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Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA,
IRVINE

Climate Change Communication of Interest Groups on Twitter

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF ARTS

in Social Ecology

by

Caitlin Benedict

Thesis Committee:
Professor David Feldman, Chair
Professor Emeritus Daniel Stokols
Professor Kirk Williams

2021

DEDICATION

To my devoted family:

To my parents for their continuous love and support,

To my brother for always making me laugh,

To my cat, Theo, for being there every step of the way.

To my wonderful friends:

For their love and support,
For their understanding,
For endless memories.

And for this valuable lesson:

“Don’t ever underestimate the importance of Doing Nothing,
of just going along, listening to all the things you can’t hear,
and not bothering.”

-Winnie the Pooh

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ABSTRACT

Climate Change Communication of Interest Groups on Twitter

By

Caitlin Benedict

Master of Arts in Social Ecology

University of California, Irvine, 2021

Professor David Feldman, Chair

The way different interest groups frame problems can influence public opinion about those issues. Since public opinion plays a large role in policy formation, it is important to understand how climate change is being conveyed to the public by influential groups. Media coverage is one of the major predictors of public concern about climate change. As Twitter has skyrocketed in popularity over the years, many organizations use this networking site to promote their interests. Twenty-five organizations were selected for content analysis of tweets relating to climate change. Over 1,600 tweets were pulled from an 8-month period through Twitter's API and coded for the use of different frames. Findings were mostly consistent with past research, however this study found that science organizations are becoming more involved in the climate discussion, more conservative political parties have shifted their framing about climate change away from questioning climate science, and mainstream environmental groups are increasingly considering equity and justice in climate impacts. Overall, the implications of this study provide messengers of climate change opportunities for collaboration and places to fill the gaps in discussion.

INTRODUCTION

While citizens and scientists around the world have been concerned about climate change since the 1960s, the 1980s brought climate change to the forefront of global policy interest. This interest led to multiple international climate conferences. International survey data shows that the 1980s and early 1990s were a time of increasing knowledge and awareness about climate change and the mid-1990s to the mid-2000s showed increasing variation in public opinion (Capstick et al, 2014). The mid- to late-2000s showed a decrease in public concern and an increase in climate skepticism among developed nations (i.e. the United States, European countries, and Australia) and the opposite among developing nations (i.e. countries in Latin America, Africa, and Asia). These polling data follow the failure of the United States to ratify the Kyoto Protocol of 1997 as this was the start of a steep decline in interest of any potential national climate policy in America. More recently, the United States withdrew from the Paris Accord of 2015 under the Trump administration, but has since rejoined in 2021 under the Biden administration.

As the second largest emitter in the world, the United States ideally should have stringent climate policies. Nonetheless, national climate change policy, either in terms of mitigation or adaptation, in the United States is practically nonexistent as of 2021 (not to discredit developments at state and local levels, such as legislation like AB 32 in California and the Regional Greenhouse Gas Initiative, a cap-and-trade system in the Northeast United States). A global, fast-approaching, predictably disastrous problem like climate change is important to study from multiple vantage points, particularly psychological and sociological perspectives. In this study, public opinion has been shown to play a large role in policy formation so research is needed to examine the mechanisms underlying support

or opposition to climate change initiatives. Framing theory points to the processes of public opinion development and the role of media in climate communication. This study examines how different groups frame climate change on social media.

Framing Theory

Previous research often did not make any distinction between priming and framing and often used the terms interchangeably. More recent research is attending to these distinctions to clarify what framing effects entail. While there is considerable variance in the nuances of each process, the overall concepts are the same. Priming refers to *what* information is being communicated whereas framing refers to *how* that information is being communicated (Sonnett, 2019). Similar to a frame that holds a piece of artwork, framing suggests a certain interpretation of an issue. Artwork displayed in a gold-plated frame will produce different interpretations than artwork displayed in a cheap, aluminum frame (Scheufele & Iyengar, 2017). The artwork is the *what* and the frame is the *how*.

The process of framing consists of (1) frame-building, (2) frame-setting, and (3) individual consequences of framing (Scheufele, 2000). “Frame-building deals with the creation and social negotiation of frames” (Tewksbury & Scheufele, 2010, p. 22) in which some frames gain more influence over others due to cultural values, elite rhetoric, or media practices. Frame-setting is how media frames influence an audience. Media frames (Scheufele, 2000), or frames in communication (Druckman, 2001), refer to the words, images, and styles a producer uses when relaying information to a receiver. Audience frames (Scheufele, 2000), or frames in thought (Druckman, 2001), refer to an individual’s understanding of a given situation. A framing effect, or frame-setting, is the process of how

media frames shape audience frames. Individual consequences of framing refer to the evaluations an individual attributes to a person or situation as a result of the frame.

The mediational process of framing includes accessibility and applicability (Chong & Druckman, 2007). In order to be accessible, a frame needs to have activation potential that exceeds a threshold so that it is retrieved from long-term memory. This is an automatic, subconscious, cognitive process and is linked to repetition in media, thereby evoking relative importance of the topic in an audience. A frame is applicable if the salient attributes of a message activate certain constructs which then increase the likelihood of use in evaluation to the message. This is a conscious cognitive process that links media content to individual cognition. A precursor to this process is whether there is any pre-existing relevant knowledge, otherwise effects are unlikely. In sum, opinions come from a set of available beliefs stored in memory; only some beliefs are accessible at any given moment; out of those accessible beliefs, only some are strong enough to be judged relevant or applicable to the situation at hand.

Framing Effects on Public Opinion

In order to produce policy changes, public support is essential. As Robert Dahl claims, “a key characteristic of democracy is the continuing responsiveness of the government to the preferences of its citizens” (1971, pg. 1). Thus, democratic competence requires citizens to be capable of forming preferences to which elected officials can respond. As Druckman (2001) points out, there are varied opinions on what it means to be well-qualified or capable of forming preferences. Some scholars argue that only citizens

who are well-informed are capable, others focus on the effectiveness of heuristics, and still others emphasize stability of ideological beliefs.

However, public opinion research suggests citizens have low-quality opinions, if they have any at all. Philip Converse (1964) holds that the public thinks about politics in very different ways, with a minority of people being ideologically sophisticated, resulting in highly unstable political attitudes over time. John Zaller (1992) backs this notion that voters do not hold structured belief systems but rather form opinions based on elite discourse reflected in his top-down Receive-Accept-Sample model. This model suggests that opinions reflect messages an individual receives (based on political awareness), accepts (based on consistency with prior beliefs), and samples (based on what holds priority to the individual in that moment). In a follow-up article, Zaller (2013) clarifies that this “elite” group does not consist of scientists but rather of interest groups, political intellectuals, and ambitious politicians. This is supported by Michael Tesler’s (2018) work on beliefs about climate change and evolution (both hold scientific consensus but public beliefs are determined by political and ideological rhetoric, respectively).

One implication of this research is that the existence of framing effects is evidence of citizen incompetence. Conversely, there are scholars that argue that this evidence can be explained by a lack of translational science efforts on the part of experts. Lakoff (2010) refers to this problem as the ‘trap of Enlightenment reason.’ This view claims that reason is conscious, logical, and universal, but we now know that to be false. As a result of this type of thinking, experts believe that if you “just tell people the facts, they will reason to the right conclusion” (Lakoff, 2010, p.73). However, facts need to be framed properly (i.e. in a

way that makes sense in the receiver's system of frames) in order to be believed, otherwise they will be ignored.

James Druckman (2001) discusses the evidence for and against citizen incompetence while focusing on two basic requisites of capable preference formation: (1) preferences should not be based on arbitrary information, and (2) preferences should not be manipulated by elites. The work of various researchers have concluded different framing effects produce mixed evidence for each of these requisites. In regards to the first criteria, equivalency framing effects can cause preferences that are effectually arbitrary. Equivalency frames are different but logically equivalent frames (e.g. glass half-full or half-empty). Experiments have shown that preferences can be manipulated based on how the frame is presented in a seemingly irrelevant way (as shown in Tversky and Kahneman's infamous Asian disease experiment).

On the other hand, there is evidence that these effects are limited. For example, effects are less likely to occur in individuals who have high cognitive ability, hold strong attitudes, have high personal involvement in an issue, or even need to provide rationale for their decision. Additionally, context matters greatly, especially in politics. Citizens generally have defined leanings toward political parties or segments of the political spectrum and are aware of what their preferred party supports. Thus, they typically support whatever option is supported by their party, which is systematic rather than arbitrary. The subsequent question becomes whether one form of incompetence replaces another – people may avoid arbitrary preferences but are exposed to elite manipulation.

With regards to the second criterion, emphasis framing effects can lead to preferences that are manipulated by elites. Emphasis frames are qualitatively different but relevant considerations (e.g. free speech or public safety in reference to a hate group rally). Since the central element of manipulation is that people utilize automatic and subconscious processing, political or media elite can increase the accessibility of certain frames by frequently using a frame and thus alter opinions. However, evidence points to a conscious and deliberate psychological process in which individuals assess relative importance of different considerations. Moreover, there are five moderators of emphasis framing effects: predisposition, citizen deliberation, political information, source credibility, and competition (Druckman, 2001).

Often, individuals compare frames with their own predispositions and accept ones that are consistent with their core beliefs. Citizens who engage in deliberative discussions form stronger opinions that are less prone to framing effects. The volume of political information an individual holds can influence framing effects but evidence suggests that these effects vary based on the type of issue, information, or other individual level attributes (e.g. familiarly with an issue). Framing effects are more likely if a speaker is credible to their audience (that is, they are trustworthy and knowledgeable). Finally, in many political contexts, people are often exposed to more than one frame of an issue, and often these frames are competing. These frames can counteract each other but only if people receive the frames in equal quantity, which rarely happens and depends on who promotes the frame, media practices, and whether they echo cultural themes. Overall, evidence suggests that citizens use frames in a systematic and well-reasoned manner.

Framing Climate Change

Frameworks are important to the understanding of climate change communication. Frames determine how people interpret and evaluate reality (e.g. whether climate change is a valid concern). Repetition of frames activates and strengthens the neural pathways for understanding those frames, making them more salient and 'normal' in everyday language (accessibility). However, individuals have their own schemas in which certain frames may or may not fit into (applicability), suggesting that while frames have similar widespread effects, these effects are not universal (Entman, 1993).

Similarly, as there is no one-size-fits-all solution to climate change, there is no one way to communicate with the general public about climate change. Communication could include a variety of modes and strategies to reflect individual values, emotions, and attitudes of the target audience. The traditional 'public understanding of science' model has become outdated. This model claims that experts only need to educate the public about the science of climate change to achieve widespread acceptance and consensus (similar to Lakoff's 'trap of Enlightenment reason'). However, as mentioned previously, facts need to be framed appropriately for the target audience so that individuals incorporate this knowledge into their belief systems. Moreover, there is no evidence of a direct correlation between communication and behavior change and this is most likely because the public is being inundated with scientific facts about climate change rather than practical solutions (Nerlich et al., 2009). Even still, individual action will only occur if it is supported by broader changes that involve removing barriers to action, such as making solar panels cheaper and easier to access.

Egan and Mullin (2017) report that there are three distinctive features of climate change as a public concern: (1) there is disagreement about whether climate change exists, (2) the invisibility and uncertainty of climate change forces people to rely on experts, and (3) climate change is a distant phenomenon. Studies that back up this third feature find that those who do believe in climate change also believe that it will not affect them personally; they believe that these impacts will be felt in other parts of the world and affect future, not current, generations (Nerlich et al., 2009). There is a clear disconnect between current communication and the public's perception of climate change. Nerlich et al. (2009) argue that communicators should look to local community initiatives to alter the discourse on climate change as well as ongoing studies of public perceptions and commitments. The current top-down, expert-driven approach to communication needs to be complemented by bottom-up, non-expert approaches. Rather than a one-way street of communication, there needs to be open dialogue and engagement with citizens.

Modes of Communication

There are numerous ways of communicating frames: verbal (conversation or public speaking), written (documents, direct messages, or publications), artistic (music, videos, or images), and media (broadcast, social, or interactive). While some forms of communication are restricted (e.g. one-on-one conversations or publications that need to be purchased), media specifically targets and reaches large audiences. For this reason, media plays a large role in the formation of public opinion on various subjects. Brulle et. al (2012) found that one of the major predictors of public concern about climate change is media coverage. As media coverage about an issue increases, public concern increases. With limited 'issue

space,' other issues may take the stage in media and public concern. Some studies show that the state of the economy predicts concern about climate change; as the economy takes a turn for the worse, concern for climate change drops (Capstick et. al, 2014). This is consistent with Down's (1972) issue-attention cycle: as one issue becomes more salient (i.e. important and relevant), others move to the backburner until something brings it to the forefront of attention again. Additionally, Down's cycle is characterized by initial eagerness to solve the problem, but once the cost of solutions becomes salient, interest declines and fades from public attention. Other researchers refer to this as 'issue space' or a 'finite pool or worry' "whereby other issues compete with climate change for the public's attention" (Capstick et. al, 2014, p. 52).

There are two categories of media that have been studied in relation to climate change communication: traditional and new media. Traditional media appeals to broader audiences through channels such as newspapers, television, radio, billboards, and magazines. New media can appeal to specific audiences through channels like social media, blogs, podcasts, and listservs. While both are important to the communication and framing of climate change, globally, traditional media has been the main focus of past research (over two-thirds of all climate change studies in relation to media focus on print media), with new media on the rise in more recent years (Schäfer & Schlichting, 2014). Still, only 17% of all studies on climate change in media examine online media, and only 4.5% are dedicated to social media (Schäfer & Schlichting, 2014). Studies that have examined climate change on new media have generally focused on public discussion surrounding events (i.e. the IPCC report or natural disasters), though there are some studies that look at the framing of climate change by the general public or different groups.

Traditional Media

The research on traditional media and climate change communication in the United States has mainly focused on television news (Feldman et al., 2011; O'Neill et al., 2015) and, largely, print media (Trumbo, 1996; Stecula & Merkley, 2019; Anderson, 2011; Liu et al., 2008; O'Neill et al., 2015). Cable television programs (i.e. CNN, Fox, and MSNBC) vary in their communication of climate change, with conservative news shows (i.e. Fox) being more dismissive and using uncertainty frames and liberal news shows (i.e. CNN, ABC, and NBC) being more accepting of climate change science and expressing fear for climate change effects (Feldman et al., 2011; O'Neill et al., 2015). Middle-ground news programs (i.e. MSNBC) tend to discuss the conflict over climate solutions and appear 'balanced,' however they are more accepting of climate science than conservative-leaning news shows (Feldman et al., 2011; O'Neill et al., 2015). This is reflected in viewers' attitudes toward climate change (Feldman et al., 2011). One study analyzed the frames used to describe the IPCC report from various sources in the US and UK (O'Neill et al., 2015). They found that the UK media covered the IPCC report much more than US media. When US media (usually broadcast media) did cover the IPCC report, they used the disaster frame most often, which emphasizes the consequences of inaction.

The research on stories in national newspapers has varied. Craig Trumbo (1996) analyzed sources and their framing techniques as defined by Robert Entman (1993). Scientists were more likely to define the problem and identify the causes whereas politicians and other interest groups were more likely to use the judgement frame. Overall, scientists as a source have decreased over time as more competing sources have joined the

climate change discussion (Trumbo, 1996; Anderson, 2011). An unlikely source that has been on the rise is celebrities, but the effects on public opinion are varied (Anderson, 2011). In another study, researchers found that frames associated with low public support for climate change policies (e.g. economic costs and uncertainty) have been declining while frames associated with high support for climate change policies (e.g. economic benefits and present risks) have been on the rise (Stecula & Merkley, 2019). On a smaller scale, Liu et al. (2008) analyzed a regional Texas newspaper and found mixed messages regarding climate change.

New Media

The research on new media and climate change communication in the United States has varied from looking at social media outlets (Jang & Hart, 2015; Schafer, 2012; Williams et al., 2015), blogs (Elgesam et al., 2014; Schafer, 2012; Sharman, 2014), and even memes¹ (Ross & Rivers, 2019). Research that focuses on the general public has found that individuals tend to select into like-minded communities ('echo-chambers') that prevent engagement with alternative viewpoints and subsequently promote more polarized views. This leads to any interactions with out-groups becoming increasingly polarized (Elgesam et al., 2014; Jang & Hart, 2015; Sharman, 2014; Williams et al., 2015). The O'Neill et al. (2015) study found that Twitter users discussed the IPCC report using frames surrounding the scientific consensus on climate change and the disaster frame (emphasizing the consequences of inaction). As for groups, environmental non-governmental organizations (NGOs) often engage in mobilizing action through social media and email (Schafer, 2012;

¹ Memes are images, texts, or videos that are circulated widely and given slightly different variations for a comedic effect

Stier et al., 2017) as well as provide information and engage with news media (Schafer, 2012). Politicians often focus on other political actors or political events (Stier et al., 2017) but the research is limited. Schafer (2012) finds that scientists play a narrow role online (typically through blogs) but when they do, their goals are education and participation.

Twitter

There have been a few studies on new media in relation to climate change communication that focus specifically on Twitter, a social networking and microblogging site. Users on Twitter can post short updates to their followers who can then “retweet” by reposting to their own timeline for their followers to see. With its rise in popularity over the last decade, many politicians, companies, and organizations have joined Twitter to reach a variety of audiences with their messages. Most Twitter studies focus on the general population (Jang & Hart, 2015; Williams et al., 2015; Kirilenko & Stepchenkova, 2014; O’Neill et al., 2015) with a majority focus on European and Western countries (Schäfer & Schlichting, 2014). However, there has been a recent upward trend in the number of studies on climate change communication in media in all regions of the world (Schäfer & Schlichting, 2014). Kirilenko and Stepchenkova (2014) illustrated that, geographically, most tweets about climate change come from more developed countries, like those in Europe and North America.

In line with the findings of Brulle et al. (2012) that two of the most important factors in forming public opinion are media coverage and elite cues, Kirilenko & Stepchenkova (2014) found that tweets from the general public contained mentions or URLs from news sources, science magazines, and news aggregators. This demonstrates that the public

generally relies on these sources for information in forming their opinion on climate change. One study examined the various actors (i.e. politicians, media, and NGOs) in policy debates on Twitter (Stier et al., 2017). Generally, events relating to climate change caused spikes in chatter on Twitter about climate change. Leading up to the 21st Conference of the Parties (COP21) for the United Nations Framework Convention on Climate Change (UNFCCC), NGOs generated a lot of attention about climate change. However, during the policy formation stage at COP21, political actors took over the attention. In relation to the policy cycle theory, NGOs played a large role in the agenda-setting phase whereas political actors played a large role in the policy formation phase (Stier et al., 2017). When analyzing content, the researchers found that political actors usually commented on the actions and positions of other political actors as well as events during decision-making processes. On the other hand, advocacy groups tended to emphasize connective action (i.e. personal actions and networking efforts) as well as specific political goals.

The Present Study

This study examines the differences between the ways different interest groups frame climate change through Twitter. Previous empirical studies that have focused on traditional media of climate change are problematic in certain respects. First, this type of news is a third party source in which producers can choose which quotes or sound bites they want to fit their agenda. I contend that how groups frame the issue of climate change on their own reveals more about their underlying perspectives than conventional, external media coverage. Second, new media are growing in popularity, in part as a news source. It is important to analyze different news sources that the public uses. Twitter is a useful

platform to study for a few reasons: (1) it is a large public arena that many individuals receive their news from, (2) tweets are produced directly from the source (i.e. the interest group), and thus, un-edited, and (3) it is relatively easy to download public tweets. For these reasons, Twitter is used in this study to analyze how different interest groups frame climate change. This study examines various interest groups, some of which have been previously researched and some of which have been ignored in the climate communication literature.

METHOD

Data Collection

To capture a wide range of groups, five categories of interest groups were selected for analysis: political parties, fossil fuel companies, science organizations, environmental justice groups, and mainstream environmental groups. The interest groups selected had to have public Twitter accounts so that data could be downloaded directly using the Twitter Application Programming Interface (API) through R Studio. [Refer to Jones et al. (2016) and Murphy (2017) for a comprehensive guide on the process of downloading Twitter data.] When retrieving data from specific users, only the most recent (from the time of initial download) 3,200 tweets can be obtained. Tweets relating to climate change were isolated by searching for tweets that contained the phrases “global warming,” “climate change,” “greenhouse gas,” and/or “emission.” Duplicate tweets were removed through a cleaning process in R.

Coding Tweets

All tweets were coded by the author and a second researcher using a coding protocol, which can be found in Appendix B. Various types of information embedded in the tweets were recorded and categorized. The search phrase in the tweet that was picked up by R was identified. The user(s) and hashtag(s) utilized in the tweets were noted and catalogued to understand which individuals or specific groups were highlighting in their tweets. Article and media content linked to the tweet were described and considered in the overall frame analysis. The direction (positive, negative, or neutral) of the tone of the tweet was noted as well. Several approaches to framing classification were used to examine the tweets, as discussed in the following section. Content analysis was used to identify each of the frames.

Framing Categorizations

There were four classifications used to analyze the data. The first was derived from Robert Entman's (1993) classification of framing techniques. The four categories are defining the problem, diagnosing causes, making moral judgements, and suggesting remedies. The second mode of analyzing the data was a general categorization based on previous research. These frames included, but were not limited to, economic, moral obligation, national security, human health, and uncertainty. The third was via the environmental discourses that John Dryzek describes in his book, *The Politics of the Earth* (2013). These discourses include problem solving, limits and survival, sustainability, and green radicalism. The last was through two competing worldviews that Michael Mendez describes in his book, *Climate Change from the Streets* (2020). These are carbon reduction

and climate change at the street level. These four categorizations are outlined in detail in the supplemental materials.

Analysis

Overall inter-rater reliability was calculated using unweighted Cohen's kappa and any discrepancies were resolved through discussion between coders, subsequently dropping the percentage of disagreement to zero. For each individual group (e.g. Democrats), the frequencies of different variables, like search phrases or frame types, were found and averaged across all of the groups in one category (e.g. political parties) to be analyzed as a whole. The individual group and category findings are all displayed in Table 1. Since some groups had many more relevant tweets than others, the frequencies are displayed as percentages. The number of tweets in each group and category are displayed next to the name at the top. Categories were compared on phrasing, user and hashtag mentions, direction, and across the four different approaches to framing categorization mentioned above.

RESULTS

Twenty-five organizations were selected within the five categories to analyze their Twitter accounts. To select the individual groups, the most prominent organizations within each category were identified based on their Twitter following and organizational membership size. The selected groups for each category are listed in Appendix A along with their Twitter handles. Since there is a limit on how much data can be downloaded from specific users, only eight months of data were downloaded from October 1st, 2019 through May 31st, 2020. After screening for the search phrases, removing duplicates, and identifying

tweets that were irrelevant, the total number of relevant tweets that were coded was 1,556. The number of relevant tweets by individual group is also listed in Appendix A. Agreement between the two coders was very high ($k = .823$).

A few issues the coders encountered during the coding process were multiple competing frames, frequently used frames with no predetermined category, and the differences between responsibility frames. When competing frames were used in a single tweet, typically the 'carbon reductionism' and 'climate change from the streets' Mendez frames, the coders chose the one that was stronger and/or was emphasized the most in the tweet. There were a few themes that came up often but did not have a predetermined code in the protocol: technology, transportation, and agriculture, which are mentioned below. Additionally, a distinction was made between the personal responsibility frame, which focused strictly on individual action (e.g. environmentally-friendly behaviors) and an 'other' responsibility frame, which focused on collective individual actions (e.g. voting or activism).

Results by Variable

Non-frame variables

The phrase 'climate change' was most often used by all of the groups, except for Republicans and fossil fuel companies, who mainly used the phrase 'emission.' Users were not commonly mentioned in any of the groups, however fossil fuel companies typically mentioned other fossil fuel companies and science organizations mentioned other science organizations. Environmental justice groups mentioned either other environmental groups or political parties, and mainstream environmental groups either mentioned other

environmental groups or someone that fell into the 'other' category. Hashtags were also not commonly applied for most groups, but were rarely utilized by political parties or fossil fuel companies. Science organizations utilized hashtags in the 'other' category (usually relating to technology); environmental justice groups either used a mitigation/adaptation policy hashtag (typically referring to the Green New Deal) or an 'other' category (usually relating to equity and activism); and mainstream environmental groups typically used climate change-related terms or an 'other' type for hashtags (usually nature-related). Political party tweets had the most negative tone overall, whereas fossil fuel company tweets were entirely positive. There was a more even distribution of positive, neutral, and negative tones across the rest of the categories, but mainstream environmental groups took a positive tone slightly more often.

Frames

For the Entman frames, Republicans, Libertarians, and fossil fuel companies largely used the 'moral judgement' frame, whereas Democrats, the Green party, science organizations, and mainstream environmental groups used the 'define problems' and 'suggest remedies' frames most often. Environmental justice groups had a more even split between the 'define problems' frame, 'moral judgements' frame, and 'suggest remedies' frame. For the general frames, Democrats and the Green Party usually employed the general information and appeal to emotion frames, whereas Republicans and Libertarians most often used the 'appeal to morality' frame. The general frame for fossil fuel companies typically fell into the 'other' category, typically relating to technology. Overall, science organizations most often used the 'general information' or 'other' frame (usually relating to

technology), whereas environmental justice groups typically employed the ‘appeal to morality’ and ‘responsibility’ frames aimed at government and industry/corporations. Mainstream environmental groups applied the ‘general information’ frame, the ‘psychological distance – near’ frame, ‘responsibility’ frames aimed at government and industry/corporations, and the ‘economic cost/benefit’ frame. Overall, most groups did not regularly utilize any of the Dryzek discourses, except for the fossil fuel companies who employed the ‘problem solving’ discourse exclusively. When groups did utilize a Dryzek frame, science organizations and mainstream environmental groups used the ‘problem solving’ discourse, and environmental justice groups used the ‘green radicalism’ discourse. Similarly, most groups did not apply a Mendez worldview, but when they did, fossil fuel companies, science organizations, and mainstream environmental groups typically used a ‘carbon reductionism’ frame, whereas environmental justice groups used a ‘climate change from the streets’ frame.

Results by Category

Political Parties

The political groupings selected in this category were Democrat, Republican, Libertarian, Green, and Constitution parties. This category resulted in one of the fewest relevant tweets overall (N = 22), with the Constitution party having 0 tweets. ‘Climate change’ was the search phrase employed in the majority of the tweets (73%) by the Democrats, Libertarians, and the Green party, whereas the main phrase employed by Republicans was ‘emission’ (67%). Users and hashtags were hardly mentioned, if at all, among these groups. The overall direction of the tweets in this category were negative

(68%) with the exception of the Green party who had a more neutral tone to their tweets (67%). Democrats and Republicans rarely used a positive frame (23%). Libertarians and Republicans applied the 'moral judgements' frame the most whereas Democrats and the Green party had a more even use of the different Entman frames. The top two general frames used by Republicans were appeal to morality (67%) and economic costs/benefits (50%) whereas Democrats used appeal to emotion (45%) and voter responsibility (45%) the most. The majority of tweets from the political parties did not utilize the Dryzek or Mendez frames.

Fossil Fuel Companies

The groups selected in this category were Chevron, ExxonMobil, Phillips 66, Valero, and Marathon. The fossil fuel groups had the least relevant tweets overall (N = 12), with Phillips 66 and Valero having 0 tweets. There was little variation between these groups. 'Emission' was the search phrase used in every tweet across groups. The most commonly mentioned users were other fossil fuel companies (19%) and energy- or technology-related terms or companies (19%). Hashtags were rarely utilized. The direction was wholly positive (100%), with only the 'suggest remedies' frame being employed across all groups. As suggested by the previous categorizations, the general frames were frequently goal-oriented with a focus on technological solutions (81%) and a 'problem solving' lens (100%). Fossil fuel companies often applied a 'carbon reductionism' view (63%) or no Mendez frame at all (31%).

Science Organizations

The groups selected into this category were American Association for the Advancement of Science (AAAS), NASA, National Geographic Society, the National Academy of Sciences (NAS), the National Science Foundation (NSF), and the Union of Concerned Scientists (UCS). Most of these groups had a small number of relevant tweets (combined N = 51), with the exception of UCS (N = 198). 'Climate change' was the most commonly used phrase (61%), followed by 'emission' (39%). The most common user category overall was other science organizations (29%). Hashtags for these groups often fell in the 'other' category (37%) typically relating to technology, clean energy, and transportation. Direction was relatively spread out between positive (28%), neutral (28%), and negative (44%) tones. The most common Entman frames were define problems (41%) and suggest remedies (42%). The general frames were often categorized as 'other' with themes of technology, environmental justice, and agriculture (37%), as well as 'responsibility' aimed at government (34%) and fossil fuel companies (21%). Dryzek and Mendez frames were occasionally applied with 'problem solving' (34%) and 'carbon reductionism' (26%) being the most common.

Environmental Justice Groups

The groups selected into this category were the Indigenous Environmental Network (IEN), the Center for Diversity and the Environment (CDE), Sunrise Movement, and Climate Justice Alliance (CJA). The majority of the tweets from these groups came from Sunrise and CJA (N = 269), while the CDE had 0 tweets. Tweets in this group regularly employed the phrase 'climate change' (83%). Users typically fell into the 'political party' (22%) and

'environmental group' (18%) categories. Hashtags in this category often referred to the Green New Deal which falls into both the mitigation and adaptation policy category (20%). The 'other' category (25%) usually included hashtags relating to equity (e.g. #americaforall and #justtransition), strikes against different projects, and activist groups. The direction of the tweets for these groups also had a relatively even spread of positive (29%), neutral (29%), and negative (43%) tones. Environmental justice groups most often utilized the 'moral judgements' (39%) and 'suggest remedies' (46%) frames with some 'define problems' (25%) Entman frames. The general frames employed were appeal to morality (33%), government responsibility (33%), and industry/corporate responsibility (22%). Half of the tweets in these groups did not include any Dryzek or Mendez frames but 'green radicalism' (27%) and 'climate change from the streets' (31%) were applied more often by environmental justice groups than by their counterparts.

Mainstream Environmental Groups

The groups incorporated into this category were The Nature Conservancy (TNC), the Audubon Society, the Environmental Defense Fund (EDF), Citizen's Climate Lobby (CCL), and 350.org. This category had the largest number of relevant tweets by far (N = 990). Tweets from these groups regularly used the phrase 'climate change' (71%) and about one-third used 'emission.' Users and hashtags were not applied often, but one-quarter of the tweets used the 'other' category for hashtags (25%). These typically included nature-related terms, strikes, or blaming fossil fuel companies (e.g. #Exxonknew or #antiChevronday). A few exceptions were The Nature Conservancy, in mentioning environmental groups in 46% of their tweets, and the Audubon Society, in using the

hashtag #birdstellus in a little over half of their tweets (referring to their interactive visualization of the link between birds and climate change). The groups in this category typically had a neutral tone (58%) with the remaining tweets divided between positive and negative directions. ‘Define problems’ (46%) and ‘suggest remedies’ (50%) were the most frequently applied Entman frames, and industry/corporate responsibility was the most common general frame (38%). The majority of tweets in these groups didn’t use Dryzek or Mendez frames, with the exception of CCL which utilized the ‘problem solving’ frame (41%) and the ‘carbon reductionism’ frame (57%) most often.

DISCUSSION

The current study explored the different climate change framing techniques used by various interest groups on social media. This study analyzed twenty-five groups over five categories: political parties, fossil fuel companies, science organizations, mainstream environmental groups, and environmental justice groups. Understanding the content that interest groups are conveying can help us to understand what information the public is receiving and how that might influence their opinions. Since public opinion is vital to policy change, it is valuable to know what messages are currently being expressed in order to alter them in the future to create a larger support base for climate action. This study provided insight into currently used framing schemas.

‘Climate change’ was the most used term across all groups, with the exception of Republicans and fossil fuel companies who used the term ‘emission’ most often. Users and hashtags were not often utilized, but in the few cases where they were employed, groups tended to mention other users that fell into the same category (e.g. science organizations

mentioning other science organizations) and hashtags typically relating to their missions (e.g. environmental justice groups using #greennewdeal or #justtransition). Most groups had an even distribution of positive, neutral, and negative tones across their tweets, with the exception of political parties, who more often used a negative tone, and fossil fuel companies, who exclusively used a positive tone. Generally, the ‘diagnose causes’ Entman frame was rarely employed across all groups, whereas ‘define problems’ was most often used by science organizations and mainstream environmental groups; and ‘moral judgements’ was most often used by more conservative political parties and environmental justice groups. ‘Suggest remedies’ was used frequently across all categories. More liberal political parties, science organizations, and mainstream environmental groups utilized the ‘general information’ frame, whereas more conservative political parties and environmental justice groups utilized the ‘appeal to morality’ frame. Fossil fuel companies and science organizations often used a technology frame, and mainstream environmental groups and environmental justice groups used the responsibility frames aimed at government and industries. Typically, groups did not employ a Dryzek or Mendez frame. However, the ‘problem solving’ and ‘carbon reductionism’ frames were used most often across all categories, apart from environmental justice groups who employed the ‘green radicalism’ and ‘climate change from the streets’ frames the most.

Previous research has shown that conservative and liberal parties diverge in their framing, with conservatives emphasizing the uncertainty of the science and being dismissive of research findings, and liberals on the other hand accepting climate science and expressing fears about the adverse impacts of climate change (Feldman et. Al, 2011; O’Neill et al., 2015). While an uncertainty frame was included in the coding protocol, it

didn't come up at all in any of the groups, which suggests an overall shift in the population toward acceptance of climate science. However, the general direction of political party tweets was negative which doesn't indicate support for climate solutions. Additionally, past research has documented the use of Entman frames in newspapers (Trumbo, 1996), where politicians typically used the 'moral judgement' frame--a pattern also reflected in the results of this study. Previous research indicated that science organizations usually referred to the causes and effects of climate change and focused on education and participation (Trumbo, 1996; Schafer, 2012). This study confirmed that scientists still have an educational approach, most often focusing on the 'define problems' and 'suggest remedies' frames. However, it seems that science organizations are taking a firmer stance on who is responsible, typically pointing to government inaction and fossil fuel companies. This study illustrated that environmental NGOs (both mainstream and environmental justice groups) typically used the 'define problems' and 'suggest remedies' frames, which mirrors past research findings that NGOs provide information and suggest political goals (Schafer, 2012; Stier et al., 2017). Moreover, the mainstream environmental groups and environmental justice groups analyzed in this study often employed a responsibility frame relating to collective action (i.e. voting and activism), which is also in line with past research (Schafer, 2012; Stier et al., 2017).

Implications

The results of this study pose a number of implications for messengers (whether they be politicians or environmental groups). There are clear gaps in the climate discussion that present opportunities for development of new frames or for collaboration. Since

political parties had such a small number of tweets surrounding the climate discussion, politicians have the chance to advance climate legislation with public support simply by talking about it more on social media. Especially since politicians hold the keys to large-scale policy changes, there should be more of an effort made to talk about climate change issues and potential solutions. Additionally, science organizations appear to be more involved in the climate discussion than before, going beyond just talking about effects and now engaging in discussions regarding responsibility and solutions. This could be an opportunity for other interest groups to collaborate on messaging. The recent mistrust of science could be corrected (or at least alleviated) by involving messaging with other trusted individuals or groups. Finally, given the considerable coverage that mainstream environmental groups give to climate change issues, it would be beneficial for them to work with environmental justice groups on messaging to spread awareness of environmental injustices and push for more equitable solutions to climate change.

Limitations and Future Directions

These findings are tentative and subject to refinement through later research. Since the political parties and fossil fuel companies had so few relevant tweets, it's hard to draw full conclusions about their messaging on climate change. It's even more difficult to do a true comparison between categories since some had substantially more tweets than others (i.e. fossil fuel companies had 12 tweets overall compared to mainstream environmental groups that had 990 tweets overall). On the other hand, this could indicate the lack of concern on climate change issues among political parties and fossil fuel companies. Another limitation is the time frame in which the data were collected. Considering that the

pandemic came to the forefront of concern in the middle of the time frame for data collection, climate change may not have been as big of a priority at the time, particularly for political parties who were trying to control the spread of COVID-19 and provide economic relief to their populations. Furthermore, it's likely that there were tweets relating to climate change that were not picked up by the search phrases used in this study. While these search phrases most likely covered a majority of relevant tweets, there are other terms that could have added further insight (e.g. 'carbon dioxide,' 'sea level rise,' 'global temperature,' and/or 'renewable energy').

Climate change messages are continually evolving and understanding how interest groups talk about climate change is an ongoing challenge. Therefore, future studies should aim to advance insight by using different time frames and adjusting search terms as discourse transforms. Additionally, it would be useful to know the connection between the messaging of different interest groups and public opinion. This could be done by monitoring who is engaging with social media posts (and how often) from different groups and surveying climate change attitudes of those audiences. While there is much research on the framing effects of climate messaging, those experiments usually entail single rather than multiple exposures. Previous research has demonstrated that schemas are more salient with repeated exposure, thus it would be beneficial to understand how repeated interactions with interest groups influence public attitudes on climate change.

CONCLUSION

This study reveals important insights about climate change communication among different interest groups. First, political parties seem to be shifting rhetoric around climate

change. Conservative groups do not deliberate about the uncertainty of climate science like they used to, which suggests there may be room for persuasion on bipartisan solutions. Second, science organizations seem to be adding to the climate conversation more than they previously have, which may afford opportunities to combine messaging on climate solutions with scientific evidence. Finally, as mainstream environmental groups are increasingly discussing environmental injustice around climate change, there is a growing opportunity for groups to collaborate on messaging to bring marginalized communities to the forefront of the conversation on climate change. Given the abundant possibilities for more enriched discussion on climate change, messengers should take advantage of the opportunities in order to garner more public support for climate solutions.

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APPENDIX A

Group Name	Twitter handle	Type of organization	# of relevant tweets within time period
Democratic Party	TheDemocrats	Political party	11
Republican Party	GOP	Political party	6
Libertarian Party	LPNational	Political party	2
Green Party	GreenPartyUS	Political party	3
Constitution Party	cnstitutionprty	Political party	0
Chevron	Chevron	Fossil fuel company	4
ExxonMobil	exxonmobil	Fossil fuel company	8
Phillips 66	Phillips66Co & Phillips66Gas	Fossil fuel company	0
Valero Energy	ValeroEnergy	Fossil fuel company	0
Marathon Petroleum	MarathonPetroCo	Fossil fuel company	4
American Association for the Advancement of Science	aaas	Science organization	9
Union of Concerned Scientists	UCSUSA	Science organization	198
NASA	NASA	Science organization	2
National Science Foundation	NSF	Science organization	1
National Academy of Sciences	theNASciences	Science organization	20
National Geographic Society	NatGeo	Science organization	19
The Nature Conservancy	nature_org	Mainstream environmental groups	109
The Audubon Society	audubonsociety	Mainstream environmental groups	130
Environmental Defense Fund	EnvDefenseFund	Mainstream environmental groups	268
350.org	350	Mainstream environmental groups	275
Citizen's Climate Lobby	citizensclimate	Mainstream environmental groups	208
Center for Diversity and the Environment	DiversityEnviro	Environmental justice groups	0
Indigenous Environmental Network	IENearth	Environmental justice groups	18
The Sunrise Movement	sunrisemvmt	Environmental justice groups	172
Climate Justice Alliance	CJAOurPower	Environmental justice groups	97

APPENDIX B

Coding Protocol

Instructions: Please write out full answer. If more than one applies, write all down with a semi-colon in between (example: climate change; global warming). Tweets with articles and/or images and threaded tweets should be analyzed as a whole. If the tweet only mentions climate change/global warming in passing or discusses emissions not related to GHGs, mark it as irrelevant in the notes and put 0's for all answers. If there is a duplicate tweet, mark it as such in the notes and put 0's for all answers. Consult the quick reference guide for the framing categorizations.

1. What phrase did the tweet use? (search.phrase)
 - a. Climate change
 - b. Global warming
 - c. Greenhouse gas
 - d. Emission
2. Does the tweet mention another user (@)? (user)
 - a. Yes
 - b. No
3. If the tweet mentions another user, what category do they fall into? If multiple users are mentioned, list in the order they are mentioned. If not, put NA. (user.category)
 - a. Politician/political party
 - b. Fossil fuel executive/company
 - c. Environmentalist/environmental group
 - d. Scientist/scientific group
 - e. Other: specify
4. Does the tweet contain a hashtag (#)? (hashtag)
 - a. Yes
 - b. No
5. If the tweet contains a hashtag, what category does it fall into? If there are multiple hashtags, list in the order they are mentioned. If not, put NA. (hashtag.category)
 - a. Climate change/global warming related terms
 - b. Pandemic (COVID-19)
 - c. Political event
 - d. Natural disaster
 - e. Mitigation policy
 - f. Adaptation policy
 - g. Other: specify
6. Does the tweet contain a link to an article? (article)
 - a. Yes
 - b. No
7. Briefly describe the article content in 1-2 sentences. If no article, put NA. (article.content)

8. Does the tweet contain an image/video? (media)
 - a. Yes
 - b. No
9. Briefly describe the media content in 1-2 sentences. If no media, put NA.
(media.content)
10. Which direction (negative/positive) is the tone of the tweet? (direction)
 - a. Positive
 - b. Negative
 - c. Neutral
11. Which of the following framing categories does the tweet fall into? (entman.frame)*
 - a. Define problems
 - b. Diagnose causes
 - c. Make moral judgements
 - d. Suggest remedies
 - e. None
12. Which of the following general categories relating to climate change does the tweet fall into? (general.frame)**
 - a. General information about effects
 - b. Scientific consensus
 - c. Appeal to morality
 - d. Appeal to emotion
 - e. Appeal to norms
 - f. Psychological distance – near/far
 - g. Responsibility – personal/government/other
 - h. Economic costs/benefits
 - i. National security
 - j. Human health
 - k. Uncertainty
 - l. Other: specify
13. Which of the following discourses does the tweet use? (dryzek.discourse)***
 - a. Problem solving
 - b. Limits and survival
 - c. Sustainability
 - d. Green radicalism
 - e. None
14. Which of the following worldviews does the tweet use? (mendez.worldview)****
 - a. Carbon reductionism
 - b. Climate change from the streets
 - c. Neither

Quick reference guide for framing:

*Description of Entman frames:

- Define problems – impacts of climate change (e.g. increase in natural disasters)
- Diagnose causes – what is creating the problem (e.g. increase in greenhouse gases)
- Make moral judgements – evaluations (e.g. fossil fuel companies are bad)
- Suggest remedies – solutions (e.g. policies like carbon tax)

**Description of General frames:

- General information about effects – environmental/social impacts of climate change
- Scientific consensus – consensus that climate change is real and human-caused
- Appeal to morality – broader obligation to earth and future generations
- Appeal to emotion – evoke emotion to get audience to care (can use fear, guilt, anger, hope)
- Appeal to norms – other people care and take action against climate change so you should too
- Psychological distance – near (local/national) or far (global/other nations)
- Responsibility – personal, government, other (e.g. industry)
- Economic costs/benefits – relates to effects of climate change or policies to combat it
- National security – displacement and migration, food/water insecurity, anything that would threaten peace in America
- Human health – how climate change causes illness (e.g. asthma, heat strokes)
- Uncertainty – improbability that climate change is happening

***Description of Dryzek frames:

- Problem solving – moderately adjusting the current political-economic state to deal with environmental problems; Solutions may look toward government regulations or free market mechanisms
 - **Basically any solution that works within a capitalist framework**
- Limits and survival – defined by planetary boundaries – there is a limit to growth; strives for redistribution of power and “reorientation away from perpetual economic growth”
 - **Earth’s resources are limited and if growth goes unchecked, human civilization with self-destruct; also could be emphasis on limited time left before irreversible change happens**
- Sustainability – dispels the conflicting values between environmental protection and economic growth

- **Solutions that satisfy both (e.g. energy transition – trade jobs in oil that transfer over to trade jobs in clean energy)**
- Green radicalism – rejects the current political-economic state, instead favoring a variety of different alternatives divided into categories of green consciousness and green politics
 - Green consciousness: changing people’s perspective (i.e. we are part of a bigger ecological picture) that leads to more tangible actions (i.e. buying sustainable)
 - Green politics: political ideology aimed at the intersection of environmentalism and social justice
 - **Basically any solution outside of a capitalist framework (closely tied with the environmental justice movement)**

****Description of Mendez frames:

- Carbon reductionism characteristics: reducing greenhouse gas emissions (specifically carbon), scientific expertise, cost-effectiveness, market-based solutions, geographic neutrality, emphasis on mitigation
 - **Emphasis on reducing carbon emissions globally**
- Climate change from the streets characteristics: co-benefits potential, local expertise and embodiment, social and health equity, community-based solutions, multi-scalar policy, mitigation and adaptation
 - **Emphasis on community-based solutions, environmental justice**