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Climate Change or Catastrophe? Examining the Use of Fear Appeals by Climate Scientists

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Samenvatting

Klimaatverandering of catastrofe? Onderzoek naar het gebruik van angstappeal door klimaatwetenschappers

Klimaatwetenschappers zijn bezorgd of emotioneel taalgebruik hun geloofwaardigheid en objectiviteit aantast. Ons digitale experiment toont aan dat een klimaatwetenschapper een beroep kan doen op angstige emoties zonder haar geloofwaardigheid te schaden, zolang angstig taalgebruik wordt gecombineerd met een concrete gedragsaanbeveling ('fear-hope appeal'). Alleen dan vertoonden respondenten hogere gevoelens van 'self-efficacy', wat op zijn beurt de intentie tot milieuvriendelijk handelen versterkte.

Abstract

Climate science communication is evolving towards a value-based model, leaving more room for advocacy and the use of emotions. However, some climate scientists are afraid that blending science with emotions may hurt their credibility and objectivity. This research tests whether emotional language, specifically fear, is effective in generating pro-environmental intentions without harming credibility, across two types of efficacy statements: an abstract and a concrete behavioural recommendation. Participants (N = 241) of an online experiment read a fictitious interview with a climate scientist, which was subject to a 2 ('no fear' vs fear) x 2 (abstract vs concrete recommendation) between-subjects design. Our results

showed that a climate scientist could effectively employ fearful language without harming their credibility, if they balance fear with a concrete efficacy statement (a fear-hope appeal). Such behavioural advocacy led to stronger intentions to act pro-environmentally. This might, therefore, align with the public's expectations of climate scientists.

Keywords: klimaatveranderingcommunicatie, klimaatwetenschapper, geloofwaardigheid, self-efficacy, pro-klimaat intenties

Introduction

"We're going to lose everything. And we're not joking, we're not lying, we're not exaggerating." (Kalmus, 2022). NASA climate scientist Peter Kalmus shared these alarming words with the world through a viral video in April 2022. Kalmus' warnings align with the trend of climate scientists speaking up normatively about their research. Climate science communication is shifting from the information-deficit model, which assumes the public simply needs more information to evoke behavioural changes, to a model characterised by dialogue and value-based participation (Metcalfe, 2022; Pidcock et al., 2021). This means that climate scientists will be driven into new territories as advocates, dialogue brokers and interpreters of scientific facts (Brüggemann et al., 2020).

Climate change is, however, a challenging topic to communicate due to its invisible causes, temporally and geographically distant impacts and the lack of immediacy among the public (Moser, 2016). Additionally, climate change is a highly politicised and polarised issue, with climate sceptics often exploiting uncertainties to discredit climate science (Corner et al., 2015; Krauss et al., 2012; Moser, 2016). The public discourse around climate change has become polluted, creating an unsafe environment for scientists to speak up in (Kahan, 2012). Additionally, scientists face practical problems, such as the fear of backlash, misinterpretations and the potential deterioration of their credibility and objectivity when speaking normatively and emotionally about their research (Boykoff & Oonk, 2020; Budescu & Broomell, 2012; Nicolaisen, 2022b; Pidcock et al., 2021; Schmidt, 2015). However, is the latter fear justified? A characteristic of the participation model of science communication is the acceptance of emotion in communication (Metcalfe, 2022; Nicolaisen, 2022a). Blending science and emotions in communication could be an effective strategy for climate scientists to encourage the public

and possibly policy makers to take pro-environmental measures. This combination makes the research more relevant, engages the public and helps convey the seriousness of climate change (Kearns, 2015; Marshall, 2014; Nicolaisen, 2022a).

Emotions have long been recognised as playing a key role in public risk perception (Taylor et al., 2014). Governments, the media and NGOs often use alarmist language to make climate change more newsworthy and attention-grabbing (Joffe, 1999). Alarmist language is part of the 'fear appeal', which has received a lot of scholarly attention within climate communication research (O'Neill & Nicholson-Cole, 2009). Some research has found that eliciting fear increased intentions to undertake pro-environmental action (Van Zomeren et al., 2010), while other research has found that fear activated counterproductive defence mechanisms that led people to deny the reality of climate change (Ruiter et al., 2014). A recent large-scale multinational experiment found that the effectiveness of a fear-appeal also depends on the intended outcome (Vlasceanu et al., 2024).

To increase the chances of a fear-appeal being effective, an efficacy statement needs to be included (Armbruster et al., 2022; O'Neill & Nicholson-Cole, 2009). This creates a 'fear-hope' appeal, where efficacy is created by mentioning actions that can counter the threat used in the fear appeal. Since climate scientists are increasingly communicating what *should* be done, the type of efficacy statement to counter climate change (i.e., we refer to this as recommendation type) proposed by a climate scientist in their communication is a novel but possibly important determinant of actual pro-environmental behaviour. This leads to the following research question: *To what extent is the effect of a fear appeal on intention to act pro-environmentally and a scientist's credibility moderated by recommendation type* (*abstract vs concrete*)*?* This research benefits climate scientists' communication skills. They often lack the skills to effectively share their findings, leading to self-silence (Besley & Dudo, 2017; Entradas et al., 2019). Self-silence negatively impacts public engagement with climate change, increasing the science-action gap (Geiger & Swim, 2016; Mann, 2020; Salama & Aboukoura, 2018). Furthermore, trust in climate scientists leads to higher concerns about and more acceptance of climate change and increases climate-friendly behaviour (Cologna, Baumberger et al., 2022a). Since credibility is an important asset for climate scientists to communicate effectively, it is important to empirically check whether it is harmed when a fear appeal is used.

Theoretical Framework

The Science-Advocacy Continuum and Emotion

Scientists are no longer expected to be dispassionate observers and can instead opt for more value-based public engagement (Pidcock et al., 2021; Shuckburgh et al., 2012). This new type of engagement raises concerns among climate scientists, such as the fear of being misunderstood, misinterpreted and decontextualised, but mainly, the fear of being accused of bias in their science (Messling, 2020). Climate scientists believe that communicating their science emotively opens the doors to being perceived as an 'advocate', which allegedly harms their scientific credibility (Boykoff & Oonk, 2020; Messling, 2020; Nicolaisen, 2022b), contradicting the scientific ideals of neutrality and objectivity (Lackey, 2007; Nielsen, 2001).

Originally, advocacy was subject to a binary perspective. Scientists making statements that contain a normative or subjective judgement about actions they feel society should take, would be deemed an advocate (Donner, 2014). Today, advocacy can be conceptualised as a continuum with on one end the 'pure scientist', characterised by objective statements, and on the other end the 'issue advocate', characterised by policy prescriptive statements (Donner, 2014; Messling, 2020). There are different levels of advocacy, such as sharing new research findings (low) and suggesting specific policies or actions (high) (Beall et al., 2017), affecting a scientist's credibility in different ways. For example, the perceived credibility of the communicating scientist is only harmed when he advocated for a controversial specific policy, while general calls for more climate action have no effect (Beall et al., 2017, Kotcher et al., 2017).

Placing emotional communication on the science-advocacy continuum is challenging. Qualitative research has shown that climate journalists and citizens accept it when climate scientists blend their science with emotions (Nicolaisen, 2022a). One reason is that scientists are perceived as entitled to show their feelings, due to their human nature (Kearns, 2015). Scholars have also argued that emotions are essential for comprehending the moral impact of climate change risks (Roeser, 2012). Considering the high importance climate communication scholars assign to the use of emotions and the general acceptance of it by citizens and journalists, it seems like emotions offer a middle ground between advocacy and objectivity. One of the most applied emotions in climate change communication is fear (O'Neill & Nicholson-Cole, 2009), which is discussed next.

Fear Appeals in Climate Change Communication

Fear appeal theory posits that threat and fear drive persuasion (Ettinger et al. 2021; Witte, 1992). When a message includes a fear appeal, it attempts to arouse fear to promote precautionary motivation and self-protective action (O'Neill & Nicholson-Cole, 2009). The effectiveness of fear appeals in climate communication is highly debated (Ettinger et al., 2021). Critics argue that fear-based messages can be counterproductive in motivating climate action, creating a backfire effect and a sense of powerlessness, leading to individuals distancing themselves from the distressing information and potentially denying it (Feinberg & Willer, 2010; Mann et al., 2017; O'Neill & Nicholson-Cole, 2009). The effectiveness of fear appeals in climate communication may depend on factors such as fear level and perceived efficacy (Hornsey et al., 2015; O'Neill & Nicholson-Cole, 2009).

Despite lacking confident empirical verification, there is reason to believe a fear appeal is effective when it comes from a climate scientist. It is argued that warnings about climate change will be underestimated and go unnoticed when spoken about dispassionately, possibly also causing cognitive dissonance among the public (Marshall, 2014; Oreskes, 2018). The aversion of climate scientists to show emotions has not been beneficial in engaging the public on climate change (Marshall, 2014). Considering these remarks, we formulate the following hypothesis for a main effect of a fear appeal on pro-environmental intentions (cf. Figure 1):

H1: The presence of a fear appeal in a message from a climate scientist leads to a higher intention to act pro-environmentally compared to a message without a fear appeal.

Efficacy Statements Combined with Fear Appeals

The Importance of Self-Efficacy

The effectiveness of fear appeals might stem from individuals' self-efficacy perceptions, as explained by the Extended Parallel Process Model (O'Neill & Nicholson-Cole, 2009). Self-efficacy refers to the belief that one can take action to avert a threat (Bandura, 1986; Roser-Renouf & Nisbet, 2008). According to the Extended Parallel Process Model, a fear appeal is processed in two phases (Witte, 1992): threat appraisal and coping appraisal. If the threat is evaluated as sufficiently severe, a threat-solving response can be formulated (response-efficacy). In turn, self-efficacy determines whether one believes to be capable to carry out the proposed response. A lack of efficacy might

lead to maladaptive response, such as psychological dissonance, message avoidance, issue derogation and denial (Feinberg & Willer, 2010; O'Neill & Nicholson-Cole, 2009; Roser-Renouf & Nisbet, 2008). When sufficient efficacy is perceived, a state of danger control will be triggered. This leads to an adaptive response in line with the proposed behaviour, stemming from Protection Motivation Theory (Popova, 2012). So, according to the Extended Parallel Process Model and Protection Motivation Theory, fear appeals should include statements that boost efficacy perceptions to maximise danger control processing. This premise was corroborated in the most recent and comprehensive meta-analysis of fear appeals (Tannenbaum et al., 2015).

Self-Efficacy in the Context of Climate Change Communication

Research contending the effectiveness of fear appeals may have drawn wrong conclusions if there were no efficacy statements included in their fear appeals (Armbruster et al., 2022), which was the case for studies that have found counterproductive effects (Feinberg & Willer, 2010; Hastings et al., 2004; O'Neill & Nicholson-Cole, 2009). Efficacy statements are essential in climate change communication, as climate change is considered a 'super wicked problem' (Levin et al., 2012), which lacks a definitive solution and a central authority to address it. Hence, many consumers doubt the effectiveness of climate change solutions or are unfamiliar with them (Moser, 2016). This could be attributed to media coverage that focuses on negative efficacy information instead of pro-climate solutions (Feldman et al., 2017). Additionally, in a relatively recent meta-analysis, Kothe et al. (2019) synthesised research that aimed to predict and change pro-environmental behaviour with Protection Motivation Theory. They concluded that self-efficacy is positively associated with behavioural intentions in pro-environmental contexts, once again highlighting its importance when fear is induced. Recent research has labelled the combination of a fear appeal with an efficacy statement the 'fear-hope' appeal (Armbruster et al., 2022). Efficacy statements stimulate a feeling of hope (Feldman & Hart, 2018), which in turn is an important predictor of pro-climate attitudes (Armbruster et al., 2022; Christensen, 2017; Nabi et al., 2018; Witte & Allen, 2000).

Type of Efficacy Statements

Despite Europeans considering climate change to be one of the greatest threats to their country (Poushter et al., 2022), a lot of inaction remains due to feelings of psychological distance (Duan et al., 2021; Hornsey & Fielding, 2019). According to construal level theory, self-efficacy can be increased by construing climate change solutions as more concrete, since this would

cause a decrease in psychological distance and make the desired behaviour more tangible (Bandura, 1986; Maiella et al., 2020; McDonald et al., 2015; Van Lange & Huckelba, 2021).

Implementation intentions generate high perceptions of self-efficacy (Fennis et al., 2011; Gollwitzer, 1999; Holland et al., 2006; Rees et al., 2018). They are used to plan very specific behaviours by describing when, where and how to act (Gollwitzer, 1999). They are especially useful when individuals display positive intention but lack the discipline and confidence to act on these intentions. This intention-behaviour gap is especially present in the context of climate change due to the uncertain nature of its consequences (Hornsey & Fielding, 2019; Poushter et al., 2022; Van Lange & Huckelba, 2021), which will only be strengthened when an individual is presented with an abstract recommendation. Individuals who hold a stronger belief in their ability to effectively tackle climate change are more inclined to participate in pro-environmental behaviour (Hornsey et al., 2022).

Based on existing research about the importance of efficacy in fear appeals, construal level theory and implementation intentions, it is expected that a concrete recommendation leads to the highest level of self-efficacy. For an abstract recommendation, an imbalance between fear and hope may occur, leading to feelings of hopelessness (backfire effect) and a decrease in self-efficacy. Therefore, the following hypotheses are formulated:

H2: The type of recommendation moderates the relationship between a fear appeal and self-efficacy. A fear appeal increases (decreases) self-efficacy when combined with a concrete (abstract) recommendation.

H3: The combination of a fear appeal with a concrete (abstract) recommendation increases (decreases) self-efficacy, which in turn (decreases) increases intention to act pro-environmentally.

Recommendation Type and Credibility

When exposed to scientific information, people tend to assess the motives behind why a scientist is presenting the information (Beall et al., 2017). From an attribution research perspective, these assessments may shape an individual's perception of climate scientists (Reeder, 2013). The level of advocacy present in the message, can influence perceived motivations (Beall et al., 2017). Participants from Fiske and Dupree's research (2014) mentioned self-serving or political motives as reasons to distrust climate scientists. The likelihood

individuals infer such motives may be higher when a climate scientist recommends very specific and concrete behaviours. Indeed, the perceived credibility of the communicating scientist was only harmed when he advocated for a (quite controversial) specific policy (Kotcher et al., 2017), compared to not hurting it when advocating for greater climate action (Beall et al., 2017, Kotcher et al., 2017). An additional factor lies in how much behavioural costs a recommendation involves, in terms of cognitive, financial and time costs (Starke et al., 2020), which may be easier to imagine for concrete recommendations. Based on this information and the information from the science-advocacy continuum paragraph, the following hypothesis is formulated:

H4: Recommendation type and fear appeal interact such that a scientist's perceived credibility decreases if a concrete recommendation is presented with a fear appeal.

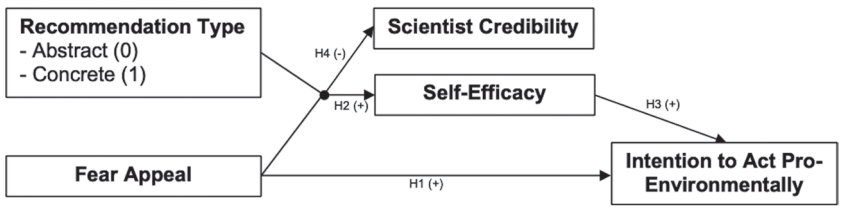

Figure 1

Method

Research Design

We investigated the effectiveness of a fear-hope appeal in the context of climate change communication. We set up an experiment in which participants were presented an interview with a climate scientist, which varied in content. The message from the climate scientist that was presented in the experiment was subject to a 2 ('no fear' vs fear) x 2 (abstract vs concrete recommendation) between-subjects design. Everybody above the age of 16 was able to participate in this research.

Participants

Participants were recruited through snowball sampling via the first author's social media and via the online research platform SurveyCircle. SurveyCircle users consist mostly of students in the final phase of their associate degree, bachelor's degree or graduate or professional degree in the Netherlands or

Belgium (SurveyCircle, n.d.). A total of 262 participants had clicked on the Qualtrics study link, but some rejected the informed consent (n = 8) or did not complete the study (n = 13). The remaining 241 were randomly assigned to one of the four conditions: the fear message with a concrete recommendation (n = 58), the fear message with an abstract recommendation (n = 61), the 'no fear'[1] message with a concrete recommendation (n = 63) or the 'no fear' message with an abstract recommendation (n = 59). Randomization checks indicated no significant differences across conditions on a selection of demographic variables. As no funds were available for participant recruitment, the sample size was determined based on feasibility. A sensitivity power analysis performed in G*Power 3.1.9.7 revealed that for 'ANOVA: Fixed effects, special, main effects and interactions' (power 1-β = 0.8, α = 0.05, numerator df = 1, number of groups = 4), the required effect size for detection would be f = 0.18.

The participants were between 17 and 85 years old (M = 37.41, SD = 17.88), with 61.80% identifying as a woman. Most participants had either completed a bachelor's degree (37.80%) or a graduate or professional degree (30.30%). In terms of political orientation (1 = most left-leaning), the sample was rather left-leaning (M = 2.88, SD = 1.31; 7-point scale). The sample scored relatively high with regards to their environmentalism (M = 5.40, SD = 0.90; 7-point scale).

Procedure

Data gathering took place between the 15 and 26 of May, 2023. It was conducted in compliance with the ethical regulations of the Department of Communication, University of Amsterdam, archived as FMG-7845_2024. Through an English questionnaire, participants were first asked to answer demographic questions. Before reading the stimulus material, participants received a short introduction explaining they were going to read an interview excerpt from well-known climate scientist Dr. Paul Attaway. They were asked to read his message carefully. After 20 seconds, they were able to continue to the evaluation survey, while not being able to return to the message. Finally, participants were thanked for their participation and debriefed. The median time spent completing the survey was just over five minutes. See Appendix C for the complete questionnaire.

Experimental Manipulation and Pre-Test

The stimulus material consisted of a fictional interview excerpt with fictional climate scientist Dr. Paul Attaway. In this excerpt, he delivered a

final message to the reader. The first paragraph comprised the interviewer's question. The rest of the message was divided into two parts: the fear appeal (first and second paragraph) and the recommendation (third paragraph), see Figure 2 for the final versions. All versions contained an image of climate scientist Peter Kalmus to increase ecological validity. In the following paragraphs, the content of the stimulus materials will be motivated.

Interviewer: Thank you Dr. Attaway for agreeing to speak with us and sharing your insights. To conclude, do you have some final notes to share with our readers?

Dr. Paul Attaway
Climate Scientist

Thank you, yes. To summarize, I feel quite terrified. Research found that more than a century of burning fossil fuels as well as unequal and unsustainable energy and land use have led to global warming of 1.1°C above pre-industrial levels. We need to shift into climate emergency mode.

While this may appear to be a small increase, even a small increase in the average temperature can cause global problems for humans, animals, and vegetation. Everywhere we see the first major consequences of global warming: Large fires, huge floods, melting glaciers, and unprecedented heat waves. The world is burning and civilization as we know it will end, unless we do something.

To prevent or constrain the negative future consequences of this climate crisis, there are a few things you can do. Individual action inspires collective action and is therefore just as important. So: live more sustainable and reduce your CO2 footprint.

Fear x abstract

Interviewer: Thank you Dr. Attaway for agreeing to speak with us and sharing your insights. To conclude, do you have some final notes to share with our readers?

Dr. Paul Attaway
Climate Scientist

Thank you, yes. To summarize, research found that more than a century of burning fossil fuels as well as unequal and unsustainable energy and land use have contributed greatly to climate change. Fossil fuels are used for transport (e.g., driving a car), electricity, the heating of houses, and the industry.

The increase in CO2 in the atmosphere has resulted in an increase in the average temperature on Earth. Its consequence is climate change. In the past 100 years, the climate on Earth has warmed 1.1° C.

To prevent or constrain the negative future consequences of climate change, there are a few things you can do. Individual action inspires collective action and is therefore just as important. So: live more sustainable and reduce your CO2 footprint.

'No fear' x abstract

Figure 2

Fear Appeal Development

To develop the fear appeal, three sources were consulted (see Appendix A). First, a few summarising sentences from the IPCC's Sixth Assessment Synthesis Report were used to create a credible and realistic scientific statement. The fear and 'no fear' condition contained the same statement. Second, the successful and valid fear versus no fear stimulus material from Van Zomeren et al. (2010) was consulted. The fear message elaborated on the negative consequences of climate change in an urgent manner, while the 'no fear' message described them in less detail and objectively. Third, tweets where Peter Kalmus expresses his concerns in an emotional manner were chosen and incorporated in the fear message only. Kalmus often expresses strong emotions in his communication about climate change and recently took part in a nonviolent protest (Tucker, 2022), making him a good representation of the 'emotional climate scientist'. Lastly, for the fear appeal the terms 'global warming' or 'climate crisis' were used to describe the issue, while in the 'no fear' message 'climate change' was used. The first two wordings add to an alarmist, urgent language, which is a characteristic for fear appeals (O'Neill & Nicholson-Cole, 2009). 'Global warming' indicates human causation and is perceived more emotive (Benjamin et al., 2017). To validate the stimulus material, a pre-test was conducted. Pre-test results showed that the fear message scored significantly higher on fearfulness than the 'no fear' message, see Appendix B.

Recommended Behaviour Choice

The second part of the stimulus material consisted of the recommended behaviour. The two selected (concrete) behaviours were: eating less meat and replacing driving with walking, biking or public transportation. These two behaviours were chosen for two reasons. First, they are both considered low-effort behaviours (Tobler et al., 2012). They do not cost too much time, money or physical or mental effort to perform. While driving less is generally found to be a high-cost behaviour (Colgona et al., 2022b, the perceived costs of this behaviour are less high in the Netherlands. Bicycles are the key transportation mode for most inhabitants, so people do not solely rely on cars to get around (De Haas & Hamersma, 2020). Second, both behaviours are judged effective in mitigating climate change effects (Cologna, Berthold et al., 2022b; De Boer et al., 2016; Dreijerink et al., 2022; Ivanova et al., 2020; Truelove & Parks, 2012). Based on an item response theory model analysis (with the so-called Rasch model, cf. Kaiser et al., 2010; Starke et al., 2020), both behaviours had low behavioural costs and a low execution difficulty (Dreijerink et al., 2022). Installing solar panels or a heat pump are examples of high-cost behaviours (Dreijerink et al., 2022).

The above-mentioned results were confirmed by the pre-test and the behaviours were therefore judged suitable for the concrete recommendation conditions, see Appendix B. The concrete recommendation follows the implementation-intention layout: 'If you drive less by walking, biking, or taking public transportation more and eat less meat, you reduce your CO_2 footprint considerably'. The abstract version does not mention specific behaviours, but essentially recommends the same: 'live more sustainable and reduce your CO_2 footprint'. Pre-test results showed that the concrete recommendation scored significantly higher on concreteness than the abstract recommendation, see Appendix B.

Dependent Variables

Scientist Credibility

A scale comprising all elements of credibility was used: competence, trustworthiness, and goodwill (Kotcher et al., 2017). Participants indicated for nine randomly presented 7-point semantic differential statements how they rated Dr. Paul Attaway.[2] A factor-analysis with Principal Axis Factoring and Oblimin rotation indicated two factors could be extracted after removing items with factor loadings below 0.60, see Appendix D. One factor included four items regarding the scientist's personal competencies (from now on referred to as 'personal credibility'), which formed a reliable scale (M = 5.14, SD = 1.01, α = .88). The other factor concerned two items regarding the scientist's care and concern for society (from now on referred to as 'societal credibility'), which also formed a reliable scale (M = 5.28, SD = 1.42, α = .82).

Perceived Self-Efficacy

Perceived self-efficacy is usually measured with one statement (Diamond & Urbanski, 2022; Hart & Feldman, 2016). Therefore, it was measured with the following statement (Hart & Feldman, 2016): 'After reading Dr. Paul Attaway's statement, I feel like I can do something to mitigate the effects of climate change'. Participants indicated to what extent they agreed or disagreed (7-point Likert scale, M = 4.82, SD = 1.31).

Intention to Act Pro-Environmentally

To measure intention to act, participants indicated to what extent they agreed or disagreed with four statements (Broomell et al., 2015): 'I plan to take some actions to stop global warming', 'I personally do not intend to do much to stop global warming' (reverse coded), 'I will make some efforts to mitigate the negative effects of global warming' and 'I intend to take

concrete steps to do something to mitigate the negative effects of global warming'. A factor-analysis with Principal Axis Factoring and Oblimin rotation indicated one factor could be extracted, which formed a reliable scale (7-point Likert scale, $M = 5.14$, $SD = 1.17$, $\alpha = .89$). See Appendix D for the factor analysis.

Manipulation Checks

Results from an independent *t*-test showed that the concrete condition scored significantly higher on concreteness ($M = 5.28$, $SD = 1.46$) than the abstract condition ($M = 3.57$, $SD = 1.82$), $t(227.68) = -8.06$, $p < .001$. Results from an independent *t*-test showed that the fear condition was rated significantly more fearful ($M = 5.33$, $SD = 1.14$) than the 'no fear' condition ($M = 4.01$, $SD = 1.47$), $t(227.51) = -7.78$, $p < .001$. This means both manipulations were successful. However, a mean of 4.01 indicated the 'no fear' message was not evaluated as fearless. To stay consistent with the intended research design, the 'no fear' label was kept but written with quotation marks throughout this research when referring to the experimental condition.

Results

Main effect of a fear appeal on pro-environmental intentions

Our dataset and analysis syntax are stored in our repository.[3] We first examined the main effect on the intention to act pro-environmentally, compared to a message without a fear appeal (H1). An independent *t*-test showed that the intention to act pro-environmentally did not differ between the fear condition ($M = 5.13$, $SD = 1.20$) and the 'no fear' condition ($M = 5.15$, $SD = 1.13$), $t(239) = 0.10$, $p = .920$. Thus, [H1] was not supported.

Interaction Effect of Fear and Recommendation Type on Self-Efficacy

We examined [H2], whether a fear appeal increased self-efficacy when combined with a concrete recommendation but decreased self-efficacy when combined with an abstract recommendation. A two-way ANOVA revealed no significant main effect of a fear appeal on self-efficacy, $F(1, 237) = 0.49$, $p = .483$, $\eta^2_{partial} = .00$. However, the test did reveal a significant but small main effect of recommendation type on self-efficacy, $F(1, 237) = 8.22$, $p = .005$, $\eta^2_{partial} = .03$, achieved power[4] = .79. Participants who were exposed to the concrete recommendation scored significantly higher on self-efficacy ($M = 5.06$, $SD = 1.24$) than the participants who were exposed to the abstract

recommendation (M = 4.58, SD = 1.35). Additionally, a significant but small interaction effect between the two factors was found, $F(1, 237) = 4.12$, $p = .044$, $\eta^2_{partial} = .02$, achieved power = .58. To directly compare groups, a post-hoc test with Bonferroni correction showed that within the 'no fear' condition, the scores on self-efficacy did not differ between the abstract and concrete recommendation ($M_{difference} = 0.14$, $p = .552$). However, for the fear condition there was a significant difference on self-efficacy scores between the abstract and concrete recommendation ($M_{difference} = 0.81$, $p < .001$). A concrete recommendation combined with fear led to the highest self-efficacy, see Figure 3. This means H2 was supported: a fear appeal indeed increased self-efficacy when combined with a concrete recommendation and decreased self-efficacy when combined with an abstract recommendation.

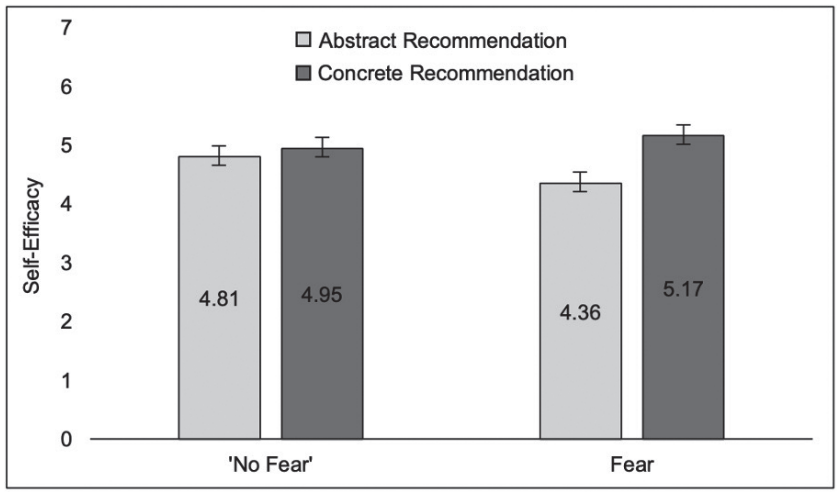

Figure 3

Self-efficacy as a Mediator

We further examined [H3], whether self-efficacy acted as a mediator between the effect of fear and recommendation type on intention to act pro-environmentally. We used model 7 of the PROCESS macro by Hayes (2013), which tested a moderated mediation model. Fear was a predictor variable, self-efficacy a mediator, recommendation type a moderator, and intention to act pro-environmentally the outcome variable. An index of moderated mediation was used to test the significance of the moderated mediation, i.e., the difference of the indirect effects per recommendation type (Hayes, 2015). If the confidence interval did not include zero, a significant effect is found. See Figure 4 for an overview of the tested paths.

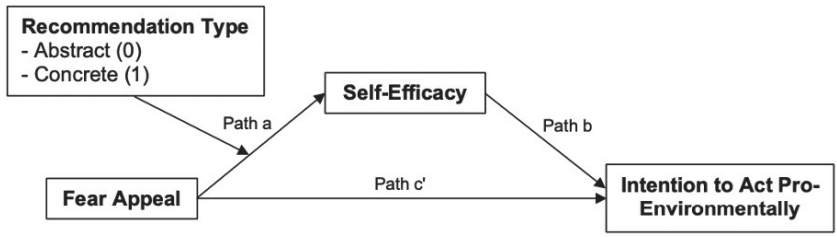

Figure 4

The index of moderated mediation was significant (b = 0.35, 95%–CI: [0.01; 0.75]). As zero did not fall within the confidence interval, this provided evidence for a moderated mediation (Hayes, 2015). However, the conditional indirect effect was insignificant for both values of the moderator.[5] The conditional indirect effect on intention to act pro-environmentally was the strongest but not significant within the abstract recommendation group, b = -0.24, 95%–CI [-0.51; 0.01]. It was weaker but neither significant for the concrete recommendation group, b = 0.11, 95%–CI: [-0.11, 0.37]. Results for the a-path showed that the interaction of fear and recommendation type was significant in predicting self-efficacy (b = 0.67, p = .044, R^2 = .02). This was in line with the results for H2. Results for the b-path showed that a higher degree of self-efficacy was associated with a stronger intention to act pro-environmentally (b = 0.52, p < .001). For each additional point of self-efficacy, which runs from 1 to 7, the average intention to act pro-environmentally increased with 0.52. Results for the direct effect of fear on intention to act pro-environmentally (path c') were not significant (b = 0.05, p = .675). This was in line with the results for H1. See for the full regression results Table 1.

While the complete moderated mediation model was supported (with a significant index of moderated mediation), and the a-path was significant, the conditional indirect effect was insignificant for both values of the moderator. So, officially there was no evidence for a moderated mediation model. However, two separate elements of the model were significant. The tests for H2 and the results for the a-path showed a fear appeal increased self-efficacy when combined with a concrete recommendation and decreased self-efficacy when combined with an abstract recommendation. The significant regression results for the b-path indicated that increased self-efficacy was associated with a stronger intention to act pro-environmentally. H3, if considered as separate effects, was therefore supported.

Table 1. Regression Results for the a-Path, b-Path and c'-Path

Predicting variable	Model a-path			Model b/c'-path		
	b[a]	*SE*[b]	*p*	*b*	*SE*	*p*
Fear	-0.45	0.24	.055	0.05	0.12	.675
Recommendation type	0.14	0.23	.552			
Fear*recommendation type	0.67	0.33	.044			
Self-efficacy				0.52	0.05	< .001

Note. Model for the a-path: $R^2 = .05$, $F(3, 237) = 4.27$, $p = .006$, model for b-path and c'-path: $R^2 = .34$, $F(2, 238) = 61.01$, $p < .001$. [a] *b* = Unstandardised regression coefficient. [b] *SE* = Standard error.

How fear and recommendation type affected a scientist's perceived credibility

Hypothesis 4 concerned the interaction effect of fear and recommendation type on the scientist's credibility. It was expected that a fear appeal in combination with a concrete recommendation decreases the scientist's credibility compared to when a fear appeal is combined with an abstract recommendation. A two-way ANOVA revealed no significant main effect of a fear appeal on personal credibility, $F(1, 237) = 0.15$, $p = .903$, $\eta^2_{\text{partial}} = .00$, nor a significant main effect of recommendation type on personal credibility, $F(1, 237) = 0.485$, $p = .487$, $\eta^2_{\text{partial}} = .00$, nor an interaction effect between the two factors, $F(1, 237) = 1.61$, $p = .206$, $\eta^2_{\text{partial}} = .01$. Therefore, H4 was not supported with regards to a scientist's personal credibility.

The same analysis was executed with societal credibility as the dependent variable. The test revealed no significant main effect of a fear appeal on societal credibility, $F(1, 237) = 3.30$, $p = .071$, $\eta^2_{\text{partial}} = .01$, nor a significant main effect of recommendation type on societal credibility, $F(1, 237) = 1.67$, $p = .198$, $\eta^2_{\text{partial}} = .01$. However, a small but significant interaction effect was found between the two factors, $F(1, 237) = 6.45$, $p = .012$, $\eta^2_{\text{partial}} = .03$. A post-hoc test with Bonferroni correction showed that within the 'no fear' condition, the scores on social credibility differed significantly between the abstract and concrete recommendation ($M_{\text{difference}} = 0.69$, $p = .007$). However, within the fear condition there was no significant difference on societal credibility scores between the abstract and concrete recommendation ($M_{\text{difference}} = 0.22$, $p = .381$). See Figure 5.

So, H4 was not supported, the opposite occurred. Contrary to expectations, a concrete recommendation in combination with a fear appeal led to a higher scientist credibility compared to when a concrete recommendation was given in combination with 'no fear'. This effect only occurred for societal credibility.

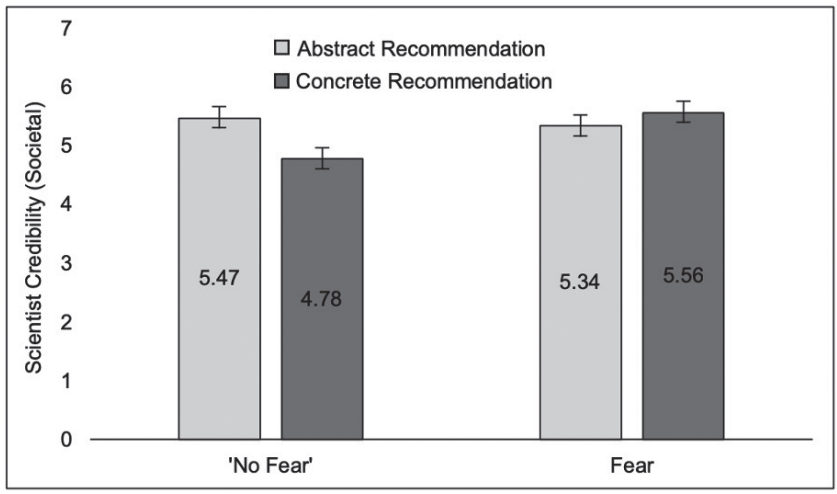

Figure 5

Conclusion and Discussion

Our experiment has examined two aspects. First, whether a climate scientist can engage in emotional, specifically fearful, communication without harming their credibility, depending on the type of behavioural recommendation (abstract or concrete). Second, whether this communication style is effective in increasing intention to act pro-environmentally through a possible increase in self-efficacy. The results showed that the effectiveness of a fear appeal depended on the content of the recommendation, in other words the efficacy statement. When participants were exposed to a fear appeal, a concrete recommendation raised their self-efficacy perceptions considerably compared to when an abstract recommendation was given. Subsequently, a high sense of self-efficacy was associated with a stronger intention to act pro-environmentally. In contrast, we found no evidence that either credibility type (personal and societal) would be significantly affected by fear or the recommendation type directly. Although all of the reported effect sizes were small, a climate scientist can effectively employ fearful language without harming their credibility, as long as they balance fear with a concrete recommendation (efficacy statement). In other words, a fear-hope appeal is recommended.

This research extends fear appeal and self-efficacy theory to an important source within climate change communication: the climate scientist. When the distributor of the fear appeal is a climate scientist, existing knowledge about fear appeals remains applicable. The importance of including concrete efficacy statements for an effective use of fear appeals, as described by the Extended Parallel Process Model and Protection Motivation Theory, was again confirmed. Without concrete tools to lighten the threat, a fear appeal may cause a backfire effect generating feelings of powerlessness in battling climate change challenges (Feinberg & Willer, 2010; Hine et al., 2016; O'Neill & Nicholson-Cole, 2009; Roser-Renouf & Nisbet, 2008). This manifests itself into fear control processing and consequently lowers self-efficacy (Tannenbaum et al., 2015). The observed strong positive relationship between self-efficacy and pro-environmental intentions is in line with previous research that has found that self-efficacy is positively associated with pro-environmental behaviours (Kothe et al., 2019; Sarrina Li & Huang, 2020).

Furthermore, previous research that investigated scientist credibility has found that credibility was hurt when a scientist advocated for a (controversial) specific policy (Kotcher et al., 2017), but not when they advocated for greater climate action in general (Beall et al., 2017, Kotcher et al., 2017). This was also observed in the present research. Behavioural advocacy, compared to issue advocacy, does not seem to activate feelings of distrust about self-serving or political motives. On the contrary, behavioural advocacy is what people nowadays might expect climate scientists to perform, possibly explaining why we have not observed a decrease in credibility (H4). This aligns with recent research that found that citizens accept it when climate scientists blend their science with emotions (Nicolaisen, 2022a). Evidently, if a climate scientist expresses their concern emotionally and provides concrete tangible solutions, people feel the scientist cares more and is concerned more about society. These are incredibly important qualities for a scientist to uphold since this can help to convey the seriousness of climate change and encourage engagement (Cologna, Baumberger et al., 2022a). Therefore, an interesting future research direction would be to gather qualitative information about what the public expects from climate scientists nowadays in terms of advocacy. Furthermore, since communication is increasingly becoming audio-visual (Montenegro, 2022), it would be interesting to perform a similar study with video or audio messages. With these modes of communication, emotions can be more easily conveyed, possibly ameliorating the impact on engagement (Loll et al., 2023).

Our study is subject to a few limitations. The study's sample is a convenience sample, recruited without any financial incentives. This has had two limiting consequences. First, the sample is relatively small for the given research design, as we could only detect small to medium effect sizes ($f = 0.18$). Because of that, some of the significant findings with relatively high p-values (i.e., 0.015–0.049) and smaller effect sizes (e.g., $\eta^2_{partial} = .02$ and smaller) are more at risk being false positives (Lakens, 2022), as the achieved power 1-β for some findings fell below the conventional 80%. This seems to apply to the hypotheses related to interaction effects between fear appeal and recommendation type on either self-efficacy or credibility. Although we stress that it is more likely that we have correctly rejected the null hypotheses in these analyses, we encourage follow-up research into these interaction effects with a higher level of statistical power.

A second sample limitation applies to the sample characteristics. It consisted of participants who scored high on environmentalism ($M = 5.40$ on a scale of 1 to 7) and was predominantly composed of highly educated people who identified to the political left. People with these characteristics are usually environmentally conscious already (Chan & Faria, 2022; Czarnek et al., 2021). Some answers might have been based on existing behaviour, not solely on exposure to the stimulus material. This may explain the lack of support for the direct effect of fear on intention to act pro-environmentally. To confidently extend the observed effects to other demographics and cultural groups, a more diverse sample-composition is needed in future research.

Another limitation lies within the manipulation of the fear appeal. The results of the manipulation check, although significant, were not as polarised as hoped. The intended no fear vs fear design was therefore not successful. The two experimental groups differed in level of fear, not presence or absence of fear. While this led to interesting results anyway, the message should be written more neutrally to make valid conclusions about the absence of fear.

Notes

1. As the results from the manipulation check showed, the 'no fear' message was not evaluated as fearless by participants. This means that the label 'no fear' did not align with the participants' message perception. However, to stay consistent with the intended design and since the intend was to create a no fear message, the label was kept but written with quotation marks throughout this research.

2. The statements were: *Not at all competent/Extremely competent*, *Not at all expert/Extremely expert*, *Extremely intelligent/Not at all intelligent* (reverse coded), *Not at all trustworthy/Extremely trustworthy*, *Not at all honest/Extremely honest*, *Extremely sincere/Not at all sincere* (reverse coded), *Cares about society a great deal/Doesn't care about society at all* (reverse coded), *Is concerned about society a great deal/Isn't concerned about society at all* (reverse coded), *Not at all sensitive/Extremely sensitive*.
3. The pre-print, dataset and analysis performed on this study can be found in our Open Science Framework repository: https://osf.io/bagj7/.
4. We contextualized our findings by reporting the achieved power for significant findings. These were obtained through post-hoc power analyses in G*Power 3.1.9.7 to compute the achieved power. Lower levels of achieved power (1-β) suggest that the probability of a false positive is higher. Note that these levels of achieved power might not accurately reflect the true power (Yuan & Maxwell, 2005).
5. When recommendation type was inserted as the predictor variable and fear as the moderator, the conditional indirect effect was significant for the fear condition, b = 0.43, 95%CI [0.17, 0.72], but not for the 'no fear' condition, b = 0.07, 95%CI [-0.18, 0.30]. This explained why the index of moderated mediation was significant, since the number stayed the same when inverting fear and recommendation type. While this is an interesting conclusion, it was not relevant for this analysis since fear was considered the predictor variable and not recommendation type.

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