognitive biases combined is more effective at changing the Pro-Climate respondents' decision-making.

Frequency of Reported Recycling at Home: There was no significant effect for the frequency of recycling at home, however, those in the pro-climate condition reported slightly higher recycling rates (M = 4.14, SD = 1.078) than Neutral respondents (M = 4.04, SD = 1.045) approach significance difference. While not significant, the pro-climate instructions may have shifted pro-climate respondents to having a higher recalled rate of home recycling.

Reported Type of Hydration: The Pro-Climate respondents reported heavier use of plastic hydration products despite recalling more instances of pro-climate behaviors at home (such as recycling), though this was not statistically significant ($z = -0.407$. $p = 0.684$.) Those in both conditions reported higher overall use of non-plastic containers as sources of hydration.

Shower Length: Though not significant, those in the pro-climate condition reported taking showers an average of 1.63 minutes less than those in the control condition [Neutral $\bar{X}$ = 13.52 (s.d. = 6.700); Pro-Climate $\bar{X}$ = 11.89 (s.d. = 6.437).

Framing Effect Positive: Words chosen in the questions have a positive connotation, hinting at favors of pro-climate behaviors for climate change policies to evaluate whether more pro-climate options will be chosen.

Response framing and compliance to climate crisis policy: With respect to aspects of climate policy that foster a desire for participant compliance, all participants were presented with two positively and two negatively framed responses. Possible positive responses aligned with personal benefits while negatively framed responses aligned with moral concerns such as guilt and personal punishment. Responses across each participant group suggest that the rationale for compliance to climate policy lay in a consideration of the benefits compared to the drawbacks of the issue and/or policy. Response frequency did not differ significantly across the two participant conditions. Within this question, all participants could select between two positively and two negatively framed statements. So far, there is a greater proportion in both surveys responding to the positives instead of potential losses.

Framing Effect Negative: Words chosen in the questions in the pro-climate carry a negative connotation, hinting at potential losses associated with anti-climate behaviors.

Concern with Environmental Issues: The message framing varied environmental "issues" in the neutral group compared to "travesties" in the Pro-Climate condition. When the word "travesties" is mentioned, the respondents of the Pro-Climate Survey selected concern for Air Pollution and Poor Waste Management at a higher proportion than respondents of the Neutral Survey. This is likely due to prior priming, such as the positive emphasis on recycling (which prevents poor waste management) in question 7, and the negative emphasis on vehicle pollution in question 1 (which leads to air pollution) presented before this question.

The positive emphasis on recycling in question 7 (which prevents poor waste management) and the negative emphasis on vehicle pollution in question 1 (which leads to air pollution), presented before this question may have primed associations for the pro-climate respondents to be concerned specifically about air and water than those in the non-primed survey condition. See **Figure 4**.

Trust in Organizations: Overall, those in the control condition reported having less frequent trust in respective climate crisis information sources than those in the Pro-Climate condition. Those in the Pro-Climate group had a significantly greater proportion of strong/moderate trust in a family member ($Z = -2.74$, $p = .006$), a scientist ($Z = -3.67$, $p \leq .001$), the government/policy maker ($Z = -2.09$, $p = .037$), and the media ($Z = -2.38$, $p = .017$). It is unclear the extent to which prior survey question framing may have impacted the processing of sentiment or the potential salience of organizations typically involved in disseminating

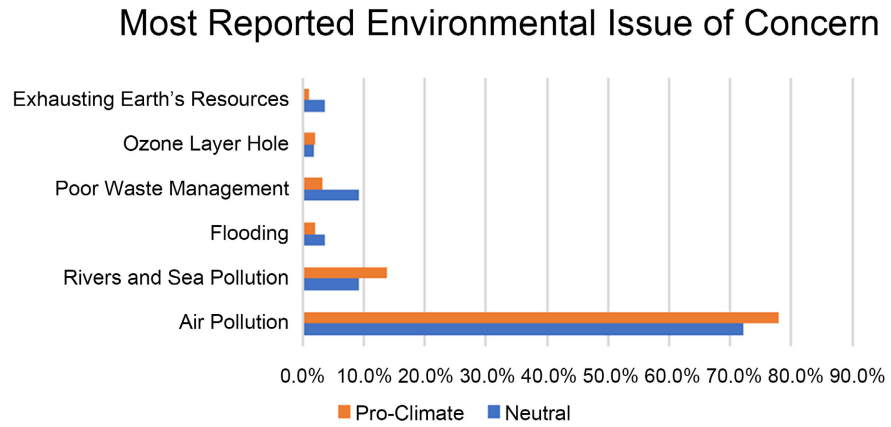

Figure 4. Reported issues of concern by survey group.

climate-oriented questionnaires. Perhaps the medium of inquiry increased the fluency of familiarity in these sources, increasing perceptions of perceived trust by proxy of familiarity. The repeated exposure to the negatively framed word "crisis" may have been enough to explain the differences in trust in source by condition.

Effectiveness of National Initiatives: Pro-Climate respondents reported more agreement, viewing the climate crisis response from the US as more effective than Neutral participants do, though the proportion of responses did not differ significantly by group (Z = −1.54 = p = 0.0.124) Neutral Survey (M = 2.46, SD = 0.818); (Pro-Climate M = 2.73, SD = 0.870).

Effectiveness of Community Environmental Policies: Pro-Climate respondents reported more agreement, viewing the climate crisis response from the US as more effective than Neutral participants do, though the proportion of responses did not differ significantly by group (Z = −474 = p = 0.635) Neutral Survey (M = 2.61, SD = 0.920); (Pro-Climate M = 2.72, SD = 0.895). Both survey group conditions reported slightly increased perceived effectiveness of climate policies within their community compared to national climate crisis policy initiatives. Perhaps we should consider here that the concrete considerations of examples within the local community may impact the perceptions of effectiveness of climate initiatives compared to more abstract constructs, such as a nationally oriented, less specified policy. Furthermore, despite non-significant data, negative framing's potential linkage to temporal construal and familiarity may be further examined by future research.

Activities that Contributed to Climate Change: No significant differences by group were reported to rating the relative impact of climate-oriented occurrences (e.g., litter, greenhouse gas) on current climate health.

Visual Anchoring: The following are responses to visual anchoring dynamics that varied across survey types. An image depicting negative aspects of climate change is presented in the Pro-Climate survey, while a neutral nature-focused image was presented in the Neutral questionnaire to determine the impact of negative visual framing on climate's impact on future generations.

Extent of Effect on Future Generations: While the difference is not statistically significant, Pro-Climate respondents reported lower agreement with climate change impacting future generations upon seeing visually triggering/negative images of pollution (M = 4.13, SD = 1.013) compared to participants in the Neutral condition (M = 4.20, SD = 1.071). However, the proportion of respondents reporting top two box responses for "extreme impact" were higher in the Pro-Climate Group compared to those in the Neutral condition.

In-group vs. Out-Group Bias: Both surveys contained language that suggested Democrats overwhelmingly choose a non-climate friendly alternative of turning air conditioning on to a level of comfort. We posited that the preference of the Democratic Party for an anti-climate option is stated to evaluate whether participants who chose the Republican Party as their affiliation would select the more Pro-Climate option as well, irrespective of the mismatch in political party affiliation.

Preferred Climate Altering Tolerance for Warm Temperatures—AC Condition: No significant differences were found in reported preference or climate adjustment during warm temperatures.

Preferred Climate Altering Tolerance for Cold Temperatures—Heating Condition: No significant responses were found in reported temperature adjustment as a function of survey type. Below, it is apparent that there is a significant difference in reported comfort behavior as a function of political party identification for issues related to home heating ($Z = -3.13$, $p = .002$), but not for home cooling ($Z = -1.13$, $p = .260$). With the Pro-Climate survey condition giving a false statistic about the majority of Democrats choosing the third option (comfort), the Democratic Party affiliated respondents likely felt less guilt in choosing a less pro-climate action as choosing this option aligns with the majority of their in-group political members. When someone in the in-group, in this case the Democrats with information about their fellow Democrats, behaves in less pro-climate ways with their at-home-heating, the natural reaction is to dismiss the behavior as not significant (Leville et al.). In this case, the significant difference suggests an underlying attitude that may also be elicited by the in-group bias—to reveal more of someone's own unfavorable behaviors (i.e., using home heating to the fullest for individual comfort rather than just a bearable temperature to save energy) when learned that others in their group reported similar unfavorable behaviors. Similar with the Republicans towards home heating: when someone in their out-group, in this case the Democrats, show predisposition for heavy use of home heating, they may tend to judge the behavior much more harshly and deviate their perception of their behaviors from this unfavorable behavior condone by out-group members (i.e. choosing bearable temperature, a more climate-friendly behavior, when learned that Democrats choose a temperature in which they are absolutely comfortable). See **Figure 5**.

Base Rates: For this series of questions, hypothetical base rates, or percentage of the population choosing the Pro-Climate option, is presented to evaluate whether participants would select a percentage above the base rate for themselves and

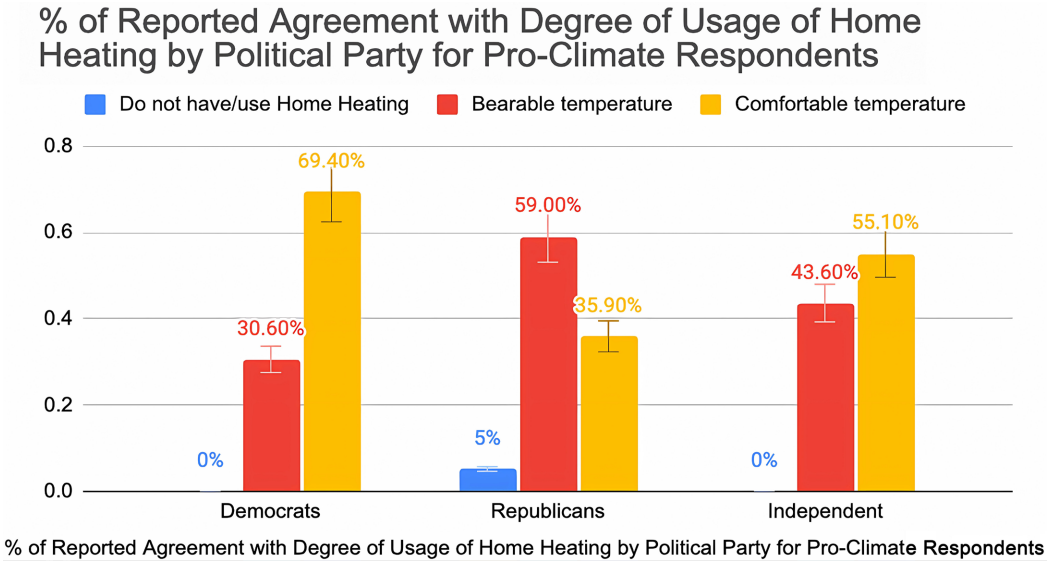

Figure 5. Reported agreement with degree of home heating use by survey condition.

their close cultural affiliates, as well as whether they would select a percentage below the base rate for a more general/distant group in attempt to justify that these groups are more of the culprits for climate change.

Social Group Distance on Recycling Engagement: Both groups are falling into the fundamental attribution error: from the most distant social group from the respondent to the closest. As the relationship with the respondent gets closer, there is an increase in fundamental attribution error for the respondent in both surveys, and the main effect of fundamental attribution error magnifies as the listed social group's relationship with the participant becomes more personal. Thus, while there is no significant difference between the two surveys on this question, we found that the responses across both surveys support the theory of fundamental attribution error. Specifically, we found that as individuals report recycling use as a function of social distance of a group, the closest social groups are perceived as conducting more pro-climate recycling behaviors compared to those social groups that are more distant. This demonstrates the use of bias as a manipulation check that our participants are responding as expected.

Rating of Air Pollution's Impact on the Respondent's Health There was no significant effect for the degree of agreement on the extent to which air pollution has affected the health of the respondents themselves despite Pro-Climate respondents (M = 2.83, SD = 1.255) being higher than Neutral respondents (M = 2.74, SD = 1.141). Nevertheless, it should be acknowledged that the Pro-Climate respondents reported less impact of air pollution on their own health. This suggests a slight priming with health, financial, and survival issues and statistics of climate change elicit an unconscious sense of accomplishment in the Pro-Climate respondents that they are not as affected due to their and their living environment's pro-climate behaviors.

Climate Change on Family's Health: No significant difference in the ratings for the health of yourself vs. the health of your family as a function of the survey

condition. After the base rates priming informed the Pro-Climate respondents of the proportion of people living in areas of high pollution, the Pro-Climate respondents reported less impact of climate change on their families' health. The base rate elicited a sense in the Pro-Climate respondents to deviate away from being potentially impacted by climate change, non-consciously defending their prior choices that favor pro-climate actions (such as Showering for shorter minutes). Within the Pro-Climate condition, the consideration of air pollution's impact on families was greater than in the Neutral condition. This difference may be due to the priming of the Pro-Climate survey questions. Such a priming may increase processing of a larger consideration set of concrete negative impact of air pollution on others beyond the self as illustrated by a higher gravitas on perceived health impact beyond the self. These findings also support the hypothesis that the base rate question framing in the Pro-Climate condition influenced the consideration of probability of air pollution impacting familial health.

Bandwagon Effect: A behavior performed by a hypothetical majority is given to evaluate whether participants would conform their selected option to the majority.

Agreement with General Statements About Climate Change: The stronger the agreement, the more Pro-Climate the respondent is for the environment. Although this question did not show statistical significance, the Pro-Climate respondents showed stronger agreement for cooperative beliefs about the climate than did the Neutral respondents. After the prior priming, the Pro-Climate respondents are more aware of pro-climate decisions being associated with a higher social respect and alignment with their communities.

Temporal Construal: Different time periods to recall personal experiences with climate change-related events to evaluate whether participants change their mental representation of the events that happened to them as a function of time.

Flood Damage: In a chi square test of proportional differences between condition and reported recall with flooding damage in either the past five years or at all, no significant differences were found. Both groups recalled having experienced flood damage at all, compared to those who reported experiencing flood damage in the past five years.

Past Weather Patterns: Less respondents in the Pro-Climate Survey than the Neutral Survey responded, "Definitely Yes" or "Probably Yes." This suggests that the framing techniques drawing negative associations with anti-climate actions have not established an overarching association of specific anti-climate actions with general changes in weather patterns for the Pro-Climate respondents at this point. Those in the Pro-Climate group tended to have a higher proportion of strong agreement to having experienced weather pattern change in a more recent time frame. This may be due to an increased salience toward issues related to climate in the experimental condition.

Anticipation for Future Weather Patterns by Temporal Construal: While the overall percentage of agreement with climate change affecting the weather pattern in the future is higher in the Neutral Survey, respondents of the Pro-Climate

Survey selected "Definitely Yes" as opposed to "Probably Yes" a greater proportion of the time than respondents of the Neutral Survey.

Regarding reported anticipation of climate change damaging the Earth in the near-term future (next 1 - 2 years), significant differences in agreement levels by survey group were found. Those in the neutral condition showed greater proportion of strong/moderate agreement (81.1%) in the near time frame consideration t (z = 2.64, p = .008) compared to those in the Pro-Climate condition (71.8%). Differences in responses in the moderate future (3 - 5 years from now) approached significant differences in agreement levels by survey group (z = 1.79, p = .073) with those in the control condition reporting higher proportions of strong to moderate agreement (90.8%) compared to those in the Pro-Climate condition (80.4%). There were no significant differences by group in strong/moderate agreement to the climate's state's impact on the earth in the long term (10+ years). The majority are in agreement consensus (N 93.2%; PC 92.4%). If anything, negative priming in the near and moderate conditions tends to dampen agreement to climate's impact on earth. Priming did not seem to impact agreement levels with respect to the climate's long-term impact on earth.

Social Desirability Bias: The positive impacts of certain pro-climate behaviors as well as the fact that the pro-climate behavior is one of rationality and virtue are emphasized to evaluate whether more participants of the Pro-Climate Survey will select the pro-climate option in order to appeal as socially acceptable/desirable.

Importance of Climate to Respondent Personally: There was no significant effect for the personal importance of climate change; however, the personal importance of climate change in Pro-Climate respondents (M = 3.60, SD = 1.019) and in Neutral respondents (M = 3.87, SD = 1.038) approached a significant difference. Pro-Climate respondents reported more moderate ratings for the importance of the climate crisis to them than did the Neutral respondents.

Likeliness to Cooperation: Of the statements related to specific topics of public policy, reported strong cooperation for "conservation resources" and "raise your income tax to support a campaign building or environmental institution close to your house" differed significantly by condition (Z = 2.12, p = .034; Z = 2.16, p = .009). Those in the Pro-Climate condition were more likely to report strong agreement to cooperate on these two issues compared to those participants within the control group. This increase in reported willingness to cooperate in the Pro-Climate group (experimental condition) may have occurred as a function of the embedded priming of negative climate issues within the Pro-Climate survey. See **Figure 6**.

Likeliness to Recommend Pro-Climate Actions: There was no significant difference in reported strong likelihood to agree with recommendations about pro-climate activities as a function of survey condition.

NIMBY Effect (*Negative Arousal*): The negative outlook of the future if pro-Climate behaviors do not happen is emphasized to evaluate whether such description will arouse negatively associated emotions in participants regarding anti-social behaviors for the climate.

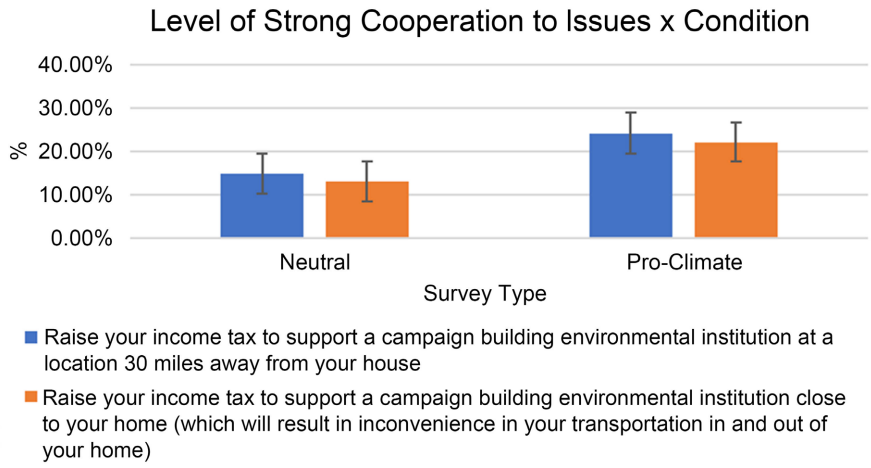

Figure 6. Reported levels of strong cooperation by survey condition.

Extent of Finance the U.S. Should Dedicate to Climate Change: No significant differences were found by condition on the question of how heavily the US should dedicate financial resources to combat the climate change/crisis." More participants in the control condition reported strong agreement to the dedication of financial resources to aid the climate crisis."

NIMBY Effect (*Positive Arousal*): After negative NIMBY arousal is proposed against a suboptimal future, pro-climate behaviors that correspond to and mitigate those issues are presented to evaluate whether the participants will experience a positively associated emotional arousal toward these pro-climate behaviors.

Awareness Level of Community Policies: There was a significant difference by condition of agreement to the reported awareness of local community policies regarding behaviors that contribute to climate change/crisis ($Z = -1.90$, $p = .029$). Pro-Climate respondents reported higher awareness of community climate policies regarding the climate than Neutral respondents. See **Figure 7**.

Attitude Change (*Internalization*): Devastating impacts of climate change on public health and prosperity were presented to evaluate whether participants will select pro-climate options as a result of feeling genuine need to contribute to mitigate climate change.

Organization Whose Policies the Respondent Will Most Likely to Follow: The Pro-Climate respondents reported higher likeliness to follow the policies of the government, both locally and nationally, and lower likeliness to follow policies from environmental groups. The prior priming imitates what an environmental lobby group would advocate, with less objective wordings and more emotionally provocative words such as "travesty" and "impair." This may account for Pro-Climate respondents reporting faith in more influential organizations such as the government to carry out pro-climate actions than smaller and less powerful organizations like environmental groups. This is informative for the policy-law model as the prior priming have led to respondents reporting more in favor of the U.S. policymakers.

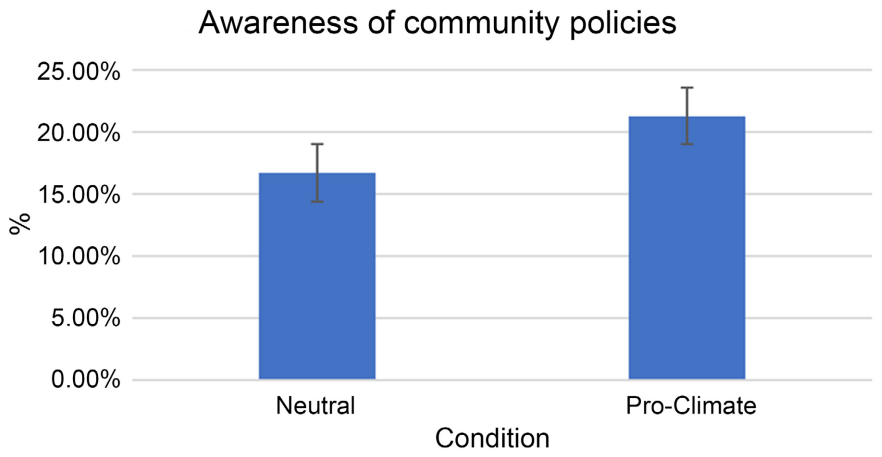

Figure 7. Reported awareness with community policies on climate by survey condition.

Organization Reported by Respondent as the Most Responsible for Generating Climate Policies: No significant differences were found by the group for the identification of organizations responsible for creating policy related to climate change. The National Government was more frequently selected by those in the Pro-Climate group compared to the control.

Adequacy of Current Policies: There was a significant effect for the adequacy of current climate policies between Pro-Climate and Neutral survey respondents, $p = .039$.

The respondents of the Pro-Climate Survey reported more polarized ratings on the adequacy of current climate policies, with more Pro-Climate respondents reporting "Very Adequate" at higher proportions than the Neutral respondents. Those in the Neutral condition rated adequacy of current climate policies as "Very Inadequate" at a rating of 1 or 2 was greater than responses in the Pro-Climate condition. See **Figure 8**.

Self-Serving Bias: Anti-social options that emphasize individual gain at the expense of the environment are presented after prior priming to evaluate whether participants will avoid agreeing with such anti-social options.

Agreement with Statements about Human Impact on Climate Issues: For agreement levels regarding general statements on climate change, only "jobs exist today are more important than the environment for the future" and "I tend to consider information about climate change irrelevant to me" differed significantly by group. ($Z = 2.34$, $p = .019$; $Z = 2.66$, $p = .008$). In holding conditions constant and comparing differences in responses to Republican and Democratic identification by the participant, no significant differences were found. See **Figure 9**.

Recall Bias: After negative priming has been associated with climate change, participants are asked to recall the number of times environmental disasters occurred to them in a period.

Adherence to Current Policies: While not significant across experimental conditions, those in the Pro-Climate condition were more likely to report levels

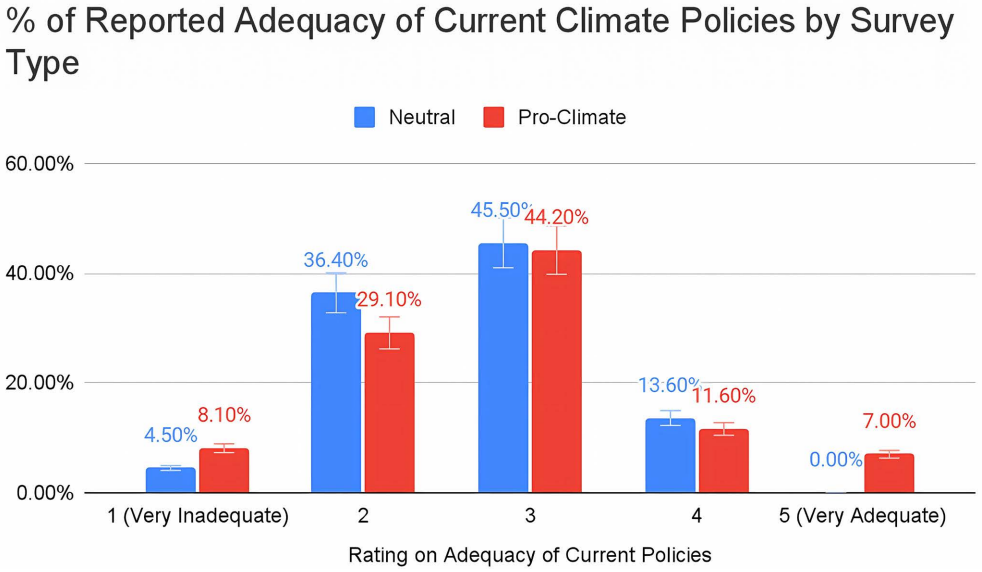

Figure 8. Reported adequacy rating of current climate policies by survey condition.

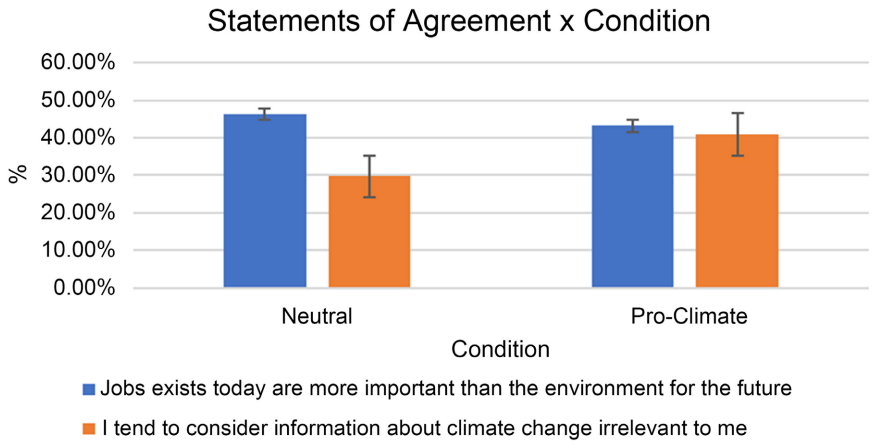

Figure 9. Reported agreement with statements on climate by survey condition.

of strong agreement to their adhering to policy change. This may be the result of priming used in the Pro-Climate survey. See **Figure 10**.

Adherence to Future Policies: Proportional differences in agreement rating were not significant by group. Nevertheless, it should be acknowledged that more Pro-climate respondents reported higher adherence to future climate policies than did the Neutral respondents.

Reported Effectiveness of Organizations: There was a significant difference in effectiveness ratings of organizations by experimental group ($Z = -1.91$, $p = .054$). The Pro-Climate respondents reported higher effectiveness of governments at enforcing climate policies than the Neutral respondents did. This demonstrates that the prior priming has, like Question 29, enhanced the Pro-Climate respondents' recall of a higher efficiency and value in the government at actions combating climate change. Understanding the effect of priming within the Pro-Climate condition may help inform policymaking processes. This survey respondent

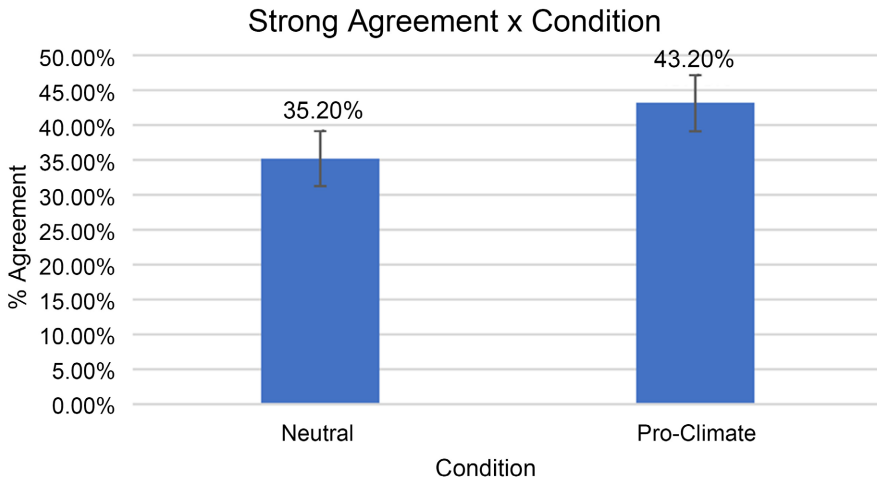

Figure 10. Reported agreement with willingness to adhere to current climate-oriented policies by survey condition.

population reported higher effectiveness in the policy-making unit when primed with cognitive biases such as positive and negative framing effects, NIMBY positive arousal, and general facts and statistics about climate change under attitude change internalization (all of which showed statistical significance in the Pro-Climate Survey questions that incorporated them). See **Figure 11**.

Cumulative Priming (*Explicit*): Asking the participants for a qualitative response that lists their conscious emotions when hearing the word "climate change," the overall effect of all the cognitive biases in priming the participants' explicit behaviors can be evaluated.

Reported Topics that Concern the Respondent: The study found a significant difference in the types of concerns expressed by respondents in the Pro-Climate Survey compared to those in the Neutral Survey ($Z = -2.240$, $p = 0.013$). The Pro-Climate respondents ($M = 4.20$, $SD = 0.879$) were significantly more likely than the Neutral respondents ($M = 3.83$, $SD = 1.014$) to select violence/war as a major concern. Additionally, statistically significant differences were found in the levels of concern for terrorism, climate change, poverty, crime and violence, and war between the two groups, with Pro-Climate respondents expressing greater concern in each area. This suggests that priming had a negative impact, associating current global issues with climate change and leading Pro-Climate respondents to express greater interest in related topics. It is worth noting that climate change itself generated more interest among Pro-Climate respondents, indicating that the survey did not fail to elicit interest in the primary subject matter.

Reported Words to Describe Emotion Upon Hearing "Climate Change": This representation of open-ended adjective responses classified negative reported emotions as either active or passive, like the fashion that is embedded in the International Affective Picture Set (IAPS) photo database of affective imagery (Bradley & Lang, 2017). See **Figure 12**.

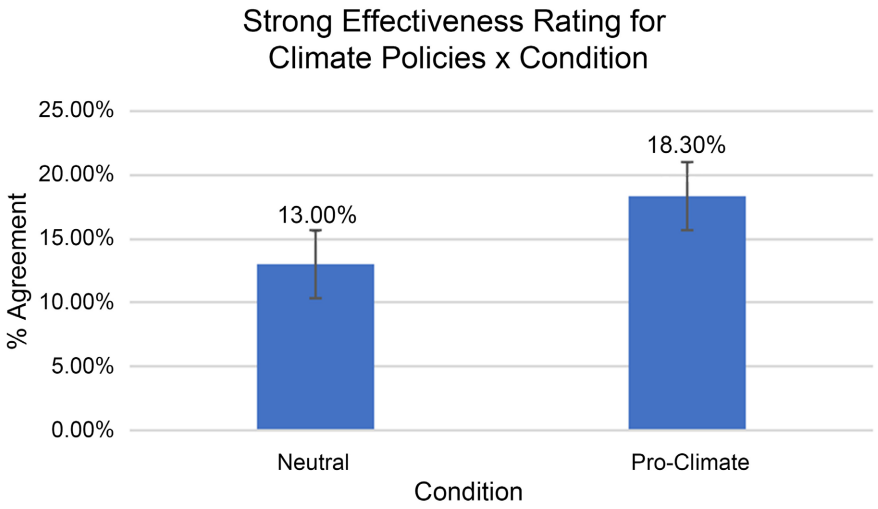

Figure 11. Reported effectiveness of climate policies by survey condition.

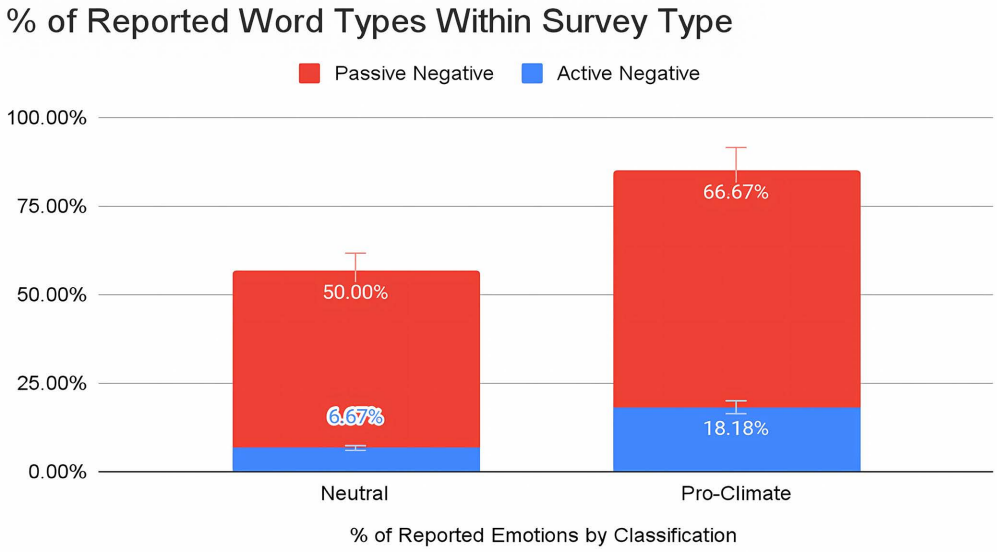

Figure 12. Reported active and passive word choices regarding climate change by survey condition.

Cumulative Priming (*Implicit*): Asking the participants who are not cognitively aware of the degree of negativity/positivity they see in a facial expression, to rate a neutral surprised face from extremely bad to extreme good, the overall effect of all the cognitive biases in priming the participants' implicit behaviors can be evaluated.

Ambiguous Face Rating: Ratings for a "surprised" ambiguous facial expression approached significance. As a function of going through the primed Pro-Climate survey, the Pro-Climate respondents are more likely to perceive neutral information such as a neutral surprised face more negatively than the Neutral respondents who were not primed. Moreover, those in the Neutral condition were more likely to rate the ambiguous facial expression as positively valanced than those in the Pro-Climate condition. This corresponds to the cumulative explicit question asking the respondents to use words to describe their emotions

when hearing the word "Climate Change." At the same time the Pro-Climate respondents consciously (explicitly) understood their attitudes towards climate change as more extreme or even crisis-like, they also developed an unconscious (implicit) tendency to view neutral information as negative. This knowledge may help inform the policymaking process as cumulative priming can impact the respondents on an unconscious level to make them perceive more gravity and greater negativity in the public issue a policy is trying to mitigate. See **Figure 13**.

Donations for Climate: No significant difference in recalled donation amount behavior was found as a function of experimental condition. For each condition, just over 40% reported not having donated any money toward climate-oriented initiatives.

8. Description of Discussion

Accounting for Significant Differences

While the participants of this study make up a probabilistic sample, there was no significant difference between the two groups as demonstrated by chi-squared tests on each demographic question (refer to Appendix F for proof). Thus, any difference observed from the results of the experimental survey compared to the control survey will be a function of the experiment manipulations and not any inherent difference between the two groups.

Qualitative Analysis of the Effects of Cognitive Biases

The results suggest that, overall, a cumulative impact of various cognitive biases built from the supporting role of specific biases to each other and the systemic pattern of pro-climate framing woven throughout the experiment survey indeed exists. Confirming the central research goal of this study and the overarching curiosity raised by existing research (Thomas & Kyung, 2019: p. 1277; Riedl, 2010: p. 69; Pillutla & Chen, 2009: p. 255), the cumulative effect of the biases worked

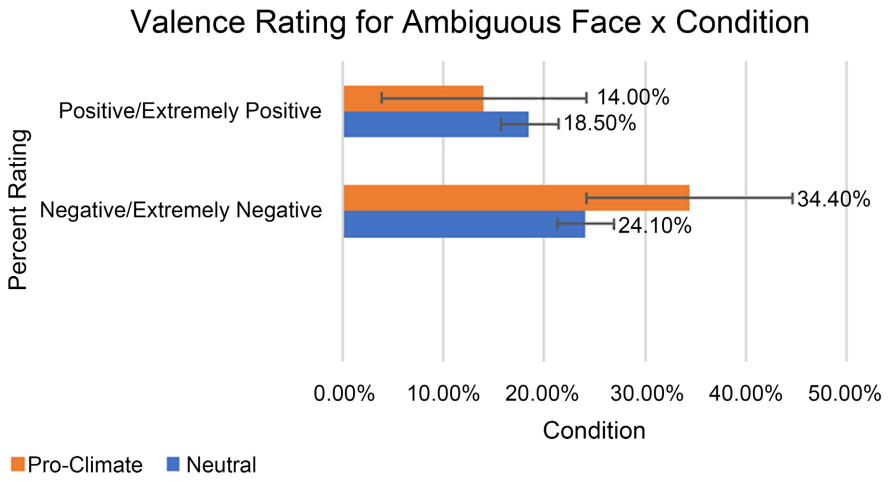

Figure 13. Reported emotional countenance rating of ambiguous image of surprised face by survey condition.

to collectively change the experiment survey participants' responses in both specific cognitive bias-framed questions and questions with the systemic pro-climate framing structure. Specifically, those experiencing the experiment condition are more likely to trust organizations and entities communicating issues of and policies for climate change (as demonstrated by question 16) and are more likely to perceive themselves as more aware of climate policies in their communities as a result of the general framing embedded throughout the experiment survey (as demonstrated by question 26). The experiment survey participants were also more likely to have attitudes of higher willingness to cooperative with climate policies that involve their personal involvement and direct action (as demonstrated by question 23) as a result of the internalization attitude change bias' specific effect of priming the participants on a deeper attitudinal level amplified by the build-up of pro-climate framing in the questions prior.

For questions 16 and 26 demonstrating the build-up effect of the pro-climate general framing throughout, the repeated exposure to the negatively-framed word "crisis" is likely the explanation for the differences in perceived trust in policy-creating institutions by survey type and in perceived personal awareness of climate policies. The results demonstrate that the persistence of the framing "climate crisis" can increase people's perceived salience in organizations typically involved in spreading information and regulating laws on the climate, as the negatively connotated word can imply a greater perceived need for the policy creating side. Furthermore, general framing can alter people's perception of their personal involvement in the policy effort, as the severity of the deliberately framed words may push for a stronger sentiment and sense of responsibility for policy awareness. These understandings can serve as the systematic basis of shaping a more pro-policy decision-making-inducing policy on a broad scale—namely, through minor changes in wording connotations and degree of severity. Reaffirming Pillutla & Chen's (2009) corresponding works of change in a population's perception as a result of systemic framing of active-passive or severe-neutral words, the persistent pattern of severity in the experiment survey's language elevates perception of issue gravity and a subsequent willingness to externally trust pro-climate organizations and internally adapt pro-climate decision-makings. For question 23 demonstrating the experiment condition's effect of amplifying the specific effect of the internalization attitude change bias, an increase in participants' practical attitude in characterizing themselves as active contributors to the policy effort (after reading brief and randomly located paragraphs on the detrimental consequences of climate change, all of which are framed into the questions with techniques used by Kelman's study on the individual effect of internalization attitude change biasing) is likely the explanation for the significant difference by survey type (Kelman, 1958: pp. 52-56). This connects to the central research goal by demonstrating the complexity of a cumulative impact casted by a framed survey: not only are the effects of the general framing effort evident, the question of whether the specific effect of cognitive biases can be strengthened in context of framings from prior question has also

been answered. While the general framing found success in participant perception of their relatedness and responsibilities for climate policies, the statistically significant result found in the specific cognitive bias question affects the participants' attitude when considering more practical ideas like their willingness to personally cooperate with the policy.

Two questions worth discussion are questions 36 and 37, which test the cumulative impact of the experiment conditions both implicitly and explicitly. The result of the cumulative explicit question further confirms the connection between different cognitive biases and their contextual position of being in a pro-climate framing survey as the conscious attitude towards climate policies of the experiment survey participants are much more involved and action-seeking (as demonstrated by question 37), suggesting that cognitive biases work together with each other and with general framing to influence people's conscious attitude. While the cumulative explicit question only approached a significant difference by survey type (as demonstrated by question 36), the results indicate a trend for participants to report an implicitly negative valence to the ambiguous emotional expression of surprise, likely due to the cumulative priming of varying cognitive biases in the subconscious perception of emotional involvement with the issue addressed by the policy.

The qualitative interpretations of this study not only help mitigate the identified scientific gap in psychological research, but also help strengthen the prominence of using accessible cognitive priming techniques like the cognitive biases or a general framing to enhance the public's perception of the issue's gravity and attitude towards increased cooperation. Furthermore, this study serves to advance the communication between experts in cognitive psychology and policymakers to achieve their shared endeavor of shaping beneficial policies (i.e. climate change initiatives) with techniques that works like this study have identified to be effective to ensure optimal outcome from the population at large (Lyden, 1976: p. 321; Cairney & Kwiatkowski, 2017: p. 37).

Potential Interests and Disputes

Integrating cognitive biases into the generation of policy related to climate change is essential because these biases significantly affect how humans perceive and respond to the issue. By recognizing and accounting for the examined cognitive biases, policymakers can create more effective policies that take into account the potential for human error and misinformation and apply understandings from research to utilize these biases in ensuring an optimal outcome in the target population is achieved, either in behavior or attitude. Overall, integrating cognitive biases into climate change policy generation is a crucial step towards creating more effective policies that ultimately return in the form of benefits achieved by its better ideation or implementation. Furthermore, as the communications between psychologists and policy makers and enforcers increase, the policy making institutions are able to access more informed insights positioned to leverage cognitive biases from studies like this to increase the perceived salience of the issues that policies are addressing and practical attitude towards

pro-policy decision-making and personal cooperation in the target population.

While critics may claim that cognitive biases could be a tool of manipulation by policymakers, understanding acquired from this study do not contribute to any unethical or politically manipulations: the use of cognitive biases assists in enhancing citizens' willingness to comply with climate-related policies and adhere to the desired behaviors are what are initially intended by policies. Furthermore, using more persuasive techniques to increase cooperation and compliance to decision-making and behaviors on issues as exigent as climate provides only benefits for the environment and improvements in progress on various environmental goals envisioned by policymakers and the public.

9. Deficiencies & Limitations

With the quantitative results and their qualitative descriptions discussed, it is crucial to note the potential limitations of this study for related future studies. Firstly, since the surveys are done in a non-monitored, remote setting on Google Form, the participants of the experiment survey could complete one portion of the survey and return in another time to complete the rest. This poses a set back as pausing the online survey may diminish the immediate effect of the general framing done by the experiment survey's wording or the effect of the specific cognitive biases incorporated within periodic questions. Another limitation exists with the cumulative explicit priming question asking for a reporting of emotion adjectives. Some participants may have a limited vocabulary that prevents them from coming up with more active negative words (i.e. more intensive words such as "anger," "rage," etc.), so they use passive negative words (i.e. "sad," "unsure," etc.) that do not fully represent their explicit association with climate change and vice versa, affecting the complete accuracy of question 37's data.

10. Alignment with Hypothesis & Summary

With multiple questions yielding statistical difference as a function of the pro-climate priming and cognitive biases used in the experiment survey, the null hypothesis (H0) of this study's manipulations having no effect can thus be rejected while the research hypothesis (H1) that the effect of the cognitive biases in context of general framing are presented can be accepted. Furthermore, subsets of the research hypothesis, namely H1a and H1b, are also accepted. As demonstrated by the statistically significant results by survey type yielded by questions 16, 23, and 26, there are changes towards more pro-climate attitudes in participant decision-making as a function of specific cognitive biases framed within the experiment survey (H1a). Additionally, as demonstrated by question 37, there is a significant difference in the explicit choice of sentiment used (e.g. passive vs. active negative) to describe climate change as a function of the cumulative impact of all question framings in the experiment survey (H1b). Since question 36 did not yield a difference that is statistically significant by survey type, H1c is rejected.

These findings suggest that, overall, a cumulative impact of various cognitive biases exists that worked to systematically change participant responses in the Pro-Climate conditions. Specifically, those in the Pro-Climate condition were more likely to trust organizations and entities communicating issues of climate change, were more likely to report a willingness to cooperate with pro-climate policies, were more aware of local community climate policies, had higher agreement on the adequacy of current climate policy, were more likely to report a willingness to comply with current climate policies, and held a stronger reported belief in government enforcement of climate policy than those in the control condition who were not exposed to cognitive biases.

Beyond explicit reporting of recalled and anticipated behaviors related to climate change, there was a trend for participants in the Pro-Climate condition to report an implicitly negative valence to the ambiguous emotional expression of surprise than those in the control condition, suggesting that the cumulative priming of varying cognitive biases impacted this group's non-conscious judgment of emotional affect.

11. Potential Application for Policy Creation and Adoption

Integrating cognitive biases into the generation of policy related to climate change is essential because these biases significantly affect how humans perceive and respond to the issue. Biases such as confirmation bias, availability heuristic, and optimism bias can lead to individuals and policymakers underestimating the severity of climate change and its potential consequences. By recognizing and accounting for these biases, policymakers can create more effective policies that consider the potential for human error and misinformation. Additionally, acknowledging cognitive biases can increase public trust in the policy-making process by demonstrating a willingness to address potential blind spots and biases. Overall, integrating cognitive biases into climate change policy generation is a crucial step towards creating more effective and equitable policies.

Specifically, with respect to the policy cycle introduced in the introduction section, policy makers and policy enforcers are ideally positioned to leverage cognitive biases to increase the salience and importance of specific issues to address related to climate during the issue ideation phase of the cycle. Those responsible for constructing persuasive communications to increase the adoption and adherence of policy can benefit in use of cognitive biases to nudge citizens into a willing compliance to climate-related regulations at both the local and national levels.

12. Future Directions

The future directions of research using cognitive biases in measuring attitudes and recalled behaviors will likely focus on the development of more precise and valid methods for assessing these biases. Researchers may explore innovative techniques, such as virtual reality simulations, to more accurately capture the ef-

fects of cognitive biases in a naturalistic setting. Additionally, there may be increased emphasis on measuring the impact of biases on decision-making processes, rather than just on attitudes and recalled behaviors. Future research may also aim to identify specific interventions and strategies that can mitigate the effects of cognitive biases, both at the individual and societal levels. Finally, given the global nature of climate change, there may be an increased focus on cross-cultural research to better understand how cognitive biases vary across different populations and contexts. Overall, the future directions of research using cognitive biases in measuring attitudes and recalled behaviors are likely to be multifaceted, interdisciplinary, and aimed at addressing critical gaps in our understanding of human decision-making.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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