Research paper

Climate visuals: A mixed methods investigation of public perceptions of climate images in three countries

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ABSTRACT

Imagery plays a central role in climate change communication. But whereas research on the verbal communication of climate change has proliferated, far fewer studies have focused on visual communication. Correspondingly, relatively little is known about how to effectively engage the public using the visual medium. The current research is the first mixed methods, cross-national investigation of public perceptions of climate images, with a focus on photographic climate change imagery. Four structured discussion groups in the UK and Germany ($N = 32$) and an international survey with an embedded experiment in the UK, Germany and the US ($N = 3014$) were conducted to examine how different types of climate change imagery were evaluated. The qualitative research pointed to the importance of the perceived authenticity and credibility of the human subjects in climate images, as well as widespread negativity towards images depicting protests and demonstrations. Images of climate 'solutions' produced positive emotional responses in the survey and were less polarizing for climate change skeptics, but they were also the least motivating of action. Familiar climate images (such as a polar bear on melting ice) were easily understood in the survey (and evaluated positively as a consequence) but viewed with cynicism in discussion groups. We present a detailed discussion of these and other key findings in this paper and describe a novel application of the data through an online image library for practitioners which accompanies the research (www.climatevisuals.org).

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1. Background

Over the past decade there has been a proliferation of academic research and practitioner literature that has sought to address the question of how to more effectively communicate climate change (e.g., CRED & ecoAmerica, 2014; Van der Linden et al., 2015b). However, although much is now understood about public engagement with climate change, the vast majority of climate communication studies have focused on verbal communication. Climate change is a particularly difficult issue to communicate, let alone visualize. The widespread perception of climate change as an abstract, distant, and uncertain phenomenon presents it as a uniquely complex problem for motivating individual and group-level engagement (Gifford, 2011; Markowtiz and Shariff, 2012). But despite the fact that thousands of climate change images are shared by journalists, campaigners and educators around the world on a daily basis, little research has focused on how to more effectively communicate climate change in the visual medium.

The lack of past research on visual imagery and climate communication is both puzzling and problematic. A wide diversity of images are used to depict climate change—from pictures of smokestacks and traffic jams (highlighting *causes* of climate change) to iconic images of polar bears on isolated patches of ice (focusing attention on potential *impacts*) to photos of people installing photovoltaics on their roofs (showing possible *solutions* to the problem). Yet despite the crucial role of climate imagery in shaping how people conceptualize the issue of climate change (Leiserowitz, 2006), non-governmental organizations and climate change advocates often have only anecdotal evidence to back up their selection of particular visuals over others; moreover, practitioners' intuitions about "effective" visual communication messages sometimes conflict with what researchers have found through controlled studies.

1.1. Research on climate change imagery

The term 'visual communication' is an extremely broad one, with research on visuals and imagery having roots in a number of academic disciplines and fields (e.g., Messaris, 1997; King, 2014; Zillmann, 2002). As a consequence, an exploration of "climate visuals" might feasibly involve an analysis of disparate visual media, from maps and three-dimensional visualizations, to cartoons, infographics, graphs and even videos (O'Neill and Smith, 2014). Given the ubiquity of photographic images depicting climate change and the potential power of this type of visual to enhance engagement with climate change, our focus in the current paper was on photographic imagery. This decision does not imply that alternative visual media such as maps, cartoons, or infographics are less relevant for academic study, but it is notable that there are also very few systematic analyses of the effectiveness of climate change videos, cartoons, or infographics, despite their widespread use and assumed-efficacy in terms of public engagement (see O'Neill and Smith, 2014; Sheppard, 2012).

A limited body of research primarily using qualitative methodologies (e.g., Q-sort, focus groups) or content analysis has investigated how people think about and respond to photographic climate change imagery. Of the work that does exist, most grapples with the dual challenge of persuading the viewer that climate change is a significant issue while presenting it as a solvable one. There is also a related nascent literature using content analysis and related methods to examine how climate change is framed and visualized in news media coverage (e.g., O'Neill, 2013; Rebich-Hespanha et al., 2015; Smith and Joffe, 2009). In a series of papers, O'Neill and colleagues (O'Neill, 2013; O'Neill, Boykoff, Niemeyer, and Day, 2013; O'Neill and Nicholson-Cole, 2009) found that dramatic and potentially fear-inducing images of climate impacts and extreme weather are good at capturing people's attention (i.e., they have high 'salience') and make climate change seem more important, but they can also act to distance viewers (both psychologically and geographically), leaving them feeling overwhelmed rather than motivated to respond to the risks portrayed. Distressing photos may prompt a "helpless hopeless" feeling in the viewer (Banse, 2012), although this is partially contradicted by recent Australian research (Leviston et al., 2014). In their work, Leviston et al. (2014) found that dramatic images of climate change impacts (including natural disasters and melting ice) prompted strong negative feelings (alarm, anger, fear, upset or frustration) and increased arousal, but these feelings did not undermine their willingness to respond. Images of climate 'solutions' tend to make people feel more able to do something about climate change (they have high 'efficacy'), but at the same time can reduce people's sense that the issue is an important one (O'Neill and Nicholson-Cole, 2009; O'Neill et al., 2013). A recent study replicated these findings in a cross-national sample from Germany, Austria, and Switzerland (Metag et al., 2016).

A similar tension exists around using 'localized' versus 'distant' climate images. Perhaps the most iconic climate change image—the polar bear—has come to function as the primary visual cue associated with the issue (Doyle, 2007). However, images such as this have become problematic, as they appear to actively reinforce impressions of climate change as a distant issue (Manzo, 2010) rather than motivate increased interest, concern, and intentions to act. Nicholson-Cole (2005) found that focus group participants often explain that they are more touched by national and local imagery because it is easier to relate to and consequently is more upsetting. However, in research by O'Neill and Hulme four years later, the same reasoning was used by participants to say why local icons are disengaging: "it will only affect locals and is not as much of a global issue" (O'Neill and Hulme, 2009). A recent review of the research suggests that reducing the perceived distance of climate change may actually have unanticipated effects on engagement (McDonald et al., 2015). Existing evidence regarding the impacts of highlighting local versus distant or global impacts of climate change on affect and issue engagement remains mixed (McDonald et al., 2015), and no research has carefully examined the importance of distance in the context of climate change imagery specifically.

Other aspects of the evidence base are more straightforward. People find it easier to engage with images if they include people (Banse, 2013; Nicholson-Cole, 2005; Braasch, 2013), and where direct eye-contact can be made with the subject of the image (Banse, 2013). While these conclusions are virtual 'truisms' among photographers, it is instructive to reflect on the images that participants in survey research spontaneously associate with the term 'climate change' (typically polar bears and 'smokestacks'), which do not necessarily conform to these principles (Leiserowitz, 2006; Smith and Leiserowitz, 2014). As even this brief review of the literature highlights, therefore, there is a need for research that provides advocates with an evidence-based assessment of climate imagery impacts on audiences.

1.2. The present research

One of the central goals of the present research was to explore non-experts' perceptions of and reactions to different forms of photographic climate change imagery in a manner that would enable us to extract applicable insights to use in developing a public database of climate change photographs (www.climatevisuals.org) for use by groups or individuals interested in climate change communication, such as climate change advocacy organizations, bloggers, or journalists. Therefore, the methodological and analytical approach of the research was primarily and purposefully exploratory in nature, with the imagery selected and questions examined being centrally guided by the goal of making practical and 'actionable' recommendations for climate change communication. To gain a robust assessment of perceptions and responses to climate change images, we utilized both qualitative (structured discussion groups) and quantitative (experimental survey) methods. In both cases, participants were presented with a variety of photographs depicting climate change causes, impacts and solutions, and we assessed their reactions to these images ranging from their comprehensibility and aesthetic appeal to the emotions and motivations they evoked. Based on the extant literature, we anticipated that four broad features of images would be particularly important in shaping responses.

First, images of climate change solutions were expected to generate the most positive affective reactions, whereas we expected images of causes and impacts to lead to more negative emotional responses (O'Neill et al., 2013). Second, images depicting ordinary people, particularly those either needing help (e.g., flood relief) or actively engaging in low-carbon behaviors (e.g., installing solar panels), were anticipated to be effective at "personalizing" climate change, increasing concern, and motivating a sense of efficacy. Third, given recent evidence suggesting that depictions of climate change as localized can produce mixed reactions (e.g., reducing geographical distance vs. reducing temporal distance; McDonald et al., 2015; see also Rickard et al., 2016), we expected that there would be contrasting or even conflicting results with regard to images that depicted 'distant' versus 'localized' images. Finally, given the importance of high-quality visuals for catching attention and promoting engagement (cf. O'Neill and Smith, 2014), aesthetically appealing images that are evaluated as authentic and/or entertaining were expected to increase the extent to which participants would engage with and attend to images favorably.

No research to date has utilized a cross-national, mixed-methods approach to study how individuals react to climate imagery. By using diverse methods, the present research allowed us to identify and assess both similarities and differences in reactions to images as a function of how they were contextualized (i.e. in a participatory, dialogic context vs. individual images viewed as part of a controlled survey). As well as the many advantages it confers (in particular the potential to 'triangulate' between different data sources), mixed-methods research raises some additional questions and challenges that are not apparent in single-method designs, including the ordering of methodologies. In the current investigation, we deployed a 'sequential exploratory' design, using intentionally broad-brush and open-ended qualitative research to inform a narrower, more focused quantitative investigation (Creswell, 2013). This permitted us to use themes present in the existing literature to design the qualitative phase of the project, without unnecessarily restricting the scope of Study 1. Study 2 involved a more precise and systematic investigation of a smaller number of variables. Given the differences in these two study designs, we anticipated both overlap and divergence in reactions to the images. Therefore, in addition to providing empirical insights into how the public reacts to climate change imagery, the design of our research also provided an opportunity to explore how methodological choices and differences may influence reactions to such imagery.

2. Structured discussion workshops

2.1. Method

2.1.1. Participants and procedure

Four structured discussion group workshops were held during June and July 2015 to examine individuals' responses to climate change images. The workshops took place in London and Berlin, with two workshops in each city. Individuals were recruited to participate in the workshops through online advertisements distributed through social media, online forums and email networks, as a well as classified sites. Interested individuals completed an online prescreening survey in order to obtain basic demographic information (age, gender, ethnicity and occupation). This ensured a diverse range of participants, broadly reflecting the demographic stratification of the U.K. and Germany. All participants were financially compensated (£35 in the UK and 45 Euros in Germany); each session lasted approximately 120 min.

Both UK workshops took place in the same location on the same day. Six men and three women attended the afternoon workshop, while five men and four women attended the early-evening

session. These participants all resided in London and came from diverse backgrounds in terms of occupation (e.g., civil servant, company director) and age (three were 18–24, two aged 45–54 and one older than 75). Three participants were from an ethnic minority background. In the German workshops, 14 adults (age range 18–44) participated (the first session contained five women and three men; the second contained four women and two men). Participants in the German workshops were from a range of different countries including Spain and Canada as well as Germany (two identified being from an ethnic minority background). The majority of participants were university students or postgraduates in the German workshops.

2.1.2. Materials and design

The images (49 in total) selected for use were drawn from a 'longlist' created through a process of reviewing existing academic literature for key themes (e.g., the distinction between causes/impacts/solutions emphasized in O'Neill, 2013), a series of semi-structured interviews with key stakeholders (academics, campaigners and journalists; see the Appendix to Corner et al., 2015 for further description of the stakeholder interviews), and an informal review of images and visual trends in high-profile climate change campaigns. The challenge was to select images from this longlist that would best provoke and stimulate conversation (rather than to systematically 'match' or 'contrast' images in a highly-controlled way). Nonetheless, we were able to select – through an iterative process of reflection and analysis among the research team – clusters of images (or 'image sets') that reflected the key themes identified from the existing literature and our stakeholder interviews (the full set of images utilized, and related images where copyright policies prevent reprinting, can be found in the online report at www.climatevisuals.org and the appendices to that report). These image sets included the central depiction of climate change causes, impacts, and solutions, as well as sets of images depicting "clichéd" climate change imagery (e.g., polar bears), location differences (e.g., local vs. distant climate change impacts), the presence of people/animals, protest imagery, and images of politicians or celebrities.

The design of the discussion groups was adapted from the 'narrative workshop' methodology developed by Climate Outreach (Corner and Roberts, 2014), and reflects principles of participatory deliberative public engagement used to study public perceptions of a wide range of social and scientific/technological issues (e.g., Pidgeon et al., 2009, 2013). Participants were first asked to discuss their core values and sense of identity prior to introducing the topic of climate change into the conversation. Image sets were then presented to participants by the facilitator sequentially, typically

Table 1
Categories and Examples of Questions Discussed in the Structured Discussion Groups.

Category	Example Questions
Understanding/salience	"What is this trying to convey/what does it show?"
	"Is it difficult to understand?"
Psychological distance/self-identification	"Does the image 'connect' with you?"
	"Are the people in the image 'like you' or 'other'?"
Affect (emotion)	"Does the image convey an emotion, and if it does, how does this make you feel?" "Fearful/fatalistic or hopeful/optimistic? Worried or reassured?"
	"Does the image depict something/someone 'good/desirable/right' or 'bad/wrong/evil'?"
'Action' (efficacy) and 'personal engagement'	"Does the image spark any desire to 'respond' to the situation depicted?"
	"What kind of response . . . something you could do yourself? Supporting a campaign? Lobbying politicians? Wanting to know more?"
Politics and values	"What (if any) political sentiments does the image convey? What values does it communicate?"
	"Do these match or conflict with your own?"
Aesthetics and humor	"Do you find the image visually attractive or not . . . is it the sort of image you would want to look at?"
	"Did the image surprise you or make you laugh? Is that a good or a bad thing?"

two sets at a time (to encourage and promote comparison and contrast between the sets of images). For logistical reasons of space around the discussion table, image sets were removed once they had been discussed, but were sometimes re-introduced if participants requested them or referred to them. The first image set for each discussion group was always the 'clichéd climate imagery' category, but the order that subsequent sets were presented varied between groups according to the direction that the conversation took. It is important to note that individual images were not captioned, and image sets were not labelled. Thus, the central aim of presenting the image sets was not to elicit a judgment from every participant on every image, but to provide a structured (and theoretically informed) framework within which to facilitate the deliberations.

The facilitators used a variety of questions to prompt responses to the images (see Table 1). In each of the workshop, a standardized script was provided for the facilitator, but as is typical in exploratory, qualitative work of this kind, conversations differed to some extent between each workshop.

2.2. Results

All discussion groups were audio recorded and detailed notes were taken from these audio recordings. Analyses proceeded through an iterative process of reading, thematic coding and reflection, with a particular focus on the variables described in Table 1. A variety of themes emerged from the four workshops. We focus here on three broad clusters of key findings: the importance of depicting credible and 'authentic' human subjects in the images; the critical reception given to 'clichéd' climate images and depictions of protests and demonstrations; and, the complexities of 'localized' images in terms of participants' reactions. Readers interested in further exploring the qualitative findings are referred to the project report (Corner et al., 2015).

2.2.1. The importance of credible and authentic human subjects

Results are consistent with past research indicating that imagery containing people tends to be more powerful, and that people respond more strongly to photos of one individual rather than many (Markowtiz et al., 2013; Nicholson-Cole, 2005; Slovic, 2007). For example, one photograph showed a man in danger in a flood in Pakistan. One focus group member commented that, "[the photo].shows how it [climate change] affects the people rather than the community . . . you don't need a lot of people to convey a message, I think just the one person by himself it's really heart breaking to look at that."

Eye contact in photos also appeared to be important for promoting attentiveness, interest, and concern when viewing imagery of people (cf. Fox et al., 2007). In one image, a Nigerian man looks directly at the camera whilst gesturing to a fire behind him. Even though this image was not entirely understood by the participants in terms of how it related to climate change, the distress in the man's face prompted the desire to seek out more information about what was happening. One participant commented that: "there's something in his face, like he's scared for his life, so whether it's war, fire, bomb, whatever that's reaction is hard to fake . . . " Where people were not present, some participants even requested their presence, with one group member remarking: 'I want scientists as well and guys in white coats, dead serious experts in their field staring you in the face, going get it together man, that's the sort of thing that motivates me'. This latter finding also fits with recent research in the public health domain suggesting that images of scientists can bolster the effectiveness of scientific consensus-based messaging strategies (Dixon et al., 2015; see also Van der Linden et al., 2015a).

The generally strong reaction among participants to identifiable individuals, who seemed genuinely in distress, was in part driven by one of the most consistent findings to emerge from the discussion groups: participants were disinterested in and reacted with disdain toward photos that they perceived as 'staged', and reported greater interest and felt more persuaded by images that appeared to be 'authentic'. This manifested itself in a number of ways, and had an influence on images of causes, impacts and solutions alike; participants were generally cynical about the images they viewed and wary of being "taken in".

Several of the images depicting solutions to climate change were particularly prone to perceptions of inauthenticity. A photograph of children posing with and celebrating their school's solar panels was met with cynical reactions. Participants described this image as 'staged' and 'gimmicky'. Another image depicting a man installing draught excluders (draught stoppers) while being watched by a smiling family was also strongly disliked and met with ridicule: "I think that family needs to get out a little more" [general laughter] "They're a little too excited about the draught excluding". Images seen as staged and inauthentic also generated associations with advertising and marketing, which appeared to reduce their effectiveness for participants: "that's a problem for me, I don't want to feel like I'm being sold the idea of, if it has to be sold to me then I don't need it . . . " However, photos that appeared un-staged and which displayed low-carbon lifestyles in a tangible way prompted positive, optimistic reactions. For example, an image of a man rolling out roof insulation was preferred because, 'it looks like "real work" is going on'.

In contrast, participants' responses to photos of politicians were, unsurprisingly, reflective of their political views. But the distaste for politicians as credible climate 'messengers' seemed to go beyond personal preferences and extended to a general cynicism about the political process as a whole, with one German group member commenting that all the images of politicians, "make me almost vomit." Obviously staged photos of politicians—for example an image of David Cameron posing with a husky dog—nearly always prompted negative reactions, whereas more 'day to day' photos of politicians were sometimes met with less disdain. Some fairly mundane images of negotiators at a climate change summit were received more favorably than other photos of politicians, because they portrayed active engagement with climate change and appeared less staged.

2.2.2. Cynicism towards 'climate clichés'

When asked (before being shown any photographs) at the beginning of the discussion groups what image first came to mind when they thought of climate change, participants readily made a series of associations – polar bears, melting ice, a burning globe, fire, pollution, and coal power stations. However, when shown these 'clichéd' images, few appeared to be persuaded or more concerned about climate change when viewing them. Participants identified these images as having lost their impact precisely because of their familiarity and over-use: " . . . the polar bear and the burning earth makes me angry for some reason. Not because I'm like, oh no that's a pressing issue, but like 'oh this is so annoying'." A widely circulated image of a burning earth held in a human hand prompted a number of mixed reactions. Some liked it because, 'it kind of says the world is in our hands a responsibility to take care of . . . just like we take care of our children,' but others referred to it as "a bit stupid", "a bit naff" and "[it] just pisses me off". One group member commented that it felt to him like "propaganda" forcing him to react in a certain way when he wasn't sure he wanted to.

A minority of participants was still moved by some of these clichéd images, particularly those depicting polar bears. Some participants reported that they might be motivated to respond pro-socially after seeing the polar bear imagery, but this was largely in

reference to helping the polar bear specifically: *"I feel really sorry for the polar bears, I might donate for the polar bear thingy, but not for global warming"*. Similarly, images of land drying out, deforestation, and droughts that are also familiar clichés were not readily associated with climate change: *" . . . .if someone was to pass me this image [of a man in a dried out landscape] it would be like, poverty, third world countries. This is just what I've been raised to think. This wouldn't affect me as far as climate change."* These results pose a difficulty for climate change communicators: the imagery most readily associated with climate change may not be the most effective at promoting concern about climate change or intentions to take personal action. Overuse of certain types of images results in a reduction in their effectiveness, and may even come to be seen as inauthentic – and this seemed to extend in the minds of most discussion group participants to images that depicted climate protests and demonstrations.

While participants expressed interest in and sympathy for social justice issues and some concern about climate change, most were not sympathetic to 'typical environmentalists' or images of environmental protest. When asked to say how they pictured environmental campaigners, one London group member described, *" . . . someone who chains themselves to a fracking banner . . . someone that marches and don't really want to communicate the full facts."* Another categorized marchers as, *"either hipsters trying to be cool or . . . lunatic extremists."* Consistent with these negative impressions, images of environmental protestors often prompted accusations of hypocrisy. In Germany, one participant objected to an image of a child at a climate change protest. The child, who was holding a banner in the shape of a foam finger, was described as: *" . . . . a classic example of jumping on the bandwagon. She wants you to take the threat seriously, but these balloons, and this foam finger, are the worst for the environment. It's so outrageous, a lot of the time these protestors that are protesting climate change are doing things like this."* An image of a protester with his face painted blue was perhaps the most negatively received of all the photographs we tested. He was accused of being a 'frat guy' or alternatively someone who *" . . . probably used the same face paint to paint himself at Glastonbury this weekend, and rubbed out climate and put Kanye West."* Overall, participants did not like the generic protest images either. One picture prompted the comment, *"For me, it feels like I've seen that image a 1000 times for pretty much every cause there is in the world"*. Specific campaign related jargon in images, such as 'divest' or 'climate justice', meant little to the group members and mostly prompted confusion.

2.2.3. The complexities of 'localizing' climate images

The results of our discussion groups support the idea that reducing the psychological distance of climate change as a strategy for engagement and the effectiveness of displaying local climate change impacts are not as straightforward as previously thought. While localizing climate change may possess some advantages, what counts as a 'local' impact and whether this motivates or undermines concern about the wider climate issue was mixed. For example, photographs of recent flooding in the UK and Germany—events that have already been linked to the warming climate—were met with a mix of positive and negative reactions. Several participants said the images made climate change feel more immediate, and worrying: *" I think [image of people protesting about flooding on a Pacific island] is good, but personally for me [image of a flood in a UK town] has got more of an effect, because it's local, because you can actually see that something's happened"*. However, not all participants exhibited this type of response.

One key factor that emerged in responses to localized imagery was participants' consideration of how the effects of climate change would impact wealthier countries relative to those less well off. One participant objected to the concept that local, familiar imagery should be used to produce reactions in Westerners, arguing *"for me the whole point of climate change is it's about knowing what's going on outside your bubble . . . to me Western people saying they feel more sorry for western people because they get flooded . . . to me that's really selfish"*.

Participants' responses suggested that they believed Western countries would be relatively resilient to climate change impacts, and were thus less concerned about the negative impacts of climate change when depicted in these local contexts. Flooding in Germany or the UK was perceived by some as less of a serious issue than effects in other countries:

> *"A flood in this country doesn't have the same emotional effect as a flood in other countries, it's going about, you're not massively inconvenienced in that picture". [looking at an image of a UK town, flooded to knee/waist level]. "And that – I know that guy's fine – if his house got flooded, he'll be fine, he'll get money from insurance or whatever because that's the society that we're living."*

In comparison, some participants had strong reactions to images of people experiencing climate change impacts in distant places: *' . . . .with [image of a Nigerian man looking directly at the camera whilst gesturing to a fire behind him] . . . he seems like in real emotional pain and it kind of affects me. Not like before when you have people yaaay solar panels . . . an honest reaction to the situation, losing everything he used to have.'*

2.3. Study 1 discussion

The results of the discussion groups yielded a number of novel insights about reactions to visual imagery related to climate change and relate to the four broad categories of images that we expected to play a central role in participants' evaluations. First, the perceived authenticity and credibility of human subjects in the images evaluated played a consistent role in shaping participants' judgments, with 'real people' preferred to 'staged' images of politicians, or even environmental protestors. Images where the subjects were 'celebrating' rather than simply engaging with low-carbon technologies were typically viewed as contrived, rather than compelling or motivating. Taken together, these findings support and extend the findings of previous studies showing that solutions-focused imagery is likely to evoke more positive reactions (O'Neill and Nicholson-Cole, 2009; O'Neill et al., 2013), and that ordinary people in images can provide a 'personalizing' influence (Banse, 2013; Nicholson-Cole, 2005; Braasch, 2013). However, they also suggest some clear but challenging conclusions for climate campaigners, as the depiction of 'celebratory' groups around particular climate solutions and picture of demonstrators on protest marches are common.

Second, our findings also fit with the growing understanding of the complexity of reducing the 'psychological distance' of climate change as a strategy for increasing engagement and action on climate change (McDonald et al., 2015). Images depicting local climate change impacts, while effective for some, also had a number of unanticipated consequences. Primary among these was the fact that participants believed that impacts in other less developed nations were going to be worse and that the UK and Germany would be resilient against climate change impacts. Therefore, depicting local impacts appeared to reduce concern and to some extent trivialize the issue. For some participants, depicting local impacts was even seen as offensive, with the belief that concern about climate change should not rest purely on self-interest, but rather on concern about global impacts.

Despite the rich findings derived from this participative exploration of public opinion, qualitative methods alone are not able to furnish climate change communicators with systematic data on public responses to climate change imagery. Study 2 was

therefore designed to provide a complimentary methodological approach to understanding public responses to climate imagery, focusing on a smaller number of images, but drawing on a much larger (and representative) sample.

3. Online survey experiment

In order to build on and test the generalizability of findings from the discussion groups, we developed an online survey with embedded experiment to administer cross-nationally. A smaller number of images from Study 1 were selected for use in Study 2 on the basis of three criteria: first, to comply with the tripartite cause/impact/solution distinction; second, to reflect a degree of diversity *within* each of these categories (e.g. climate impact images depicted a range of impacts); and third, where specific images in Study 1 had attracted particular attention (e.g., an image of children 'celebrating' around newly installed solar panels). Our outcome variables included many of the dimensions that emerged during the discussion groups (e.g., understanding of image meaning, emotional reactions) but were also designed to assess aspects we considered particularly important to quantify (e.g., willingness to share the images, motivations to change behavior after seeing the image). We also sought to gain a more nuanced perspective on how these different image types are interpreted by individuals with different identities. Therefore, we also explored cross-national differences in responses to imagery, as well as the role of climate change skepticism in determining how participants reacted to differing types of climate change imagery. Given the growing role of social media and importance of social sharing and "viral" media, we were also interested in assessing how individuals thought *others* would react to these images. As this was not a direct focus of the findings presented here, the results of these exploratory analyses are not described here but can be found in the online Supplementary material for this paper.

3.1. Method

3.1.1. Participants

A market research firm, Research Now, was contracted to conduct a three-country, online (internet) survey with embedded experiment in the US, UK and Germany. Research Now provided non-probability, nationally representative quota samples for each country. These samples are matched to country-level census data on geographic region, gender and age, and education level was also tracked in the U.S. Difficulty in obtaining a sufficient number of older adults in all countries resulted in samples that slightly underrepresent adults over the age of 65 (*Mean* = 44.46, *SD* = 16.60, *Median* = 44, *Min* = 18, *Max* = 88). In total, 3014 participants (U.S., n = 1001; U.K., n = 1007; Germany, n = 1006) participated in the study. Gender quotas were met closely (51.4% female).

3.1.2. Measures and procedure

Research Now invited individuals to participate in a 15–20 min survey in exchange for financial compensation. The survey was conducted in the primary language of the country in which participants lived (English for US and UK, German for Germany). The research team constructed the original survey materials in English, which were then translated into German by a native speaker. A second native German speaker later reviewed the translated version of the survey. Where appropriate, changes to improve readability and comprehension were made.

After consenting to participate in the study, participants reported on their degree of *climate change skepticism* using two items (e.g., "I am uncertain about whether climate change is happening or not"; 1 = *strongly disagree,* 7 = *strongly agree*; M = 3.71, SD = 1.663; r = 0.552). Skepticism did not differ between experimental conditions, $F(2, 3011)$ = 2.061, p = 0.127, R^2 = 0.001. However, the three countries slightly differed on their level of skepticism, $F(2, 3011)$ = 9.231, $p < 0.001$, R^2 = 0.006, with the U.S. sample (M = 3.82, SD = 1.768) and U.K. sample (M = 3.78, SD = 1.632) reporting greater slightly greater skepticism than the German sample (M = 3.53, SD = 1.570; differences between U.S. and U.K. are not statistically significant, but both significantly differ from Germany at $p < 0.001$).

Participants were then randomly assigned to see images that portrayed either climate change causes, impacts, or solutions, which served as the three conditions for the experimental component of the study (approximately 333 participants in each country saw causes, impacts, or solutions). In total, each participant saw a series of six images from one category, which were fully randomized within condition (the set of images used in the experiment, as well as descriptive statistics for each individual image, can be found in the online report at www.climatevisuals.org/research/).

Table 2
Cnonstructs, Items, and Scales Used in the Online Survey Experimet.

Construct	Item	Scale
Understanding of image	To what extent do you feel as though you have an understanding of what this image is trying to convey?	1 = *not at all,* 5 = *completely*
Affective response	On a scale of −5 to +5, where −5 equals "really negative" and +5 equals "really positive," how does this image make you feel?	−5 = *really negative,* +5 = *really positive*
Information seeking motivations	How motivated do you feel to seek out more information about what this image depicts?	1 = *not at all motivated,* 4 = *very motivated*
Willingness to share the image	Compared to most other images about climate change that you've seen, how much more or less willing would you be to share this image with friends on social media?	1 = *much less willing,* 5 = *much more willing*
Motivation to change personal behavior	Does the image make you want to change your own behavior to reduce your impact on the environment?	1 = *not at all* 5 = *very much*
Motivation to support climate change policy	Does the image make you more or less supportive of government policies to tackle climate change?	1 = *much less supportive* 7 = *much more supportive*

After each image was displayed on the screen, participants were asked to respond to a set of six items. As there are no psychometrically validated measures of reactivity to climate change imagery, the scale items were created by the researchers to address some of the key themes and focal points of the findings from Study 1. Table 2 displays these items and the construct they were intended to measure. After completing all measures for all six images shown, participants were thanked for their participation.

3.2. Results

Table 3 displays the correlations between each outcome variable in this study. Our primary analyses examined whether there were differences between our experimental conditions (causes vs. impacts vs. solutions) on our outcome variables. Therefore, we computed average scores for participants' responses (i.e., understanding, affect, etc.) collapsed across the six images that they saw during the study. The majority of these were very highly correlated with one another. However, emotional responses to images were only weakly correlated with the other outcomes.

3.2.1. Emotional response to images

There was a large and significant effect of condition on participants' affective reactions to the images in each category, $F(2, 3011) = 747.174$, $p < 0.001$, $R^2 = 0.332$. Images of climate change solutions generated a modestly positive emotional reaction ($M = 1.21$, $SD = 1.653$), whereas images of climate change impacts ($M = -1.14$, $SD = 1.97$) and causes ($M = -1.68$, $SD = 1.695$) both generated negative emotional reactions. Tukey's post-hoc analyses indicate that all three conditions significantly differed from one another on affective reactions (Mean differences ranged from 0.54 to 2.88, p's < 0.001).

3.2.2. Motivation to change personal behavior and support government policy

There was also a significant effect of image condition on expressed motivations to change personal behavior after viewing the images, $F(2, 3011) = 37.128$, $p < 0.001$, $R^2 = 0.024$. Climate change impacts generated the greatest desire to change personal behavior ($M = 3.36$, $SD = 1.023$), which was significantly greater than motivations generated by causes ($M = 3.17$, $SD = 0.973$; Mean difference = 0.189, $p < 0.001$) and solutions ($M = 2.98$, $SD = 0.954$; Mean difference = 0.379, $p < 0.001$). The effect of image condition on support for climate change policy at the governmental level was also small but significant and followed the same pattern as the results for personal behavior, $F(2, 3011) = 44.998$, $p < 0.001$, $R^2 = 0.029$. Images of impacts generated greater support ($M = 4.84$, $SD = 1.20$) for climate change policy than pictures of causes ($M = 4.65$, $SD = 1.083$; Mean difference = 0.193, $p < 0.001$)

and solutions ($M = 4.36$, $SD = 1.141$; Mean difference = 0.481, $p < 0.001$).

3.2.3. Motivations to share images with others

Image category also produced a significant effect on participants' willingness to share the images with others, $F(2, 3011) = 32.591$, $p < 0.001$, $R^2 = 0.021$. Images of impacts generated the greatest motivation to share the images with others ($M = 3.40$, $SD = 0.899$). Solutions images were the least likely to engender motivations to share ($M = 3.09$, $SD = 0.851$), while causes fell in between the impacts and solutions categories ($M = 3.22$, $SD = 0.819$). Post-hoc analyses revealed that all conditions differed significantly, if minimally, from one another (Mean differences > 0.18, p's < 0.005).

3.2.4. Understanding of images and motivations to seek out more information

Understanding of the images was also significantly affected by image condition, $F(2, 3011) = 22.821$, $p < 0.001$, $R^2 = 0.015$. Images of climate change impacts were slightly better understood by participants ($M = 3.80$, $SD = 0.813$) than causes ($M = 3.66$, $SD = 0.798$, Mean difference = 0.141, $p < 0.001$) or solutions ($M = 3.55$, $SD = 0.815$; Mean difference = 0.243, $p < 0.001$). Consistent with these findings, there was also a small but significant effect of condition on motivations to seek out more information, $F(2, 3011) = 27.146$, $p < 0.001$, $R^2 = 0.018$. Impacts images generated greater information seeking ($M = 2.67$, $SD = 0.803$) than causes ($M = 2.53$, $SD = 0.766$; Mean difference = 0.139, $p < 0.001$) or solutions ($M = 2.42$, $SD = 0.761$; Mean difference = 0.255, $p < 0.001$)

3.2.5. Country level differences

Table 4 displays tests of significance and mean differences between each country on the outcome measures, collapsed across image type. The German sample tended to report the highest reactivity to imagery used in the study (e.g., greater affective reactivity, greater willingness to change personal behavior, etc.), while participants in the United Kingdom tended to report the lowest responses. The country-level effect on image responses was particularly pronounced for reported understanding of images, willingness to seek out more information, and motivation to change personal environmental behavior.

There was also a small but significant interaction between image condition and country of origin on the affective reactivity measure, $F(4, 2005) = 7.693$, $p < 0.001$, $\eta_p^2 = 0.01$. In the causes and impacts conditions, the German participants reported significantly greater negative affect (Causes: $M = -1.96$, $SD = 1.609$; Impacts: $M = -1.61$, $SD = 1.846$) than the U.K. (Causes: $M = -1.56$, $SD = 1.657$; Impacts: $M = -0.836$, $SD = 1.908$; Mean difference = 0.40, $p = 0.002$) and U.S. (Causes: $M = -1.51$, $SD = 1.784$; Impacts: $M = -0.953$, $SD = 2.061$) conditions. Post hoc tests indicate that the German

Table 3
Bivariate Correlations between Study Measures Assessing Responses to Imagery.

	Understanding	Emotional response	Seek out information	Share image with others	Change personal behavior	Support government climate policy
Understanding	1					
Emotional response	0.067	1				
Seek out information	0.634	0.090	1			
Share image with others	0.580	0.109	0.818	1		
Change personal behavior	0.601	0.057[**]	0.857	0.834	1	
Support government climate policy	0.554	0.037[*]	0.747	0.809	0.828	1

All other coefficients are significant at $p < 0.001$.
[*] $p < 0.05$.
[**] $p < 0.01$.

Table 4
Country-level Differences on Image Responses Collapsed across Image-Type.

Item	F	R^2	Country	Mean	SD
Understanding	86.217***	0.054	U.K.	3.43	0.805
			U.S.	3.68	0.804
			Germany	3.89	0.768
Affective response	9.498***	0.006	U.K.	−0.434[a]	2.051
			U.S.	−0.392[a]	2.232
			Germany	−0.776	2.217
Seek out more information	72.025***	0.045	U.K.	2.32	0.776
			U.S.	2.58	0.788
			Germany	2.72	0.731
Share image with others	14.133***	0.009	U.K.	3.12	0.819
			U.S.	3.31[b]	0.889
			Germany	3.28[b]	0.878
Change personal behavior	40.403***	0.026	U.K.	2.95	1.005
			U.S.	3.22	1.037
			Germany	3.33	0.906
Support government policy	15.313***	0.01	U.K.	4.47	1.085
			U.S.	4.63	1.271
			Germany	4.75	1.101

Note: Post-hoc analyses to examine between-country differences were performed using Tukey's adjustment. Matching superscripts denote post-hoc tests that did not attain significance. All other post-hoc comparisons are significant at $p < 0.05$.

sample significantly differed from both (Mean differences > 0.35, p's < 0.005), while the U.S. and U.K. samples did not significantly differ on affective reactivity in these two conditions (Mean differences <0.15, p's > 0.7). In contrast, in the solutions condition, while all samples reported greater positive affect, the U.S. sample ($M = 1.41$, $SD = 1.670$) and German sample ($M = 1.25$, $SD = 1.599$) reported comparable levels of positive affect (Mean difference = 0.16, $p = 0.442$). The U.K. sample ($M = 0.981$, $SD = 1.665$) reported less positive affect in than the U.S. sample (Mean difference =

−0.43, $p = 0.002$) and marginally less than the German sample (Mean difference = −0.27, $p = 0.075$). There were no other significant or trending interactions between image type and country of origin.

3.2.6. Interaction between image type and climate change skepticism

There were also significant interactions between climate change skepticism and image type condition on five of the six items assessing participants' image responses. Table 5 displays the interactions for each measure (including the non-significant interaction for the understanding measure), each of which follows a very similar pattern. While in the causes and impacts conditions, greater skepticism predicts less pro-environmental responses (e.g., flatter emotional response, less willingness to change personal behavior), this effect is reduced in the solutions condition. This interaction appears to be driven by reduced motivations to act by non-skeptics after seeing solutions images, rather than a positive shift by skeptical participants. Similar, though weaker, interactions emerged for several measures when examining political ideology as a moderator rather than climate change skepticism (see online Supplementary material).

3.3. Discussion

The results of the experimental survey yielded a number of interesting findings, some consistent and some inconsistent with the results of the qualitative research (see General discussion below). Consistent with the qualitative results, images of politicians and protesters were rated as particularly ineffective in the quantitative study. Images of climate change impacts were the most effective at increasing self-reported motivations to change behavior and support government policy. While climate change impacts also produced negative emotional reactions, given these other findings, it seems that this negative affect may have been important for increasing intentions to act. In contrast, images of climate change solutions, while producing substantially more

Table 5
Interactions between Climate Change Skepticism and Imagery Condition.

	Interaction (F)	Condition	b	SE	95% Confidence Intervals	
					Lower	Upper
Understanding	1.662	Causes	−0.04*	0.02	−0.068	−0.007
		Impacts	−0.04*	0.01	−0.070	−0.012
		Solutions	−0.01	0.02	−0.035	0.025
Affective response	118.399***	Causes	0.41***	0.03	0.348	0.473
		Impacts	0.53***	0.03	0.469	0.588
		Solution	−0.11***	0.03	−0.176	−0.051
Seek out more information	3.739*	Causes	−0.05**	0.02	−0.078	−0.019
		Impacts	−0.06***	0.01	−0.087	−0.031
		Solutions	−0.01	0.01	−0.034	0.024
Share image with others	3.045*	Causes	−0.04*	0.02	−0.075	−0.010
		Impacts	−0.07***	0.02	−0.102	−0.040
		Solutions	−0.01	0.02	−0.047	−0.017
Change personal behavior	5.306**	Causes	−0.08***	0.02	−0.119	−0.045
		Impacts	−0.10***	0.02	−0.133	−0.062
		Solutions	0.02	0.02	−0.054	0.020
Support government policy	5.736**	Causes	−0.14***	0.02	−0.187	−0.102
		Impacts	−0.18***	0.02	−0.218	−0.137
		Solutions	−0.08***	0.02	−0.120	−0.036

* $p < 0.05$.
** $p < 0.01$
*** $p < 0.001$.

positive affect, also tended to score the lowest on motivations to change behavior, support government policy, or seek out more information about the image. Indeed, solutions images decreased non-skeptics' issue engagement on nearly all response items such that there were no differences between skeptics and non-skeptics in that condition. Thus, it is not clear from this evidence that the use of solutions imagery on its own—while less polarizing—will be conducive to greater environmental action overall. This finding does in some days differ from O'Neill et al. (2013), who found that images of solutions produced greater feelings of self-efficacy in a Q-sort task. One possibility for this difference in results could be due to variations in the types of 'solutions' imagery used. For example, the images depicting solutions to climate change in the research presented here tended to focus on depicting concrete actions being taken by individuals, which may have communicated to individuals that they no longer needed to take personal action because others were doing so. Future research should examine the influence of different types of 'solutions' imagery on behavior change, motivation, and efficacy in more detail to better understand these differences.

Limitations of these findings include the use of single-item measures to assess each construct, as well as the fact that our items assessed self-reported intentions rather than measuring actual concrete behaviors. Future quantitative research should use expanded scale measures and assess actual behavior in order to more comprehensively understand the influence of different types of climate change imagery. Furthermore, the items assessed in this study, which were designed to gain a broad assessment of individuals' perceptions, differed from some of the past research on imagery (e.g., O'Neill et al., 2013). Therefore future research would also benefit by using multiple measurement types from past research to better understand the diverse effects of imagery on public perceptions.

4. General discussion

The current research presents some of the first evidence gathered regarding the impact of climate change imagery on individuals' affective, attitudinal and behavioral responses to the issue. Using a unique (in this domain) combination of qualitative and quantitative methods, we uncovered a number of practically-relevant and theoretically interesting findings that can inform and improve climate change communication in a cross-national context. Importantly, we found points of both convergence and divergence between the results of the two studies, highlighting the critical importance of studying the impact of visual imagery using a variety of methods. For an expanded discussion of the research findings, see Corner et al., 2015 and the accompanying Appendix to that report.

Images depicting climate change impacts, such as those displaying individuals with authentic, identifiable emotional expressions evoked issue concern and emotional reactions from participants in the discussion groups and, overall, images of impacts were the most motivating for individuals (e.g., intentions to change personal behavior) in the quantitative survey. Findings regarding images of climate change solutions were also similar across the two studies. In the survey, images of solutions evoked positive affect, but were among the least motivating for participants, while in the discussion groups, although images of individuals genuinely engaging with climate solutions were well regarded, a number of solution-based images (e.g., protestors advocating for solutions to climate change) were met with cynicism.

The present work also challenges, or at least raises questions about, current orthodoxy regarding the communication of climate change impacts and causes versus solutions. Many climate

communications guides (e.g., CRED & ecoAmerica, 2014) and research findings (e.g., Campbell and Kay, 2014) suggest that highlighting possible solutions to climate change is critical for engaging many audiences. Although doing so may be necessary in many cases, the present findings suggest images of such solutions (e.g., installing solar photovoltaics) may not be sufficient for motivating action, in part because audiences do not always connect these images to climate change. On the other hand, images depicting climate impacts were readily connected to the issue by our participants and were also more motivating of action. Participants were also motivated to share these images with others and believed that they would be effective visuals for prompting others to act as well, although results from the qualitative work also indicate that these images can be over-whelming for viewers, possibly reducing engagement for some individuals (see also Lertzman, 2015). Together these results suggest that, just as with verbal climate communications (e.g., CRED & ecoAmerica, 2014), coupling images of climate impacts with concrete behavioral actions for people to take (i.e., solutions) may be particularly important for maintaining engagement.

Our results also raise questions about the relative efficacy of localizing the issue of climate change for audiences. In our discussion groups, many participants exhibited greater empathetic reactions to depictions of distant climate change impacts, particularly in developing countries. In contrast, some participants saw local climate change impacts as either trivializing the issue or else as offensive by focusing on one's own country rather than others. These results align with recent work suggesting that at least some groups (e.g., Democrats) react more positively to stories about climate impacts affecting people living far off geographically or temporally (Hart and Nisbet, 2012). However, this was also one area where the two studies disagree, as localized images fared better than more distant images in the survey experiment. One possible explanation that can accommodate both sets of findings (and corresponds to current theorizing on psychological distance) is that localized images are effective to the extent that they are perceived as serious (rather than trivializing the wider issue of climate change by suggesting that limited local disruption is equivalent to major climate impacts elsewhere). Future research is needed to more comprehensively examine how different climate change images impact individuals' perceptions of the psychological distance of climate change.

Finally, the results of both studies also suggest that clichéd images of climate change produce mixed responses among the public. Images that our survey participants could quickly and easily understand – such as 'smokestacks', deforestation, and polar bears on melting ice – were positively received and associated with the greatest support for climate change policy and action. In the qualitative work, however, while these 'classic' climate images were easily recognizable by participants, they also produced a muted emotional response and often prompted cynicism. Together, these results highlight the challenging balance communicators must strike between using easily-recognizable but over-saturated climate images and less familiar but potentially more engaging visuals. Our work suggests that contextualizing less familiar but potentially powerful images by connecting them with more readily recognizable aspects of climate change may be one effective pathway forward.

5. Future directions

The present findings raise a number of important questions to be resolved by future research. Perhaps most critically, additional research is needed to examine whether different types of solutions-based imagery resonate more or less strongly with particular audiences, as recent work suggests that various

solutions (e.g., more regulation versus more reliance on nuclear energy) appeal to different audiences in quite divergent ways (e.g., Kahan et al., 2011). More generally, additional research is needed to identify ways in which the positive affect associated with many climate solutions can be leveraged into greater issue engagement. In addition, future research should continue to unpack the complex dynamics involved in using imagery that depicts climate change impacts and how this interacts with key issues such as psychological distance, reactance and apathy (see McDonald et al., 2015; O'Neill et al., 2013). Another fruitful future research direction would be to examine how photographic climate change imagery may differentially influence individuals' responses depending on different accompanying text-based frames of climate change. For example, Hart and Feldman (2016) recently found that images of solar panels were more likely to increase perceived efficacy to act on climate change when text accompanying the image discussed actions that can be taken to address climate change.

It is also worth re-emphasizing that the research presented here focused on photographic climate change imagery, rather than visuals about climate change more broadly. However, it seems likely that a number of the principle themes uncovered in these analyses may reasonably extend to other forms of visuals. The value of authenticity is likely to be important regardless of the visual medium, and indeed may emerge as even more important in other mediums aside from photographs (e.g., documentary films, animations). There may be other instances where divergence in responses occurs across types of visuals. For example, producing effective illustrations, infographics or animations may follow different criteria for effectiveness than photographs or films altogether (e.g., is presenting people in a cartoon depicting climate change similar to presenting real people in photographs?). These are important empirical questions beyond the scope of the present investigation; future research is needed to uncover the relative importance of different principles examined here in the context of other visual mediums.

Finally, points of both convergence and divergence between the findings of our qualitative and quantitative work point to the importance of mixed-methods studies in this domain. One important advantage of qualitative over quantitative methods in the context of studying climate imagery is the ability they provide to more fully contextualize images for study participants; the lack of context in the quantitative work may help explain some of the findings regarding both iconic and solutions-oriented imagery. On the other hand, quantitative approaches can support generalizability. Although the design and findings of these studies do not permit definitive explanations of the points of divergence between the quantitative and qualitative findings, several possibilities exist. First, the discussion group design may have permitted participants to be more elaborative both in their cognitive processing of the images themselves as well as in their reported reactions to the imagery. In contrast, the closed-ended, narrowly specific questions that participants answered in the quantitative study may not have allowed for the same degree of elaboration by participants. In future mixed-methods approaches, allowing for open-ended responses by participants in the quantitative portion, as well as assessing depth of information processing, may help shed light on the origin of these discrepancies. Second, whereas in the quantitative survey participants viewed the images by themselves one at a time, participants in the discussion groups viewed the images in rotating sets (and saw all of the images of the causes, impacts, and solutions) in a group setting. These clear contextual differences may have allowed for different elaborations and interpretations of the images, such as participants cognitively comparing and contrasting the image sets differently while responding in the two studies. Future mixed-methods research

might consider standardizing the cross-method design and deliberately asking participants to make or not make comparisons across images sets in order to help explore the effects these processes may have on responses. Future research should continue to use a mixed-methods approach as well as attempt to capture the unique advantages afforded by various methodologies in order to better understand how individuals interpret and react to what will often be strongly-framed, context-rich climate imagery.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.gloenvcha.2016.10.003.

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