Title: Researching Visual Representations of Climate Change

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Abstract: This paper responds to Schaffer et al.'s (2016) call for greater clarity about the application of theory and method in research on mediated communication about climate-change. Specifically, it identifies conceptual and methodological challenges for researching visual representations of climate change. We suggest current research is impeded by a lack of methodological explication and an unclear relationship between theories of visual meaning and the application of social science methods such as content analysis and frame analysis. As a first step towards addressing these issues, we review existing research to identify the methodological procedures that require explication in order to support the replication of studies and the comparison of findings. We then draw on the seminal work of Roland Barthes' (1967, 1977) to examine how theories of visual meaning may be integrated into social-scientific research methods. Specifically, we demonstrate how Barthes' concepts of denotation, connotation and mythology may be related to research concerns about the selection of visual content, the classification of image frames, audience responses, and analyses of ideological meaning. The conclusion highlights further possibilities for developing a robust form of visual analysis that meets the standards of social scientific research while addressing the fundamental insights about visual meaning derived from cultural theories of meaning.

Keywords: visual analysis, climate change, environmental communication, semiotics

Introduction

The Intergovernmental Panel on Climate Change (2014:8) observes that continued emission of greenhouse gases will increase "the likelihood of severe, pervasive and irreversible impacts for people and ecosystems". Despite this grave forecast, communicating climate change to the public has been challenging (Whitmarsh & Lorenzoni 2010) leading researchers to examine the cognitive and cultural constraints that limit public understanding of environmental science (Evans and Durant, 1995; Norgaard 2009) and the psychological factors that inhibit public engagement with climate change (Weintrobe, 2012). As public understanding and engagement are often influenced by media representations (Carvalho 2007; Painter 2013), much empirical research has examined the coverage and framing of climate change in news media (see Metag 2016; Schäfer & Schlichting 2014). However, decades of research on news coverage, coupled with evidence of poor understanding and engagement, has led researchers to question the effectiveness of communication about climate change (Moser 2010; Weber & Stern 2011).

To this end, scholars from diverse disciplinary backgrounds have turned their attention to visual representations (DiFrancesco & Young 2011; Doyle 2007; Lester & Cottle 2009; Manzo 2010a, 2010b; Metag et al. 2016; O'Neill, Boykoff, Day, & Niemeyer 2013; O'Neill 2013; O'Neill & Smith 2014; Schroth, Angel, Sheppard, & Dulic 2014). Following an almost exclusive interest in text (O'Neill 2013), these researchers recognise that images are a potentially valuable form of climate-change communication. Images aid cognitive processing because they are easily comprehensible and can thereby "provide a kind of cognitive short cut compressing a complex argument into one that is easily comprehensible and ethically stimulating" (Hannigan 2006: 78). Such basic comprehension is important because "visualizing the environment in order to comprehend it is a constitutive aspect of making the environment meaningful" for audiences (Doyle 2009: 285). This argument resonates with research on the history of science, which argues that scientific image-making - for example, in anatomy, botany, and astronomy - gave rise to visual representations that exemplify a procedural detachment from emotion (Daston & Galison 1992).

In contrast to the remoteness of scientific images, images with wider cultural import are valuable because they can provoke affective responses and promote lines of identification with visual subjects (Höijer 2010; Leiserowitz 2006; Nicholson-Cole 2005; Smith & Joffe 2009). The psychological literature on risk perception recognizes the importance of emotion and affect for shaping perceptions of climate change (Smith & Joffe 2009) and Leiserowitz (2006:55) suggests that a lack of public concern about climate change may be linked to a lack

of “vivid, concrete, and personally-relevant affective images”. More broadly, images are valuable in digital culture because they occupy a central role in the economy of media attention (Rose 2012) by influencing the content people choose to read (Adam, Quinn, & Edmonds 2007) and share with peers in social networks (Duggan 2013).

To date, research on visual representations of climate change has focused on national newspapers (DiFrancesco & Young 2011; O’Neill 2013; Smith & Joffe 2009); advertising and NGO campaigns (Doyle 2007; Linder 2006; Manzo 2010b; Rebich-Hespanha & Rice 2016); the datasets of image agencies (Hansen & Machin 2008); and audience responses (O’Neill et al. 2013). Much of this work serves three goals: it defines and classifies the body of images referencing climate change; it identifies the implications for public understanding and engagement; and it offers recommendations regarding the efficacy of certain types of image for different audiences. However, the research area is currently impeded by the absence of agreed procedures for applying visual methodologies. This is compounded by fact that methodological procedures are often implied rather than explicitly described (Christmann in O’Neill 2013). Consequently, it is often difficult to draw comparisons between the findings of different studies and develop a systematic picture of the research area. In addition, there is a conceptual tension between the application of methods widely used to research textual media, specifically content analysis and frame analysis, and the understanding of visual meaning put forth by major theorists of photography and media reception such as Roland Barthes and Stuart Hall. Although these and similar theorists are referenced in some studies, the lack of methodological explication often makes it difficult to understand how the theoretical framework relates to the applied methodology.

As a first step towards addressing these issues, this paper attempts to reconcile the demand for robust, social-scientific methods with the conceptual insights that may be derived from cultural theorists of visual meaning. As a representative of the later, we draw on the seminal work of Roland Barthes’ (1967, 1977) to demonstrate how his concepts of denotation, connotation and mythology may be related to a matrix of research concerns about identifying and classifying visual subjects, visual frames, audience responses, and ideological meaning. By referencing Barthes, we are not necessarily advocating the adoption of his semiotic theory. Rather, we aim to highlight how theories of visual meaning may be integrated into empirical studies and provide clarity about methodological procedures for various kinds of visual research.

As such, the paper responds to Schaffer et al.’s (2016) call for greater clarity about the application of theoretical and methodological frameworks in research on mediated

communication about climate change. Consequently, "meta-knowledge" about how "analyses can be done successfully, which research strategies work well, or which objects and concepts lend themselves well to analysis" remains unstated in much research (Schaffer et al. 2016: 1). This paper is an attempt to extract and clarify the meta-knowledge that might inform the development of future research on visual representations of climate change.

The paper proceeds as follows. First, we review existing research to identify the methodological procedures that require explication to support the replication of studies and the comparison of findings between studies. Second, we draw on Barthes' (1967, 1977) semiotic theory to examine how the tension between theories of visual meaning and social-scientific methods may be reconciled. Specifically, we demonstrate how Barthes' concepts of denotation, connotation and mythology may be related to research concerns about image content, image frames, audience responses, and ideological meaning. Third, we demonstrate the application of Barthes' semiotics in a study of visual representations of climate change. In conclusion, we discuss further possibilities for developing a robust form of visual analysis that meets the standards of social scientific research while addressing the fundamental insights about visual meaning derived from cultural theories of meaning.

Research on visual representations of climate change

The growing body of work examining visual representations of climate change emanates from a range of disciplines across the humanities and social sciences. To date, research has predominantly focused on analyses of print news media using both qualitative and quantitative approaches to content analysis and frame analysis. O'Neill's (2013) comprehensive content analysis of thirteen newspapers found that climate change is visually framed as a political, contested, and distant issue. Other studies affirm a tendency towards distant framing (Lester & Cottle 2009; Rebich-Hespanha et al. 2015) and the prominence of political figures (Carvalho & Burgess 2005; DiFrancesco & Young 2011; Rebich-Hespanha et al. 2015; Smith & Joffe 2009). Some studies additionally investigate audience responses (Chapman et al. 2016; Maes 2017; Metag et al. 2016; O'Neill & Nicholson-Cole 2009; O'Neill & Hulme 2009). For example, O'Neill and Nicholson-Cole (2009) find that negative and fear-driven images are ineffective for motivating behavior change while images linked to "individuals' everyday emotions and concerns … tend to be the most engaging" (O'Neill & Nicholson-Cole 2009: 355)." For an in-depth overview of research findings in this area see Hansen (2017); O'Neill (2017); and Rebich-Hespanha et al. (2015).

In his summary of the research area, Hansen (2017) identifies the following methodological challenges: accounting for the multimodal nature of mediated communication about climate change; generating reliable and comparable definitions of frames; accounting for narrative development in visual representation; and, finally, documenting and accounting for historical change. We suggest these challenges may be partly addressed by developing a more robust link between theories of visual meaning and the application of social-scientific methods and by clearly explicating methodological procedures to support comparisons between studies.

Our central contention is that the conceptual and methodological approaches which dominated studies of print media, content and frame analyses, need to be refined to accommodate theories of visual meaning. Many of the studies referenced above draw on theories of media framing (Coleman 2010), which is one of the most common analytical frameworks applied to news media generally and to climate-change news specifically (see Metag 2016). Frame theory assumes that media coverage influences how audiences perceive an issue as a problem, including the possibilities for action to address that problem. Entman (1993: 52), a leading exponent of frame theory, defines framing as follows: "to frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described". Frame analysis allows researchers to examine how various media producers - news media, governments, NGOs, corporations, and so on - define climate change for specific audiences. However, conducting a frame analysis presents many challenges, which are often more pronounced when applied to visual, rather than purely textual, content.

Typically, the definition of frames is derived from existing typologies within a research area such as Nisbet's (2009) nine frames for analyzing climate-change coverage in print media. However, the process of identifying frames remains contentious because "a frame is a quite abstract variable that is hard to identify and hard to code in content analysis" (Matthes & Kohring 2008:258) and various approaches to frame analysis rely on different epistemological and methodological assumptions. Consequently, frame analysis, particularly qualitative frame analysis, "runs the risk of extracting researcher frames, not media frames … because the perception and coding of frames strongly depend upon how the researcher perceives the issue" (Matthes & Kohring 2008: 260). Moreover, when researchers define new frames they limit the capacity for comparative analysis (Nisbet 2010).

Typically, frames are defined in reference to the dominant language of headlines and opening paragraphs (see D'Angelo & Kuypers 2010) and then related to wider patterns of media

coverage. However, the origin of media frames is not always transparent because the "situated social and routinized processes" of news media production shape the framing process in varied ways (Vliegenthart & Van Zoonen 2011:108). For example, media framing may be influenced by journalistic routines of sourcing; the ideological orientation of journalists or media outlets; organisational constraints and pressures such as a lack of resources for reporting; as well as prevailing social norms and values (Scheufele 1999).

Moreover, it is difficult to specify visual frames systematically (Metag et al. 2016; O'Neill, 2013) because there are many ways to define images as an object of study. Textual frames are defined with reference to language and language placement, but the equivalent units of analysis are less clear, and often unstated, in studies of visual framing. Within theories of visual meaning, framing is typically understood in terms of the point-of-view encapsulated by an image because "it is the position of point-of-view, occupied in fact by the camera, which is bestowed upon the spectator" (Burgin 1982: 146). As such, visual framing is about the composition of images including the choice of subject, camera angle, focus, and so on (Domke, Perlmutter, & Spratt 2002; Rose 2012). Taking an image in isolation, we may think about the position of a focal subject relative to its surroundings. Thus, a close-up of a polar bear's head has less relevance for climate-change communication than a wide-shot depicting an emaciated polar bear on an ice-less landscape. Alternatively, an image may be assessed in its publication context such that a close up of a polar bear's head may be directly linked to climate change through the use of captions and accompanying content about climate change.

Accordingly, there is a crucial distinction between the visual framing of an image and news media framing of particular stories associated with that image. Regarding the latter, Parry (2010:68) observes that "photographs can give salience to particular framing(s) of news events offered in newspapers through their selection and omission, depiction, symbolism and lexical context (caption and headline)". To identify image frames, some researchers analyze the articles that accompany images (DiFrancesco & Young 2011) while other analyze image captions (O'Neill 2013) As such, these researchers are identifying the preferred frame of the media outlets that published the images. However, media images may have a contradictory relationship with the articles they accompany because image selection and article writing are two separate processes within a newsroom (DiFrancesco & Young 2011).

To complicate matters, audience and reception studies demonstrate that audience perceptions are not determined by the intentions of content producers (Hall 2007; Kellner 2011). As Hansen and Machin (2015:3) argue, "there are different kinds of seeing" and the capacity of audiences to reject the intended meaning is an important consideration when

thinking about any visual representation. Similarly, it is a mistake to assume that concepts applied to images by researchers - such as defining a photograph of an emaciated polar bear as an 'impact' image - are accepted or understood as such by other viewers. Rather, individual responses to images are influenced by people's identities, social and cultural backgrounds, and motivations (Bevk et al. 2017; Scott, Carter, Brown & White 2009). Consequently, it is important to clarify the context of audience responses: are audiences responding to frames defined by the researchers, to images in isolation or in their publication contexts, or to wider personal or cultural factors that are tangential to image content and publication context?

A related difficulty concerns the definition of frame typologies; existing studies draw on a wide range of typologies (Duan, Zwickle & Takahashi 2017), which is further complicated by the fact that many images may fall between existing typologies (Nerlich & Jaspal 2014) and frames can be defined at different levels of visual meaning. For example, O'Neil's (2013) visual frames - impacts, causes, protest, solutions, science and technology, weather, and other - includes a conceptual mix of thematic frames that are interpretations of content (e.g. impacts, solutions) and descriptive frames that refer to the visual subject (e.g. protests, weather). As we argue below, it is useful to understand descriptive frames as antecedent to interpretative frames to allow for a distinction between image content (e.g. science and technology) and the meaning of that content for an analysis of climate-change communication (e.g. a solution frame).

Maintaining a distinction between descriptive and interpretative frames is also beneficial for comparative and longitudinal analysis between studies. In their study of British press images, Smith and Joffe (2009) utilize three frame categories derived from the IPCC's climate-change agenda - cause, impact, and solution – as well as an inductive coding scheme to support the emergence of themes from the data. The authors explain, "an image of a flooded village in Britain, for example, rather than simply coded as 'impact', was also coded as 'local' reflecting the location of the impact being depicted" (Smith & Joffe 2009: 651). However, we suggest it is helpful to first code such images based on the descriptive content - in this case, flooding - because it is important to record precisely what kind of subjects are used to convey local impacts. When this information is recorded, researchers may compare studies to identify what kind of impact images are prioritized in particular media, in particular regions, and how these change over time. The distinction between descriptive content and interpretative frames thereby addresses the challenges identified by Hansen (2017) in terms of generating reliable and comparable definitions of frames and accounting for historical changes in the visual representation of climate change.

In making the above criticisms, we hope to advance the valuable work that has already been undertaken and to develop a more systematic area of study. The following section aims to further refine a conceptual and methodological approach to visual representations of climate change by integrating a semiotic theory of visual meaning with current social-scientific methodologies. Although we draw on Barthes' semiotic theory, the overall aim is not to endorse a specific theory, but to investigate how theories of visual meaning can provide clarity about conducting research.

Integrating theories of visual meaning

Media and communication research is a vast field drawing on multiple disciplines across the humanities and social sciences (Jensen 2013; Turow 2011). Consequently, there are a wide range of theoretical traditions that may be employed to analyze how visual representations create meaning. In this paper, we focus on Barthes' semiotics as a foundational theory of meaning that may be applied to any texts "whatever their substance and limits; images, gestures, musical sounds, objects" (Barthes 1967:9). Although Barthes revised his understanding of semiotics in his later work (see Allen 2004), most researchers follow his original theory of visual meaning outlined in "Rhetoric of the Image" (Barthes 1964/2004). By parsing three levels of meaning, Barthes creates a distinction between what is depicted in an image (denotation), what the image means in a specific context (connotation), and what the image implies or normalizes (mythology). These levels of meaning may be mapped onto different kinds of visual research.

Denotation refers to the descriptive subject of an image and is readily understood by people across cultures. For example, we can generally agree that an image of water rising over the river banks depicts a flood, but we may disagree significantly about whether the same image may be interpreted as the impact of climate change. As denotation identifies the visual subject prior to the application of interpretative frames, it corresponds to a content analysis. As noted above, it is useful to identify visual content at a purely descriptive level because this information supports a comparative and longitudinal understanding of what kind of visual subjects are used to represent climate change. A descriptive content analysis requires methodological choices about whether to define the visual subject in terms of the image in isolation or in association with any accompanying text or captions. In practice, it may be difficult to identify a single subject for every image so it is beneficial to highlight difficult cases and how they have been resolved by the researchers. As with text-based content analysis, it is also relevant to record the process of data collection, data sampling, and so on.

Barthes' second level of meaning, connotation, refers to the thoughts, emotions, or critical values people ascribe to visual subjects. Although "connotation relies upon the prior existence of denotation" (Jamieson 2007: 43), it is at the level of connotation that viewers, including researchers, bring distinct interpretations about meaning. For example, researchers interested in climate-change communication may interpret an image of flooding as a 'climate-change impact', but there are any number of interpretative frames that may be applied relative to the viewer's context. A viewer might interpret a flood image negatively in terms of loss and destruction, neutrally in terms of typically weather patterns, or even perhaps positively in terms of improved conditions for fishing. Moreover, even if the image caption specifically links the flood image to climate change, viewers can resist this anchoring to advance their own interpretative connotations. Consequently, we suggest that connotative meaning corresponds to the application of frame analysis by researchers while audiences may employ denotative or connotative meaning when articulating their responses.

As current frame typologies are strikingly diverse (Duan, Zwickle & Takahashi 2017), research will benefit from the development of an agreed typology and procedures for identifying frames across different kinds of visual content. Currently, many studies employ frames relating to climate-change causes, impacts, and solutions, but it is not always clear how these frames are defined. Greater explication about the definition of frames and about the difficulties that emerge when images defy frame categorization will support the refinement of frame typologies and the development of commonly agreed procedures.

In terms of audience analysis, methodological procedures will vary according to the use of specific audience methods such as the selection of participants for focus groups and so on. Regardless of the specific method, a key concern is to understand what prompts participants' responses. Thus, it is important to explicate how the images were presented to participants, including any interpretative frames introduced by the researchers, and whether participants formulated their responses in reference to the image subject or to their personal or cultural impressions of that subject. In other words, the meaning viewers ascribe to an image may also be understood in terms of both denotative and connotative levels of meaning, which may help to explain differences in audience responses.

Finally, mythology refers to the ideological values that are assumed or normalized by an image. Mythology highlights the significance of engaging in critical reflection to expose the ideological implications that may go unnoticed in fleeting engagements with an image. In Barthes' widely cited example, a 1955 cover of *Paris Match* magazine denotes a young African soldier saluting the French flag and carries connotations of the French military and empire. For

Barthes, this image obscures colonial racism by mythologizing the idea "that France is a great Empire, that all her sons, without any colour discrimination, faithfully serve under her flag" (Barthes 2000: 124).

Such ideological analysis is widely employed to examine how images normalize certain perspectives at the expense of others (Doyle 2007, 2009; Jaworski & Thurlow 2010; Kassinis & Panayiotou 2018; Morton 2009). For example, Kassinis and Panayiotou (2018) expose the corporate greenwashing of BP advertising following the 2010 Deepwater Horizon disaster while Morton (2009) applies an ecological theory of aesthetics to critique the reification of nature in landscape imagery. Such interpretative analyses are valuable for exposing how images, and other cultural texts, conceal and even normalize environmental exploitation. However, mythology can be dismissed by appealing to the obviousness of denotative meaning: "how can one, after all, argue with a photograph: the camera, as people say (thus evoking another general myth), never lies" (Allen 2004: 37-38). For example, someone may counter Barthes' analysis by pointing to the *Paris Match* photograph as evidence of a patriotic African soldier. Similarly, climate-change sceptics may counter that a flood image has little to say about climate change impacts because it only depicts one flooded landscape.

To summarize the above, Table 1 outlines how different research methods may be related to different levels of visual meaning. The table also highlights the methodological procedures that require explication to understand how the visual analysis is conducted and to support comparisons between studies. We have not included the standard procedures associated with each method such as the need to explicate the method of data collection or the recruitment of participants for an audience study. Following Barthes, the three levels of visual meaning become progressively more abstract whereby an abstract meaning such as the designation of an 'impact frame' is dependent upon the identification of more concrete or obvious meaning at the denotative level. We suggest the research area might benefit by maintaining such distinctions and by explicating associated methodological considerations. In what follows, we report on the application of these methods in a study conducted by the authors.

Table 1 about here

Image analysis in practice

As part of a larger project examining mediated communication about climate-change in Ireland, the authors conducted a study of visual representations. As the research objectives were guided

by the wider goals of the project, we primarily report on the methodological process, rather than study findings, to tease out the challenges that arise when conducting different kinds of image analysis and to examine how future comparative research may be supported. The study consisted of a content analysis, frame analysis, audience analysis, and a brief ideological analysis.

Content analysis and denotative meaning*:* A visual content analysis was undertaken on images attached to news stories about climate change in the online version of *The Irish Times*. This outlet was selected as it is Ireland's leading quality newspaper with a dedicated environmental correspondent. A key aim was to identify the range of visual subjects that are linked to climate change in Irish news media by including images that explicitly reference climate change, such as photographs of climate-change summits, and images that tangentially reference climate change in reference to other issues such as housing, agriculture, and tourism. Consequently, we did not limit our corpus to images that included the phrase 'climate change' in the image caption or in the headline or opening paragraphs of the accompanying article. Using LexisNexis, we identified all articles published between January 2013 and June 2015 that included the words "climate change" anywhere in the text. We then used a HTML image-scraping technique to extract any associated images from *The Irish Times* website. This generated a corpus of 290 images.

The visual subject of each image was recorded and, following a preliminary analysis, eight subject categories were identified: agriculture and food; animal kingdom; earth iconography; landscapes; people; technology and energy; topical event; and other. Most images were easily categorized by identifying what was prioritized in the image in terms of camera focus and positioning. For example, a photograph of people protesting was categorized as 'topical event' based on the use of a medium shot that emphasized the action rather than the individual people. However, it was sometimes necessary to refer to captions when images straddled the boundary of two or more categories. For example, an image of two people beside their solar technology invention was categorized 'people' rather than 'technology and energy' because the caption placed emphasis on the people as entrepreneurs rather than the development of their technology.

To attain a more detailed understanding of visual coverage, each category was further divided into more specific subject descriptions. Thus, 'people' was divided into celebrities, community leaders, politicians, scientists, and ordinary citizens. Further denotative sub-divisions were coded for each category as required such as whether the politicians were Irish or international and whether the ordinary people were stock images or originals. Image captions

were used to clarify the status of individuals with whom the researchers were unfamiliar. A 'community leader' was distinguished from an 'ordinary citizen' when the caption indicated that the individual was head of a community association. Similarly, caption references clarified if an individual was a celebrity from the world of television, arts, or sport.

Summarizing our key findings, images of people dominated the corpus, at 49 percent, and politicians were the most represented group accounting for 42 percent of all people images. In contrast, agriculture and food represented only 9 percent of the corpus even though this is arguably the most important sector for climate change mitigation in Ireland. Thus, tracking changes in representations of food and agriculture is a primary interest for future research as well as comparing patterns of visual coverage across other media outlets. Such comparative and longitudinal studies will be aided, we believe, by the fact that our analysis was conducted at the purely descriptive level of visual subjects.

Frame analysis and connotative meaning: To assess the visual framing of climate change, we drew on the standard typology of causes, impacts, and solutions. A fourth frame 'other' was used for images that did not exhibit a clear climate-change frame. Images were coded in conjunction with their captions, but in isolation from any accompanying text. As a result, many images were designated 'other' even though there was a reference to climate change in the accompanying text. For example, an article about fruit and nut cultivation discussed the uncertainties of climate change, but the accompanying image of a hazelnut farm was designated 'other' as neither the image nor its caption clearly referenced climate change.

Prior to coding and with reference to the existing literature, we defined a list of subjects that would fall under each visual frame. The causes frame included subjects that contribute to climate change such as fossil fuels; the impacts frame included depictions of consequences such as drought; and the solutions frame included subjects that contribute to climate action such as climate summits and environmental protests. In practice, there was little difficulty in designating cause and impact frames because the visual references were limited and relied heavily on stock imagery of smoke stacks and retreating Arctic-ice. However, solutions frames were more diverse and open to contestation. For example, images of politicians attending climate summits and images of green technology entrepreneurs fell under our definition of a solution frame, but could be described more accurately under a "business as usual" frame (Jackson 2016). We retrospectively labelled these images as a distinct type of solution frame to capture a more comprehensive understanding of the overall coverage. Consequently, charting the evolution of solution frames, and refining the definition of such frames, is a significant avenue for future research.

Audience Analysis and Denotative/Connotative Meaning*:* As engaging the perspectives of Irish environmentalists was a key goal of the wider project, we complemented our visual analysis with a focus group of 15 experts from environmental organisations. Based on the content analysis, a set of six to eight images were chosen to reflect the range of representations in each of the eight subject categories discussed above. Using individual handouts, participants ranked both the subject categories and the set of images within each category in terms of their "importance for conveying the urgency of climate action - whether at global, national or local levels - to an Irish audience?". Guided by the researchers, participants then collectively discussed the reasons for their choices in terms of image salience (the strength of the association between the images and climate change); efficacy and engagement (the capacity of the images to inspire action); values (the environmental values conveyed by the images); and affect (the emotional impact and identification associated with the images). The discussion was recorded to facilitate subsequent analysis.

Most participants considered agriculture and food to be the most important category for communicating climate change in Ireland. However, this consensus had little to do with the descriptive content of individual images; rather, participants primarily discussed their pre-existing attitudes. For example, responses to images of the rural landscape fell into two clear camps: those who idealized rural landscapes for exemplifying national identity and heritage and those who disparaged the same landscapes for exemplifying environmental degradation. These divisions were consistent across the set of agriculture and food images suggesting that participants were not responding to the images per se, in the sense of being influenced by an image, but using the images as a starting-point for discussing their existing attitudes. Undoubtedly, this was partially due to the fact that our expert participants had already formed strong opinions about climate change and the lack of climate action in Ireland. Nevertheless, the lack of consensus about the meaning of an image among a relatively homogenous group was surprising. For example, a stock image of geese flying past wind turbines provoked disagreement as some saw it as evidence that windfarms are compatible with wildlife, while others saw it as evidence that windfarms are inherently threatening to birds. Furthermore, contrary to academic perspectives, most participants indicated a strong preference for cliché images of endangered Arctic mammals and melting ice-caps because such alarming images are easily-understood by the general population.

Future research here would extend the analysis to include wider audience groups such as farmers, food producers, and rural communities. By investigating how these groups form their own connotations about agriculture, and whether these connotations change over time in

response to ongoing communication about climate change, we would hope to produce new insights into effective strategies for communicating climate change in Ireland and elsewhere. Currently, as indicated by the expert focus group, there are pronounced disagreements about the connotations of agricultural imagery and its role in communicating change.

Ideological analysis and mythology*:* The final component of the visual study engaged an ecological analysis of a sub-set of the images used in the focus group study. For brevity, we will briefly summarize an analysis of one image. At the denotative level, the image depicts a depleted peatland in low light. There is little vegetative growth and pools of water across the landscape. Some 15 working wind turbines, the only human-created structure in the image, recede from the mid-ground to the horizon. Considering the connotations of the image in Irish culture, we may summarize that peatlands carry negative connotations of poor land that is unsuitable for agriculture or housing, but they also carry positive connotations of rural heritage as peat was a traditional source of fuel. On this basis, the ideological analysis adopted an eco-critical perspective (Brereton 2016) to argue that the wind turbines represent a contemporary form of exploitation of this unique habitat. That is, the cultural value of peatlands is conceived on instrumental terms; it is valuable as long as it has utility as a resource. With the peat depleted, the wind turbines return instrumental value to the landscape by creating another source of energy. Absent here is an appreciation of intrinsic value, whereby the landscape – with its unique habitat for wildlife – is worthy irrespective of its utility for humans. This ideological analysis was further integrated into arguments about the role of peatlands as carbon sinks and the failure to enact conservation rules on Irish peatlands.

Conclusion

It is clear that people's willingness to embrace the urgency of climate action does not simply follow from scientific consensus. Rather, attitudes towards the need for climate action engage a broader set of ideas, attitudes and emotions about non-scientific spheres such as morality, politics, economics and culture (Höijer 2010; Norgaard 2011). As such, public support or opposition to climate action is likely to be influenced by the extent to which people deem climate change relevant to their everyday lives. To this end, visual communication is a promising avenue for public engagement given the capacity of images to stimulate comprehension and engagement. However, images remain a complex object of study given the multiple ways in which visual meaning can be defined.

This paper contributes to the growing literature on visual representations of climate change by investigating the conceptual and methodological challenges that impede

comparative and longitudinal research. Specifically, we argue that the conceptual and methodological approaches which dominated studies of print media - content and frame analyses - need to be refined to accommodate theories of visual meaning. Working with Barthes' theory of visual meaning, we draw a fundamental distinction between what is depicted in an image (denotation), what the image means in a specific context of reception (connotation), and what ideological ideas are implied or normalized in an image (mythology). These levels of meaning may then be mapped onto different kinds of visual research including content analysis, frame analysis, audience analysis, and ideological analysis. However, we are not necessarily advocating the adoption of Barthes' semiotic theory. Rather, we used Barthes to highlight how theories of visual meaning may be integrated into empirical studies and provide clarity about methodological procedures for various kinds of visual research.

Our key insight is that maintaining a distinction between descriptive content and interpretative frames will help to address the challenges identified by Hansen (2017) in terms of generating reliable and comparable definitions of frames and accounting for historical change in visual representations. Longitudinal comparative research can provide the foundation for understanding how visual representations of the environment reflects broader historical changes and are themselves a driver of such change (Hansen 2017). However, these research goals are currently impeded because researchers rely on a diverse range of frame typologies (Duan, Zwickle & Takahashi 2017), use a mix of descriptive and interpretative frames, and often do not clarify the link between theories of visual meaning and the application of visual methods. Consequently, we believe research will also benefit from greater explication of methodological procedures such as clarifying how theory informs the use of methods, how the visual object was defined, and highlighting any difficulties that emerged when identifying visual subjects or applying visual frame typologies. Over time, such explication of procedures should support the refinement of methods and the development of a more robust area of study.

Similarly, in relation to audience responses, it is useful to understand how participants are formulating their responses as this information helps to clarify differences in meaning construction. In relation to climate change specifically, Carvalho and Burgess (2005:1457) develop the "circuit of culture" model to maintain that "the producers and consumers of media texts are jointly engaged in dynamic, meaning-making activities that are context-specific and that change over time." Although previous research indicates that visual representations can influence perceptions of climate change and motivations to act on climate change, understanding disagreements about meaning can potentially strengthen the use of visual communication. This concurs with the aim of identifying how "the use of particular visual

framings helps to promote particular ways of conceptualizing climate change, whilst marginalizing others" (O'Neill 2013: 11).

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