This image does (not) make me feel climate change is important

(Artistic Information) Visualizations and Climate Change

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ABSTRACT: Climate change is one of the most communicated topics of our time. Its communication is characterized by complexity, credibility issues, and information overload (Hagen, Middel, & Pijawka, 2015; Moser, 2009). In the Netherlands, many people are aware of the issue. It hence becomes essential to render it an important topic to consider, i.e. to create feelings of salience (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007). Communicators use different visualizations to achieve this, among them information visualizations (Johansson, Schmid-Neset, & Linnér, 2010). However, it is unclear how effective the artistic modifications of information visualizations, so-called artistic information visualizations (AIVs), are. This Master thesis therefore poses the following main research question: *How* engaging in terms of feelings of salience do viewers perceive AIVs on climate change, and *what reasoning* for felt salience can be identified? Three-part qualitative research consisting of a short survey, sorting task and semi-structured interview was employed (O'Neill, Boykoff, Niemeyer, & Day, 2013). Participants were asked to sort 25 visualizations: the AIVs and four other visualization forms, each form depicting the same five problem-focused climate change themes. The AIVs were found least engaging in comparison to the other four visualization types, i.e. they least made viewers feel climate change is important. In contrast, photos were found to be the most engaging, followed by artistic simulations, cartoons and information visualizations. Different possible explanations for this little engagement with AIVs could be identified. First, participants indeed made numerous references to the visual types' capabilities concerning their cognitive and emotional engagement (sub-RQ1): clarity, immediacy, and emotional impact. These could largely be found in photos, and artistic simulations. Second, the audience's educational background played a role in the decoding (sub-RQ2). Participants with art (science) education engaged more with AIVs (information visualizations) than participants without this education. It appears that – at least for this sample – the concepts of AIVs surrounding their free choice of data focus and artistic freedom (Kosara, 2007) need to be revised for a complex topic such as climate change. A need for clarity, at least when targeted at the general public might be necessary. This finding supports an art novice – art expert difference for the interest in, and understanding of complex artworks such as AIVs (Bourdieu, 1979; Silvia, 2005). Therefore in this research, both visual properties *and* audience background played important roles in the decoding, supporting recent research in the field of information visualizations (Kennedy, Hill, Allen, & Kirk, 2016). Third, art's involvement in climate change (sub-RQ3) was generally *not* opposed to. This shows how scholars could be less concerned about art's participation in the climate change debate, and more about *how* artists could be involved. While AIVs had clarity issues, apocalyptic artistic simulations suffered from credibility problems because of their drastic content. Cartoons elicited morality deliberations concerning the use of humour for such a serious topic. Further, more generalizable research is needed to support the present research findings.

KEYWORDS: Communication model, Climate change visualizations, (Artistic) information visualizations, Engagement in terms of feelings of salience, Audience research.

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1. Introduction

We live in a time of a vast amount of information, which has led scholars to describe our civilization as an information society. The creation, dispersion, and use of information forms a significant part of our daily economic, political, and cultural lives. Driven by revolutionary advancements in information and communication technology, an information explosion is experienced in our modern society, described as information overload (Britz, 2008; Hesse, Müller, & Ruß, 2008). Among the most communicated topics of our times are the risks of climate change, and need for environmental sustainability (Hagen, Middel, & Pijawka, 2015; Moser, 2009).

Many scholars acknowledge that it is not only about the problems of environmental pollution themselves, but also largely about the challenges of effectively *communicating* about these problems. Communicators of climate change frequently use visualizations to make this multifaceted issue visible, understandable, and meaningful to the broader public. They amongst others face challenges of a) over-complexity of the issue, b) the audience's breakdown of trust in reliability, and c) a data-saturated culture (O'Neill & Smith, 2013; Weingart, Engels, & Pansegrau, 2000). As the majority in the Netherlands is indeed *aware* of the problem of climate change (Hagen et al., 2015; Steentjes et al., 2017), it is crucial to effectively engage the public beyond awareness. One possibility for such engagement is to depict climate change as an *important* topic to be considered by the public, i.e. to create so-called feelings of salience (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; O'Neill & Smith, 2013).

The focus of this Master thesis is on audience engagement in terms of feelings of salience with a specific visual form of climate change visualization: the artistic modification of information visualizations, so-called artistic information visualizations. This visual form emerged, because artists discovered their potential role in creatively contributing to the augmentation of information visualizations in an increasingly rationalist world (Lau & Moere, 2007). In a Ted Talk with data artist Aaron Koblin[2], the blurry boundaries between information and art were described as combining the language of the eye for the beauty of visualizations with the language of the mind about words, numbers, and concepts. This enables us to speak two languages simultaneously, each enhancing the other (www.ted.com/playlists/201/art_from_data). Information about air pollution for instance, can be communicated in vastly different ways. In a purely analytical way by displaying a list of destinations, and kilometre numbers, i.e. in pragmatic information visualizations (Johansson, Schmid-Neset, & Linnér, 2010; Nocke, Sterzel, Boettinger, & Wrobel, 2008). The exact same data could however also be shown in an artistic way by painting the flight patterns, as Aaron Koblin has shown.

Artistic information visualizations are deemed promising to consider for the communication of climate change for several reasons. First of all, they are based on information visualizations, which are a) capable to effectively depict complexity, and b) whose narratives are fact-based, i.e. credible (Card,

[2] Artists of AIVs are referred to as 'data artists'.

Mackinlay, & Shneiderman, 1999; Johansson et al., 2010; Moere & Purchase, 2011). Artistic information visualizations themselves are furthermore potentially strong on a c) novel style, adding an emotional component to the "imaginative deficit of scientific data" (Miles, 2010, p.13). Their core value lies in this unique ability of *artistic freedom*, and boundary-less capability to produce attention-capturing data based visuals, at all times able to question the 'status-quo' of visualizations (Lau & Moere, 2007; Moere & Purchase, 2011). While an information visualization on climate change has indeed be found to produce feelings of salience among viewers (O'Neill, Boykoff, Niemeyer, & Day, 2013), this is however unclear for the artistic adaptations. The overall research question, which this research hence addresses, is as follows:

> *How* engaging in terms of feelings of salience do viewers perceive artistic information visualizations on climate change, and *what reasoning* for felt salience can be identified?[3]

This two-folded RQ was studied in the following way: The first part of the RQ (how engaging) was mainly investigated through a q-sort. In this sort, participants were asked to arrange several climate change visualizations according to the statement "This image makes me feel climate change is important", which stands for feelings of salience. While the AIVs are the focus of this Master thesis, four other visual forms are included in the visual sets to allow for meaningful comparison: pragmatic information visualizations, photos, artistic simulations, and cartoons. These visuals show a problem-focused narrative, identified as dominant in climate change communication, i.e. depict causes or impacts such as pollution, fossil fuel use, temperature increase, intensified weather events, and melting ice (O'Neill et al., 2013; O'Neill & Smith, 2013). The second part of the RQ (why engaging, i.e. what reasoning) was then fathomed in the post-sorting semi-structured interviews by asking questions, and allowing participants to express their views. Furthermore, a short survey supplied data on the audience's relation to climate change, and art.

In academic terms, overall the present Master thesis makes contributions to the growing body of research on the perception of climate change visualizations. It adds to it in at least three specific ways. First, this research contributes to previous studies investigating engagement with climate change visualizations in terms of feelings of salience for a type, which has not been researched before. It however does not limits itself to only the AIVs. It also includes visual types under study in previous research (photos and graphs) in other countries (e.g. Australia, United Kingdom, and the United States). This research hence investigates the respective elicited feelings of salience for the *Dutch* context, and also allows for meaningful comparisons between *different* visual forms. Second, the research does not only address the different visual characteristics in the perception process. It also builds on very recently voiced claims in the field of information visualization. They point towards the

[3] 'Artistic information visualizations' will be mentioned by their full name once in the beginning of each chapter and then abbreviated 'AIVs' in the subsequent sections (except in the formulation of research questions). 'Research question' will be abbreviated 'RQ' throughout this thesis.

urgent need to integrate audience characteristics and their relation to the visual's form and content into the study of peoples' perception of information visualizations (Kennedy, Hill, Allen, & Kirk, 2016). Third, by including artistic styles such as artistic simulations and cartons next to the AIVs, this Master thesis adds to the still rather limited work on whether art's communicative role in addressing environmental issues is effective (Dunaway, 2009; Miles, 2014; Neill & Smith, 2013). The present research intends to answer the question whether the arts, and the AIVs specifically, are more effective in creating feelings of salience for climate change than rather pragmatic visuals. This has so far not been compared in a single study for feelings of salience.

Societal relevance of this research is shown as it has implications for the communication strategies of entities involved in the communication of climate change, such as environmental organizations. Acknowledging different perceptions of visuals on environmental problems could have important implications in contributing to tailored, targeted visualizations for specific audiences, such as students frequenting the art faculty, or students enrolled in science programs, such as data management. Furthermore, it could be of guidance to (data) artists desiring to get involved in this issue.

Following this introduction, chapter two provides insight into the process of climate change communication, explaining both the encoding and decoding side, and highlights the importance of investigating the engagement with AIVs on climate change. Chapter three details the methodological procedures of the survey, q-sort and interview addressing the two-folded RQ, and gives more information on the chosen visual sets. In the results chapter four, participants' sorting of the visuals and their reasoning are explained. The engagement with each visualization form will also be described, lastly focusing on the AIVs. The thesis finishes with a conclusion, where the overall picture of AIVs in the communication of climate change is painted, limitations are pointed out, and recommendations for environmental organizations, and artists are given.

2. Theory and Concepts

The first section introduces the Encoding-Decoding Model as the general framework in which the communication of climate change visualizations can be situated. The second section then focuses on the encoding side, presenting the involved communicators, their communication goals, and narratives. The challenges in the communication of climate change are also explained, and information visualizations and artistic visualizations information visualizations (AIVs) are introduced as promising types for the visualization of this topic. In the third section, the decoding (engagement) side of climate change visualizations – with a specific focus on the AIVs – is elaborated upon, and also how audience characteristics might influence this decoding process.

2.1 The Encoding-Decoding Model for the Visual Communication of Climate Change

The climate has most likely been fluctuating over the course of the past hundreds of thousands of years, as scientists have discovered through analysing ice cores, tree rings, and other indirect measures. Recent climate change however, especially since the mid-20th century, is different to the pre-industrial era. The magnitude in changing weather patterns, rising sea level, and more extreme weather events cannot be explained by natural factors alone. A large amount of scientific evidence shows that human factors are extremely likely to make a significant contribution to climate change, for instance through human-made greenhouse gas emissions (Cook et al., 2013; Moser, 2009). Since the discovery of this anthropogenic contribution in the 1980s, and the acknowledgment of accompanying negative consequences for nature, animals and human beings, the communication of climate change has experienced a sharp increase. Nowadays, it does not only include the scientific and policy domain anymore. It intensely permeates the economic and social sphere rendering climate change one of the most important issues of the 21st century (Hagen et al., 2015; Moser, 2009).[4]

A significant part of the communication of climate change involves visual imagery, such as photographs, films, and scientific figures to create meaning of causes, consequences, and mitigation and adaptation options concerning climate change. As the sense of sight constitutes the human sense with the highest bandwidth, visual imagery is especially able to draw observers in, to facilitate the remembering of information, and is furthermore able to traverse geographical barriers (Johansson et al., 2010; O'Neill & Smith, 2013). As many different actors are involved in the creation of diverse visualizations, perceived in different ways by the public, an overall framework is needed. It will help to situate the creators of visuals, the forms and contents, and the recipients in this complex interaction. Several scholars refer to the usefulness of the Encoding-Decoding Model of Communication, originally conceived by Hall (1980), for the understanding of the public's engagement with

[4] Certainly there also exists communication of climate change information, which counters the strong scientific consensus and denies the anthropogenic contribution or the existence, of the phenomenon itself. This communication however is not part of the scope of the present Master thesis.

environmental visual imagery. The Encoding-Decoding Model is not only capable to acknowledge the act of producing the visual (encoding), but also the process of engaging with it (decoding). The latter might not only be influenced by the visual's form and content, but also by 'noise' elements disrupting the communication, and audience factors (Kennedy et al., 2016; O'Neill & Smith, 2013). Please see the following figure 2.1 for an overview, which will be referred to throughout the following sections.

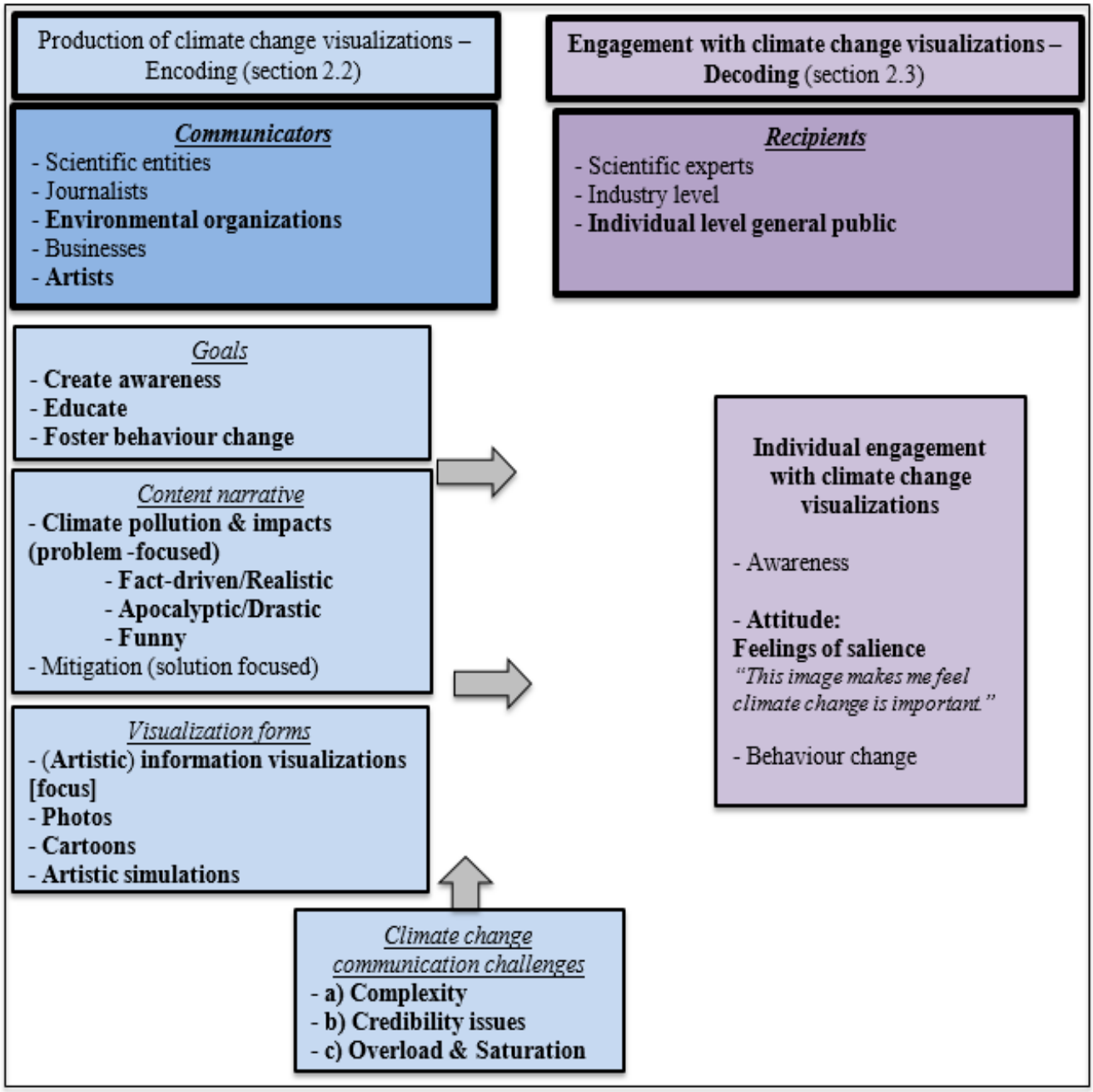

Figure 2.1: Communication Model illustrating the visual communication of climate change. Adapted to present topic from Hall (1980), Kennedy et al. (2016), Lorenzoni et al. (2007), O'Neill and Smith (2013)

2.2 The Encoding of Climate Change Visualizations

Before the decoding side of the communication, which is the focus of this thesis, is elaborated upon in section 2.3, the following two sub-sections give an overview of the left side of figure 2.1, the encoding side. This leads to introducing the AIVs as promising types for the visualization of this topic.

2.2.1 The Communicators, Communication Goals and Narratives

There are many different actors from several domains involved in the production of climate change visualizations: scientific bodies such as the Intergovernmental Panel on Climate change, global organizations such as the United Nations, environmental groups such as Greenpeace, journalists of news media, commercial advertisers, and visual artists (box "Communicators" in figure above). Certainly this list of producers is non-exhaustive, and their specific purposes are diverse. A part of climate change communication is *addressed* at the scientific expert community, or at the industry level. Large industries, such as the energy or automobile sector, have a considerable direct impact on carbon dioxide emissions. However, there also exists a strong consensus among scholars of acknowledging *individuals'* attitudes and behaviours of the public (Hagen et al., 2015). This thesis focuses on environmental organizations and artists as communicators of climate change visuals (who draw their information from scientists) targeted at this broader general public. Both these groups of actors acknowledge the possibility of mobilizing individuals in achieving change. Artists have discovered their involvement in this politicized matter of climate change as "art is now less interested in beauty, and more in resistance, interruption, contradictions, and the fissures which demonstrate the dominant society's inbuilt failure" (Miles, 2016, p.16). Art's relation to nature and the environment has vastly shifted, from depicting the beautiful and sublime in romanticism, to environmentalist art. Nowadays it includes addressing the issue of climate change (Miles, 2010). It strives to "meet[s] the imaginative deficit of scientific data" (Miles, 2010, p.13) in adding an emotional component.

Some of the most relevant goals for creating climate change imagery addressed at individuals of a society can then in general be summarized as follows: creating awareness, and educating about climate change, which ideally fosters behaviour change (box "Goals" in figure above). The latter can then support climate change mitigation and adaptation strategies, for instance through changes in consumption or political voting behaviour (Hagen et al., 2015; Moser, 2009; O'Neill & Smith, 2013).

As previous content analyses have revealed, only a minority of climate change communication was found to be about mitigation and adaptation, i.e. solution-focused (e.g. energy futures, international treaties). Instead, dominant themes shown in the communicated visuals are mostly following a problem-focused narrative (O'Neill, 2013; O'Neil & Smith, 2013). This includes *causes* of climate change, such as the production of greenhouse gas emission through transportation, and energy. It also involves climate *impacts* such as rising temperatures, intensified weather events, and melting ice. This thesis focuses on visuals with this dominant problem-focus narrative, which in turn can be depicted by using different tones, such as fact-driven, apocalyptic or funny (box "Content narrative" in figure above). This will be further explained in the next sections.

2.2.2 Climate Change Communication Challenges and (Artistic) Information Visualizations

Scholars have detected several challenges specific to the communication of climate change issues, among them the a) complexity of the phenomenon, b) credibility issues, and c) information overload (box "Climate change communication challenges" in figure above).

a) The phenomenon of climate change is complex rendering its communication a difficult endeavour (Moser, 2009). This complexity stems from the research on climate change involving a large amount of heterogeneous, abstract data making spatial and temporal references. Furthermore, climate research is a boundary crossing undertaking, as several disciplines, such as biology, sociology, and political science, are involved in the analysis, decision-making and communication processes (Tominski, Donges, & Nocke, 2011). While still acknowledging the underlying scientific processes, this complex data hence needs to be communicated in an understandable way to reach the lay masses for that behavioural and policy changes can be achieved.

b) Although there exists a strong scientific consensus on climate change (97% of climate scientists agree on humanity's contribution), the public belief pertains that the science behind climate change is still unsettled (Steentjes et al., 2017). Therefore, an important task for encoders is to design the communicated message in a way to be perceived as reliable by the audience. This appears especially important in times of 'alternative facts', and where The United States recently withdrew their Paris 2015 climate agreement (https://www.whitehouse.gov/the-press-office/2017/06/01/statement-president-trump-paris-climate-accord). An important research finding is that the communicated content should refrain from depicting the apocalyptic, unbelievable and unrealistic. Albeit catching the viewers' attention, people tend to feel helpless, doubtful and overwhelmed when exposed to such imagery. This would certainly be counterproductive to the ultimate goal of climate change mitigation (Johansson et al., 2010; O'Neill & Smith, 2013). Instead, the depicted scenarios should be fact-based, and as realistic as possible.

c) The communication of climate change falls in a time, which is characterized by an amount and dispersion of information flows never experienced before. Modern communication technologies lead to a transformation of the information and socioeconomic spheres. Scholars therefore repeatedly refer to our modern civilization as the global information society (Britz, 2008; Hesse et al., 2008). On the one side, this has many advantages. More people can be exposed to relevant information, and information can be customized. In Europe in general, and in the Netherlands specifically, the majority of people is aware of climate change, although not necessarily acting accordingly (Hagen et al., 2015; Steentjes et al., 2017). On the other side however, the speed of information production and dissemination also exceeds our capacity to process it. This information overload puts new demands on society. People need to learn channelling, categorizing, and making sense of information. For communicators of climate change these are important implications. In a society of information overload, and high awareness of climate change, it is of utter importance to catch the viewer's attention in the first place, and to interest him or her in this topic (Lorenzoni et al., 2007; Moser, 2009; O'Neill & Smith, 2013).

The need for the a) understandable depiction of complexity, the b) establishment of credibility, and for c) novelty in the depiction of climate change to catch the viewer's attention, renders the consideration of certain visual forms especially relevant (Lorenzoni et al., 2007; Moser, 2009; O'Neill & Smith, 2013). Information visualizations are promising for the communication of climate change, because they are able to successfully address these challenges (box "Visualization forms" in figure above) (Card et al., 1999; Johansson et al., 2010; Moere & Purchase, 2011). *How* able they are in depicting complexity, how credible they are, and how novel, likely depends on the chosen type. Scholars largely agree upon a conceptual continuum between purely *pragmatic* on the one side, and *artistic* on the other (Kosara, 2007; Moere & Purchase, 2011; Pousman, Stasko, & Mateas, 2007; Viégas & Wattenberg, 2007). These two different types of information visualizations are based on data, and strive to educate about the underling information. Yet, each follows rather different motivations concerning what kind of perception they primarily aim to elicit among viewers. They are discussed in the following.

One of the earliest conceptions of information visualizations originates from Card et al. (1999): they involve "the use of computer-supported, interactive, visual representations of abstract, non-physically-based data" (p. 7). They hence create analytical insights in terms of discovery, decision-making, and exploration. These pragmatic information visualizations generally aim at amplifying the recipient's cognition about the presented information, are palpably fact-based, and purely functional (Lau & Moere, 2007; Pousman et al., 2007). The data recognisability and readability of this style of information visualization is generally high (Kosara, 2007). Hence, they are especially strong on a) ability to depict complexity. Furthermore, they are likely to b) establish credibility, provided they are realistic, and their communicators are trusted, such as environmental organizations (Hagen et al., 2015). The artistic modifications of pragmatic information visualizations – AIVs – emerged at the beginning of the 21st century. They originated due to the wide distribution of Internet, availability of software and datasets, development of interdisciplinary skills, and recognition of aesthetics in the field of information visualizations. They do not necessarily need to make use of graphic design, but can also be created in a painterly style for instance (Lau & Moere, 2007).

While scholars explicitly support the application of an information visualization approach to climate change visualization (Johansson et al., 2010; Tominski et al., 2011), it is unclear how *artistic* versions work for the topic of climate change. There exists neither research for AIVs in general nor connecting them to this topic. Their possible promising abilities are however deducted from scholars' theoretical works on AIVs. They are especially strong on c) to produce novel visualizations in informative-coined times. This is largely due to their core benefit of artistic freedom. They can be subjective, emotional, and captivating. Data artists can choose freely the degree of data focus. While a stronger data focus allows for more recognizability, but less artistry, a weaker data focus permits more artistry, but might impede the visual's data recognizability (Kosara, 2007; Lau & More, 2007; Moere & Purchase, 2011). Their ability to a) depict complexity hence likely depends on their balance between the chosen data focus and artistic freedom. This might be important for the understanding of

the topic of climate change. Concerning b), although they are modifications of fact-based information visualizations, their ability to establish credibility is rather unclear. The credibility of (data) artists in climate change communication is under-researched. See figure 2.2 for an overview of the mentioned (artistic) information visualizations' abilities within climate change communication.

Type of information visualization / **Climate change communication challenges**	**Information visualizations**	**Artistic information visualizations** (Note: No theory or research for specific topic of climate change, their abilities and risks are deducted from other topical areas)
a) Ability to depict complexity	Very strong	Depends on chosen data focus and degree of artistic freedom (possibly in tension with (c) 'novelty')
b) Ability to establish credibility	Possible, especially if: - Realistic (non-apocalyptic) - Source are scientists or environmental organizations	Credibility of data artists on climate change unclear Risk of loss of autonomy Risk of instrumentalization
b) Ability for novelty	Possible, if use of aesthetics	Very strong due to artistic freedom

Figure 2.2: Overview about how (artistic) information visualizations can address challenges in the communication of climate change. Based on Johansson et al (2010), Kosara (2007), Lorenzoni et al. (2007), Moser (2009), O'Neill and Smith (2013)

Many artists claim that the arts and its creative expression can effectively communicate environmental problems and inspire its viewers to become engaged with the problem, because they are involved through the arts. Consider for instance data artist Jill Pelto's statement:

> "I create pieces to raise awareness about interesting and important environmental topics. […] Art is a uniquely articulate lens: through it I can address environmental concerns to raise awareness and inspire people to take action. My goal is to collaborate in order to reach a broader audience. […] Nature is fascinating and beautiful, and I hope you will help me fight to preserve it." (www.jillpelto.com)

Referring back to the encoding-decoding concept, the producer's *motivation* to use artistic means to engage the viewers is of course only one side of the communication. The pressing question is, if the audience *decodes* the visual as intended by the creator. Furthermore, the question remains, how AIVs compare to other visual types recurring in the communication of climate change. Although the AIVs are the focus of this Master thesis, only comparing AIVs with each other or to their pendant, the

pragmatic information visualizations, would limit the results to this field. Three other visual forms next to the AIVs and pragmatic information visualizations are hence included in this research to allow establishing the AIVs' overall position in climate change communication: photos, cartoons, and artistic simulations. The specific reasons for their inclusion in this research will be the focus of the next section, which details the audience's engagement (decoding) with these climate visualizations, and by what elements it might be influenced.

2.3 The Decoding of Climate Change Visualizations

The decoding side of the communication of climate change is the focus of this Master thesis. As viewers might 'read' climate change visualizations differently than intended by encoders, scholars are interested in the study of this side of the communication process. As already mentioned above, this thesis emphasizes individual people's engagement with the visualized environmental issues (box "Recipients" in figure 2.1 above). In general, engagement with climate change imagery can be defined as the viewer's emotional, cognitive and behavioural commitment (Lorenzoni et al., 2007; Moser, 2009; O'Neill & Smith, 2013). Emotional response variables of interest to scholars, amongst others, refer to positive or negative emotions, emotions of fear, guilt, outrage, and hope. Cognitive deliberations concern feelings of salience (visual makes viewer feel climate change is important), risk perceptions, reflective insights, and willingness to change one's lifestyle (see box" Individual engagement with climate change imagery" in figure 2.1 above) (Lorenzoni et al., 2007; O'Neill & Smith, 2013; Steentjes et al., 2017).

2.3.1 Engagement with Climate Change Visualizations: Feelings of Salience

As most people in the Netherlands are already aware of climate change (Hagen et al., 2015; Steentjes et al., 2017), and as an investigation of a behavioural shift would be outside the realm of feasibility of this Master thesis, the research focuses on people's attitude induced by the visual. This concerns the visual's capability to portray climate change in a way to make the viewer feel climate change is important (feelings of salience). This sub-section deals with the first part of the overall RQ about *how* engaging viewers find the visualizations in terms of feelings of salience.

The engagement with climate change visualizations has only recently begun to be investigated. What role AIVs, and the arts in general, have in engaging viewers is a largely under-researched area. As much as the arts strive to be a transformational power, and scholars indeed certify art's emotional power in climate change communication, art's contribution to induce people's engagement with the topic of climate change is still rather unclear. Much of the statements concern art's *potential* contributions. Considering that art reflects and inflects a society's shared values, art could have theoretically a contribution to shift people's consciousness and behaviour towards values supporting sustainability. Repeatedly, the question is asked whether art can *really* influence attitudes and actions, which in turn support adaptation and mitigation strategies to climate change (Miles, 2014; Miles, 2016; O'Neill & Smith, 2013).

While for AIVs there exists no research concerning feelings of salience, for other visualization forms it does. As already mentioned above, this research situates the AIVs vis-à-vis other visual forms, which are used in the communication of climate change. Hence, the AIVs position in terms of their ability to elicit feelings of salience can be asserted not in isolation, but in meaningful comparisons in terms of the audience's elicited feelings of salience for each type. The inclusion of each visual form will be explained in the following.

First of all, the pragmatic *information visualizations* are certainly included. Scholars point to information visualizations as a key technology in climate change visualization both for researchers, and the general public (Johansson et al., 2010; Nocke et al., 2008). In a study, a scientific figure was found to elicit feelings of salience (O'Neill et al., 2013). They are included to find out if AIVs are more or less engaging than their promising pendants, and why this is the case.

Second, photography takes a dominant role in the communication of climate change (Manzo, 2012). *Newspaper photos* picturing climate impacts and pollution were found in previous studies as being especially capable to elicit feelings of salience among viewers (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). The reasoning to include photos hence refers to their role as providing a strong benchmark against which this research's focal visual form AIVs can be compared to.

Moreover, as artists dealing with climate change do not always follow the data-focused path of AIVs, two other artistic visuals are included in the research. This is to acknowledge that the overall problem-focused discourse can be depicted in a rather fear-inducing or even cartoonist way. Fear-inducing images were found to elicit salience, but they also might distance the viewer, rendering him or her helpless (O'Neill & Nicholson-Cole, 2009; O'Neill & Smith, 2013). If this can be found for *artistic apocalyptic simulations*, as suggested by scholars (Dunaway, 2009; Miles, 2010), and if they engage the viewer more or less than the fact-based AIVs is the justification for their inclusion. Raised questions thus are: Does art have to be apocalyptic art to catch the viewer's attention? Can novel, but non-apocalyptic art in form of AIVs come to rescue where attention is needed?

Lastly, *cartoons* serve as the fifth form. Although there is no existing research on feelings of salience concerning cartoons dealing with climate change, cartoons are "effective forms of visual commentary" in climate change communication (Manzo, 2012, p.481). Including them in this research responds to scholars' calls for more studies into audience engagement with cartoons (Manzo, 2012). Figure 2.3 offers an overview of the visual types, their respective tone and people's resulting (possible) engagement with them. Visual examples for each types are presented in the third chapter of this thesis on the 'Method' or can be seen in appendix B.

Overall discourse: Climate pollution and climate change impacts, i.e. a problem-focused discourse. **Themes:** Pollution, fossil fuel use, temperature increase, intensified weather events, melting ice.		
Visualization form	**Tone**	**Engagement**
Artistic information visualizations	Palpably fact-based and artistic	→ Feelings of salience?
Information visualizations	Palpably fact-based	Feelings of salience shown in previous studies
Photos	Realistic	Feelings of salience shown in previous studies
Artistic simulations	Drastic, dramatic, apocalyptic, artistic	→ Feelings of salience? Helplessness?
Cartoons	Satirist, parody, funny, artistic	→ Feelings of salience? Appropriate for serious topic?

Figure 2.3: Chosen visual forms, respective tones, and resulting (possible) engagement with the climate change visualizations

2.3.2 Reasoning of Feelings of Salience

Feelings of salience could be connected to several characteristics of the visual (sub-RQ 1a, 1b), to the participant's decoding skills (sub-RQ 2) and opinions (sub-RQ 3). This section therefore focuses on the second part of the overall RQ about participants' reasoning, which will be detailed throughout the following three sections leading to sub-RQ 1a, 1b, 2, and 3. These sub-RQs revolve around the AIVs being the focus of this thesis, comparing them to the other four forms. They are strongly based on theory and research insights from their pendant, the pragmatic information visualizations, and on insights from climate change engagement.

Visual Properties: AIVs' Capabilities for Cognitive and Emotional Engagement

Some images could be found rendering climate change more or less salient than others, because of their rather fact-based narrative, or the emotional impact they have on the viewer. Evidence and emotive imagery have been identified as reasoning in previous research on climate change images (O'Neill et al., 2013; O'Neill & Smith, 2013). This *cognitive* and *emotive* engagement is detailed throughout the next paragraphs leading to sub-RQ 1a and 1b.

As mentioned above in the section on challenges, the phenomenon of climate change is complex rendering its communication a difficult endeavour (Moser, 2009).When information visualizations support information extraction, and information comprehension (cognitive engagement), viewers can engage with the visual (Card et al. 1999; Cawthon & Moere, 2007; Evergreen & Metzner, 2013; Kennedy et al., 2016). As has recently been researched for instance by Johansson et al. (2010), information visualizations constitute a powerful tool in depicting this complex data in a persuasive and

understandable way. Therefore, information visualizations are expected to facilitate viewer's engagement. AIVs, on the other hand, are often associated with the elicitation of emotional responses. They are nevertheless not necessarily constrained to creating affective responses alone; just as much as the arts in general have been recognized for their potential to facilitate the full engagement of emotional *and* cognitive systems (Goldman, 2001). As Dewey (2005 [1934]) has already proclaimed it in the 20th century, art can be – just like science – a source of knowledge providing cognitive insights. The question is however, how well the AIVs are able to provide those for a complex topic such as climate change. Artists of AIVs can choose freely the degree of artistry and data focus in guaranteeing that the complexity and the underlying issue itself is still recognizable and readable to a sufficient degree (Kosara, 2007). As the acknowledgement of art in information visualization is a young endeavour, and scholars have been preoccupied with the identification of art's position, motivations, and general value within this discipline, its ability to cognitively *engage* viewers is however under-researched[6], leading to the following sub-RQ:

> *Sub-RQ 1a: How are the fact-based artistic information visualizations on climate change perceived in terms of cognition compared to other visuals?*

When information visualizations are able to provoke strong conducive emotions, they are able to engage viewers with the visualizations. These emotions could for instance origin from the style as being perceived as particularly novel (Kennedy et al., 2016). The need for the inclusion of aesthetic designs in information visualizations has been validated through several studies (e.g. Cawthon & Moere, 2007). Scholars are largely in agreement that the arts can provide important lessons for the field of information visualizations (Evers & Nack, 2016; Gaviria, 2008; Kosara, 2007; Pousman et al., 2007; Viégas & Wattenberg, 2007). The arts in general are widely acknowledged, for instance under Expression Theory, for their potential to communicate emotions and letting the audience feel these emotions (Freeland, 2002). This emotional component appears to be especially important in times of information overload, where some scholars see human's affective capabilities and capacities for deep experiences fading. Seen from this angle, art can enable the audience to become vividly absorbed in aesthetic experiences in a world where rational information processes prevail (Shusterman, 1997). This capability of the arts in general for the creation of aesthetic experience and affective responses has also been widely acknowledged in the literature on AIVs. As artists enjoy artistic freedom, they are not necessarily bound by objective and functional requirements when creating their information visualizations. They are able to choose freely between a design, which is less representative or more representative of the dataset (Moere & Purchase, 2011). Therefore, artists have the unique capability to use ambiguous and interpretive methods. They are able to provoke, challenge, and question current

[6] There exist only few studies in the field of *scientific* visualizations – a related field of information visualizations – (Healey & Enns, 2002; Laidlaw, 2001).

visualization styles. Consequently they can produce novel, attention-capturing visuals based on the data, eliciting emotional responses from the viewer (Gaviria, 2008; Lau & Moere, 2007; Moere & Purchase, 2011). Some scholars in the early stage of the recognition of AIVs (beginning of 2000) stressed their value in being sublime (Kosara, 2007). Sublimity or beauty are however not necessary conditions for the value of AIVs. Rather, it is the defamiliarization, which is a key competency (Manovich, 2008; Pousman et al., 2007). The emotional or surprising effect on the audience's perception can then be that of interest, captivation (Kosara, 2007), curiosity, puzzlement, frustration (Pousman et al., 2007), and personal reflection (Lau & Moere, 2007). This is exactly what art strives to achieve when getting involved with climate change, as Miles (2014) has interestingly summarized: "Art cannot save the planet or the whale; it can represent, critique, and play imaginatively. Art interrupts and exposes contradictions" (Miles, 2014, p.3). In a recent publication (Miles, 2016, p.16), he continues: "Art is now less interested in beauty, and more in resistance, interruption, contradictions, and the fissures which demonstrate the dominant society's inbuilt failure".

Sub-RQ 1b: How are the fact-based artistic information visualizations on climate change perceived in terms of their capability for novelty and eliciting affective responses (emotion) compared to other visuals?

Audience Skills for Decoding AIVs: Science and Art Interest and Education

Decoding is not only influenced by the visual's technical parameters seen in isolation, but likely also by placing these factors in relation to the audience. Building upon Bourdieu's (1979) landmark work on distinction, Hall (1980) asserted the influence of the viewer's education and class on his or her decoding process. Instead of looking at a monolithic mass, different audience segments and their relations to the visual were hence acknowledged. However, in the field of information visualizations the users have not received elaborate academic attention.

Only a minority of studies have started to pay attention to audience factors, for instance to user personality traits and gender, and their effects on visualization engagement (Kennedy et al., 2016; Ziemkiewicz & Kosara, 2003). Kennedy et al. (2016) are one of the few scholars to explicitly remark the importance of recognizing audience characteristics and their relations to the depicted visual. This is comparable to media audience research in the field of communication and media studies, and in line with the above proposed Encoding-Decoding Model of Communication. They make two important remarks concerning the depicted content and style, and the audience's relation to it. First, Kennedy et al. (2016) could show that, rather unsurprisingly, when the visualized subject matter depicted a participant's topic of interest, the person was also engaged in the visualization. Certain topics of climate change, for instance temperature increase, could especially make viewers feel climate change

is important and hence determine the person's sorting.[7] Second, the audience's confidence and skills have an influence on their engagement with information visualizations, as they need to be convinced to be able to decode the visualizations. This could concern a background in science or numeracy skills. The AIVs being a modification of information visualizations suggests that they possibly require an audience skilled in numeracy and/or art literacy. This thesis is especially interested in viewers' understanding of the arts. As the information visualizations not only concern the topic of environmental issues, but are also palpably depicted in an artistic style, it is relevant to consider viewers' understanding of the arts.

People with a background in the arts might have a different perception of the visuals than people without it (Bourdieu, 1979; Ellsworth, 2013; Silvia, 2005). Some images could be found rendering climate change more or less salient than others, because some viewers might be interested or skilled in the arts. Thus, they are likely to be more interested in artistic depictions. As has been shown in several research studies, artist training, and knowledge influence peoples' interest in the visuals. Art experts hold for instance a higher level of the appraisal structure of coping potential, resulting in a higher appraisal of interest in artistic visuals than art novices (Silvia, 2005). This appraisal perspective is therefore able to fathom why people react differently to artistic objects, considering that they make subjectivist evaluations of events or objects. These are influenced by the person's knowledge, experience, and their appraisal basis of expertise (Ellsworth, 2013; Silvia, 2005). This has been shown for complex artistic visuals (Silvia, 2005). Of the artistic visual types, the AIVs could be considered rather complex (in contrast to the more simple artistic simulations and cartoons).

This Master thesis hence fathoms if an art expert – novice difference can be witnessed in the case of AIVs, and if the artistic style might engage people holding arts expertise – for instance through their *educational* background and *interest* in the arts – more with the topic of climate change.

> *Sub-RQ 2: How does a background in the arts (education and interest) influence the viewer's engagement with the artistic information visualizations on climate change?*[8]

[7] Interest in particular climate change topics certainly is a possible sorting rationale, and will be referred to in the results chapter if it emerges. However, it does not constitute the essence and purpose of the present thesis. It is hence not included in the sub-RQ.

[8] A participant's background in science or numeracy skills could certainly also play a role in the decoding process (Kennedy et al., 2016). The research puts less emphasis on this possibility, as the focus is on viewers' understanding of the arts. It does however acknowledge, if the participant holds a degree in a scientific field, and if this is connected to his or her engagement with the AIVs, or their pendant, the information visualizations.

Audience Perception of Art's involvement in Climate Change Communication

Some images could be found rendering climate change more or less salient than others, because viewers might (dis)like an involvement of the arts with the issue of climate change. For the arts in general, researchers are exploring its critical role in relation to environmental issues and human-nature relationships. This role is superseding its original mere romantic conception of nature as beautiful and inspiring (Miles, 2010; Miles, 2014). The question is raised, if art is an effective means for engaging people with climate change issues, or if it instead distances them (Miles, 2010; Miles, 2014; O'Neill & Smith, 2013).

Critically viewing art's involvement could be connected to the concern of art's instrumentalization, and its loss of autonomy. Moreover, artists might be perceived as lacking expertise to create and communicate such images. Furthermore, viewers might have distrust in the source being connected to the artistic sphere (Dunaway, 2009; Hannah, 2012; Miles, 2010). Trust in the source and message however play an important role in the success of climate change communication: it is an important predictor of people's willingness to support mitigation strategies (Hagen et al., 2015; Moser, 2009). As has been discovered in a recent study, scientists and environmental organizations are among most trusted communicators, while governments, and corporations ranked among the least trusted institutions for communicating climate change in the Netherlands (Hagen et al., 2015). Trust in the source has also been acknowledged as a factor predicting engagement with the specific field of information visualizations. For people to be engaged with information visualizations they must consider the source and message as trustworthy, and believable (Kennedy et al., 2016). Scientifically sound information visualizations, communicated by environmental initiatives addressing individuals' consciousness and actions, could hence be expected to be trusted. However, the question remains how trusted (data) artists are as sources of information visualizations and moreover dealing with the topic of climate change.

This Master thesis strives to contribute to the stream of research about the perception of art's involvement in climate change communication. As mentioned, this could concern its instrumentalization, loss of autonomy, expertise for scientific topic of climate change, and trust issues. The following sub-RQ is raised:

> *Sub-RQ 3: How is the involvement of art (and artistic information visualizations specifically) in the communication of climate change perceived?*

3. Method

In the following sections, the choice of designing this research in three parts of survey, q-sort and interview is justified. The focus on the Dutch context and rationale for sampling is furthermore explained. Moreover, illustrations of the five different forms of climate change visualizations are given. This is followed by a description of how the theoretical concepts detailed in the last chapter are rendered observable. Lastly, the steps of the data collection process of this three-part research are discussed.

3.1 Choice of Methodology

This research consists of three elements: a survey, a q-sort, and in-depth, face-to-face, semi-structured interviews. All three parts refer to qualitative research, which is concerned with peoples' experiences, meanings, and perceptions, i.e. the focus of this thesis. Each of the three parts allows addressing the present main and sub-RQs of different participants' engagement in terms of feelings of salience with climate change visualizations, as the following paragraphs detail.

The q-methodology and interview data collection processes are based on methodological practices used by scholars in previous research, who started to use them for the study of people's engagement with climate change visualizations (Nicholson-Cole, 2004, O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). These scholars were interested in studying "how people engage with particular visual *discourses"* (O'Neill & Smith, 2013, p.9), i.e. problem *and* solution-focused discourses. This was investigated mostly through showing the *same* visualization (mostly photographs, some graphs*).* This thesis adapts the q-sort and interview to the present research, i.e. how viewers engage with climate change through the five *different* visualization forms with the *same* problem-focused narrative (each part is further explained below in section 3.5. Data Collection).

Q-sort methodology acknowledges the person's subjectivity (revealing key viewpoints), and is interested in discovering discourses about a particular issue (understanding key viewpoints holistically). It also allows engaging participants in the practical task of sorting, before cognitively pondering their choices, which eases the explanation of respective viewpoints (Watts & Stenner, 2013). It enables both quantitative and qualitative analyses of which the latter is made use of for the present Master thesis. Although the sorting q-method has originally been used for statements, in this way it has recently also been carried out using images.

After the q-sort, the final part of the research is a qualitative semi-structured interview, as employed by scholars in previous research. The qualitative interview research design enables the researcher to shed light on participants' experiences by eliciting their views of an object. Engagement in terms of feelings of salience can be measured in an interview, as it constitutes an immediate response to visual stimuli (Patton, 2002). Moreover, the qualitative method allows the researcher to establish a complex, holistic account of the issue under study, including multiple perspectives from different actors (participants with different backgrounds, i.e. participants' expertise, and knowledge

with respect to visual content and form) (Creswell, 2003). Also, the semi-structured design enables the researcher to still exert a medium amount of control and flexibility over the interview situation while acknowledging respondents' freedom to express their personal views and opinions. This can confirm already existing knowledge, while adding new insights to the topic under study, allowing two-way communication (Creswell, 2003; Marshall & Rossman, 2011; Patton, 2002). For instance, other influences might be detected and hence added to the understanding of peoples' engagement with climate change visualizations.

This research also added a short survey before the q-sort and interview. This was not part of previous research in climate change visualization, as it did not consider audience interests and skills, and their relation to the visualizations. The survey allows accounting for participants' climate change interest, interest in the arts, and their field of education in a comparable manner. This is a response to Kennedy et al.'s (2016) demand for audience research in the study of engagement with information visualizations.

3.2 Context of Study and Sample

The focus of the present Master thesis is on Western Europe, and the research in specifics investigates the perception in the Netherlands. The Netherlands is relevant to consider with regards to climate change as around one third of the country area is situated below sea level. Although the negative impacts are gauged to be manageable, the country directly has to cope with already existent or likely projected climate change effects (e.g. rising sea levels, and more extreme weather events). Furthermore, the country lags behind in terms of emission reduction and sustainability measures, such as new energies (www.erasmusmagazine.nl/en/2017/04/24/hoogleraren-willen-minister-van-energie-en-klimaat/, www.nos.nl/nieuwsuur/artikel/2043231-historische-uitspraak-over-klimaatbeleid.html). The issue of climate change is moreover not considered salient in comparison to "other more tangible, visible, immediate, urgent needs that the country and government face" (Hagen et al., 2015, p.175). Climate change is perceived only as moderate risk (Hagen et al., 2015).

A majority of residents is aware of climate change, and the involvement of the broader public's attitude and behaviour is essential in the combat against climate change (Hagen et al., 2015; Moser, 2009). Climate change is a phenomenon, which is not only perceived by a particular segment of the population but permeates society in general. Therefore, this research strives to include a rather diverse sample of members from the public in Rotterdam holding distinct perspectives. This was aimed to achieve by considering several audience background characteristics.

First, it was intended to include people with international backgrounds as the Netherlands, and Rotterdam specifically, is a multi-cultural place (www.rotterdam.nl). Thus, the Dutch context for the research does not imply the inclusion of only Dutch residents. Students are relevant to consider as they represent diverse international backgrounds (www.eur.nl/fw/english/exchange).

Second, in purposefully selecting students from different backgrounds, a further degree of diversity of attitudes was aimed to be achieved to account for different possible responses to climate

change and the arts (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). Therefore, the sample includes six students enrolled in different study programs at Erasmus University, Willem de Kooning Academy, and Erasmus Medical Center. The programs are: information management, health care, sociology, fine arts, medicine, and arts and culture. It was paid attention to including a couple of students enrolled in arts programs. This was done to investigate if these people might show a distinct sorting behaviour in comparison to the other non-educational-arts participants (Silvia, 2005).

Third, in an attempt to not only restrict the perceptions to students, but to diversify the sample base to other social backgrounds and ages, the researcher furthermore asked five subjects currently working. They were approached in the public in Rotterdam. These workers pursue different occupations: sports masseuse/illustrator, carpet store owner, communication manager, accountant, art dealer/art café owner. In a similar vein to the selection of students, it was paid attention to include a couple of workers with an arts education background. Although the workers hold different educational levels from HAVO to Bachelor to Master degree, in general most happen to work in reputable work positions. This certainly limits the diversity of the sample, as other social backgrounds, such as low-income groups are not represented here (see future research in section 5.2).

Overall, a balance between female and male respondents was aimed for to involve in the study to avoid being restricted to the viewpoints of a particular gender (five males, six female) (O'Neill et al., 2013). Certainly, with a sample size of eleven participants, the sample cannot be representatively diverse (also see section 3.5.1 on the short survey). See appendix A for an overview of all research participants.

3.3 The Climate Change Visualization Sets

The indication of a satisfactory number of items varies across the literature on q-methodology. Some scholars indicate a range of 40 to 80 images to produce meaningful results (Curt, 1994). Others deem a smaller amount sufficient for yielding substantial interpretations. Watts and Stenner (2005) for instance mention 25 images as a sufficient number. A rule of thumb in q-methodology refers to the number of participants being smaller than the q-sort items (Watts & Stenner, 2013). Thus, with eleven participants, 25 images can be considered appropriate for this research. Furthermore, this image amount prevents rendering the sorting process cumbersome, which can occur when too many visuals are included. The choice of a smaller image amount can moreover be supported by the fact that this thesis does not strive for a quantitative analysis.

The 25 images consist of five sets of each five images. One set includes five artistic information visualizations (AIVs), the second shows five pragmatic information visualizations, the third set consists of five photos, the fourth set covers apocalyptic artistic simulations, and the last set features five cartoons. Across all sets, the same discourse and themes have been chosen to allow meaningful comparisons between the different sets and hence visual forms. The overall discourse refers to climate change *causes* and climate change *impacts*, i.e. a problem-focused discourse. Themes of causes include air pollution, and fossil fuel use. Themes of impacts include temperature increase, intensified

weather events, and melting ice. This discourse and the themes have been identified as recurring in public press coverage of climate change (O'Neill, 2013; O'Neil & Smith, 2013; Smith & Joffe, 2009).

The visuals include image captions, indicating the depicted content: 'Flight traffic/air pollution'; 'Increasing use of fossil use'; 'Temperature increase'; 'Intensified weather events'; 'Melting ice'. Moreover, the caption also mentions the source or entity, which uses these images for the communication of climate change. Certainly, in real life these sources might collaborate in the communication, and thus blur the boundaries. For the sake of guaranteeing comparisons between non-artistic and artistic sources in this Master thesis research, the following sources are indicated: by environmental organization, by data artist, by artist, and by cartoonist. Providing captions has been justified by scholars to help relate the viewer to the image. This mirrors the real-life scenario, where images are not considered in isolation, but in context and with consideration of their caption (Hall, 1973; O'Neill, 2013).

For the first set, the AIVs, several data artists are chosen to reflect the diverse visualizations, which are accessible by the public: Aaron Koblin (flight traffic), Tom Wright (increasing temperatures), Jill Pelto (increasing fossil fuel use, and melting ice), and Nathalie Miebach (intensified weather events). See figure 3.1 for an illustration of Aaron Koblin's AIV.

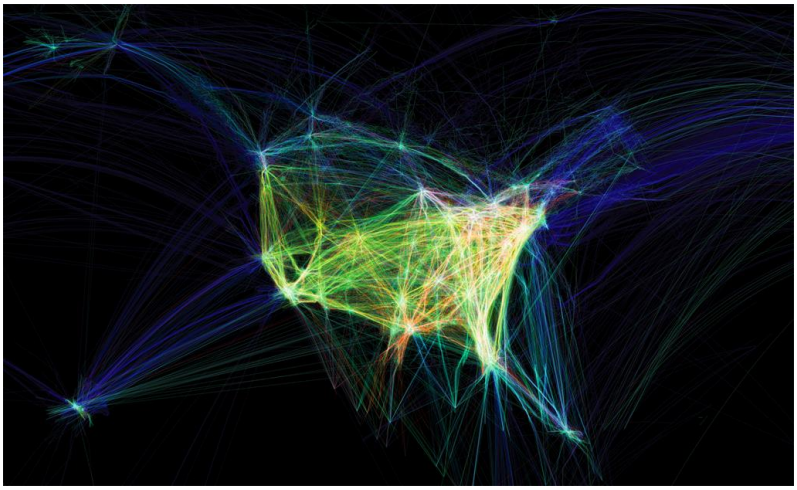

Figure 3.1: Artistic information visualization 'Flight traffic / air pollution' (used by data artist in climate change communication)
Source: http://www.aaronkoblin.com/work/flightpatterns/

The accompanying pragmatic information visualizations constitute the second set, again mirroring the themes to enable meaningful comparisons, i.e. to limit that choices are made in terms of the topics depicted rather than the *way* the topics are depicted. See figure 3.2 for the informative illustration of the theme of air pollution. While AIVs are indicated to be communicated by artists, the pragmatic information visualizations are specified to be used by environmental organizations.

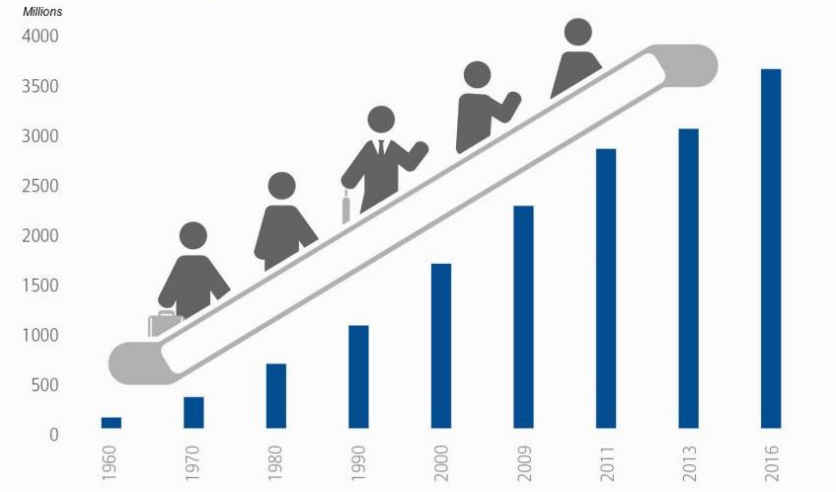

Figure 3.2: Information visualization 'Flight traffic / air pollution (used by environmental organizations in climate change communication)
Source: http://www.agcs.allianz.com/insights/expert-risk-articles/how-aviation-safety-has-improved/

The third set refers to photos on climate impacts and pollution taken by non-artistic entities, and is for instance used by environmental organizations in the communication of climate change. During the selection of photos it was paid attention to selecting photos, which depict present, realistic climate pollution and impact themes, i.e. not apocalyptic, unrealistic images.

Figure 3.3: Photo 'Flight traffic / air pollution' (used by environmental organizations in climate change communication)
Source: https://www.emaze.com/@ALTQCTZZ/How-can-we-reduce-plane-pollution

These preceding three sets refer to present-state, already existing issues of climate change, i.e. they are not projecting apocalyptic future scenarios. Artists dealing with climate change however do not always follow the fact-based path as data artists Aaron Koblin and Jill Pelto of set one. Artistic simulations such as the one illustrated in figure 3.4 about air pollution are also part of this research.

Figure 3.4: Artistic simulation 'Air pollution' (used by artist in climate change communication)
Source: http://www.dailyo.in/arts/delhi-smog-air-pollution-art-iconic-paintings-mona-lisa-the-scream-the-lovers-american-gothic/story/1/13896.html

Lastly, a fifth set of cartoons, and hence a third artistic style next to the AIVs, and apocalyptic simulations is included for comparison (see figure 3.5). Please see appendix B for the complete overview of the different climate change visualizations.

Figure 3.5: Cartoon 'Flight traffic / air pollution' (used by cartoonist in climate change communication)
Source: https://scottthong.files.wordpress.com/2007/12/baliemissions.jpg

3.4 Operationalization of Theoretical Concepts

As the previous section detailed, participants are provided with the different forms of climate change visualizations with captions clearly indicating theme, and communicator. The theoretical concepts concerning the engagement with these climate change visualizations are rendered visible in multiple ways: by examining participants' arrangement of visuals (q-sort), non-verbal expressions (q-sorting behaviour if striking), verbal expressions (during q-sort if applicable, and interview), and written expressions (survey).

The concept of *how* engaging in terms of feelings of salience the visualizations are found (first part of overall RQ) is mainly investigated through the q-sort, i.e. the arrangement of visuals according to the statement "This image makes me feel climate change is important". Therefore engagement is visible in a photo of every participant's sort. During the sorting, participants' non-verbal behaviour might furthermore significantly define their engagement. In that case, observation notes will be analysed.

Participants' *reasoning* for their feelings of salience, i.e. why engaging (second part of overall RQ and sub-RQ 1 a, 1b, 2, 3) are measured in the post-sorting interviews. Specifically this concerns verbal expressions (participants statements at own initiative and to the researcher's questions) regarding the capabilities of AIVs and other visual forms (sub-RQ 1a and 1b, interview question 3, 4-9 & 14-15, 17, 21-28 in interview guide, appendix C). Furthermore this regards verbal expressions about art interest and education (sub-RQ 2, interview question 16, 29,30), and regarding art's involvement in climate change (sub-RQ 3, interview question 11-15 / 18-20 & 27-28).

Participants' interest in the arts, and their education in a scientific field, in the arts, or other, and opinion and interest in climate change (audience background) is furthermore not only part of the interviews. It is asked in the short survey in the beginning of the research (sub-RQ 2, survey question 1-7 in short survey guide, appendix C).

3.5 Data Collection

The data was collected in Rotterdam and – being accompanied by immediate transcription after each interview – spanned four weeks between the 13th of April and 12th of May 2017. The six non-fellow students were interviewed at Erasmus University Rotterdam, Erasmus MC, and Willem de Kooning Academy in a quiet room or area. The other subjects, the workers, were identified in the public domain in Rotterdam. Participants were approached to take part in a Master thesis research, which studies peoples' thoughts about climate change visuals. This is comparable to the way O'Neill et al. (2013) informed their participants semi-openly about the intent of their research. Before the study started, potential subjects were asked for their consent by providing them with a 'Consent Request' to be signed or orally confirmed.

The approximate total duration of the three-part workshop of short survey, sort and interview lay between 52 and 85 minutes, largely dependent on the participant's pace of speech, available time, and interest in the artistic depictions. The average time for the short survey was six minutes, for the sorting

ten minutes and for the interview 44 minutes. There were however large difference between the minimum and maximum times of sorting (four minutes versus 27 minutes) and interview (35 minutes versus 52 minutes). For more details on the times needed for each task per participant, please see table A2 in appendix A. The following three sections and appendix C 'Survey**,** Q-sort and Interview Guide' detail the data collection process.

3.5.1 First Part: Short Survey

Before the sorting and interviews started, the participants were asked to fill out a short survey consisting of questions concerning their backgrounds, their climate change attitude and interest, and their interest in the arts. Placing these questions in front instead of after the interview is based on the approach by O'Neill et al. (2013). Two main goals can be identified for the inclusion of a short survey in this research. First, it allows identifying the degree of diversity of the sample. Second, it enables verifying if and how audience characteristics are connected to engagement with the visuals, which has been shown by several scholars (Kennedy's et al., 2016; Silvia, 2005). Therefore, this part adds to the second part of the main RQ, and in specifics to sub-RQ 2.

The survey included questions about participants' age, gender, education, place of residence, international background, and occupation. This thesis uses participants' first names, and they are only included in the study if s/he prefers the name being mentioned in the thesis (one alias for "Sam" was created, who preferred to stay anonymous). The survey also consists of statements and questions about the participant's relation to climate change: *The Dutch government should treat climate change as a very important policy priority. How worried are you about climate change? How serious a threat do you consider climate change?* These were asked to get an overview of the participants' possibly diverse conceptions of climate change. Participants were furthermore questioned about their interest in climate change and related environmental topics: *How interested are you in the topic of climate change?* This question was included as people with an interest in particular subjects are likely to be more engaged with the visuals (Kennedy's et al., 2016). Moreover, the participants were asked about their engagement with art and culture. This background is needed, as three sets are palpably artistic. People with an interest or education in the arts might be more interested in the artistic depictions than people without an interest or education in the arts (Silvia, 2005): *How interested are you in the arts?*

Analysing participants' responses concerning climate change and art shows the following. First, *opinions* of climate change being a policy priority, worrying and a serious threat show slight and strong agreement across the whole sample[9]. *Interest* in climate change is mostly slight[10]. Every participant was *aware* of the climate change phenomenon. This sample is hence indeed both aware and considering climate change as important and worrying. This is in contrast to the survey results of Dutch residents being aware of climate change, but not strongly worried about it, and not treating it as

[9] Except for two participants who indicated neutral for worry and threat of climate change.
[10] Except for one participant indicating neutral, and two strong interest in climate change.

an important policy priority (Hagen et al., 2015). Second, the arts find slight or strong interest across the sample[11]. Thus, not a single participant indicated slight or strong *disagreement* or *disinterest* with climate change, or art. See table A3 in appendix A for a complete overview of participants' indications in the short survey. Given this rather homogenous opinion of and interest in climate change and art, a distinction between uninterested and interested participants was not necessary, which could have possibly influenced engagement with the climate change visualizations (Kennedy et al., 2016). However, participants held different educations, some in scientific, some in artistic fields. This connection between education and engagement is further elaborated upon in the chapter on 'Results'.

3.5.2 Second Part: Sorting

After the participants have filled out the short survey, the q-sort was conducted. The goal of the q-method is to achieve a meaningful sorting from most disagree to most agree, and reveals *which* image is sorted *where*. Thus, it addresses the first part of the overall RQ about *how* engaging viewers perceive AIVs. Furthermore, a q-sort serves as a practical means to ease participants' reasoning in the post-sort interview.

Participants are provided with 25 colour images of postcard size, and a sorting grid in the form depicted in figure 3.6. The q-sorting procedure is explained to the participants, as they might not be familiar with the approach. Participants are instructed to both consider the image and the accompanying captions when making their sorting choices according to the following statement: *This image makes me feel climate change is important* (feelings of salience).

Before sorting the images on the grid ranging from most disagree -4 to most agree +4 (undecided or unsure in middle at zero), participants could first create three piles: 1. "These visuals make me feel climate change is not important", 2. "I am undecided about these visuals", and "These visuals make me feel climate change is important". The pile sorting eases the further distribution in the grid. While the participants were sorting the images, the researcher's role was not passive. In contrast, she attentively (but inconspicuously) observed the subjects, and took notes. Do they hesitate with the sorting of certain images? Which images are quickly sorted? After the participants have sorted the visuals, a picture of the sort was taken.

[11] Except for two participants who stated a neutral interest in art.

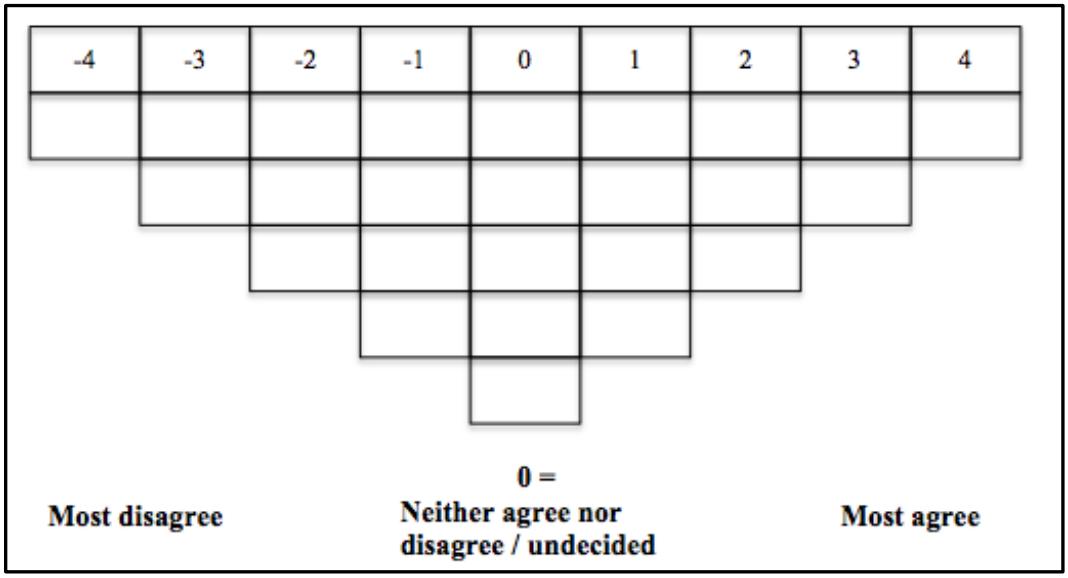

Figure 3.6: Logic of the q-sort of 25 images to sort from -4 to +4, rows for each column 1,2,3,4,5,4,3,2,1

3.5.3 Third Part: Post-sorting Interview

In the post-sorting interview, the participants were asked about their reasoning of sorting the visuals. While the q-sort reveals which images are sorted where, the interview enables to uncover *why* participants arranged the images in the way they did. The interview therefore allows advancing the data richness and quality of the q-sort (Watts & Stenner, 2013). This part of the research hence addresses the second part of the overall RQ about what reasoning for felt salience can be identified.

First, the discussion was initiated by asking the participant to shortly mention the overall sorting *places*, i.e. what images are sorted where. Then, the participant was asked to explain the *reasoning* for his or her sorting with a special focus on the extreme and middle parts of the distribution. At this point of the interview, the researcher did *not* refer to any reasoning logics herself. Rather she attentively listened and asked follow-up questions to deepen the understanding of the participant's sorting logic. Several scenarios were possible for the participant's reasoning, which the follow-up questions strongly depended upon: according to their tone (e.g. fact-based vs. apocalyptic vs. funny); depending on if they are artistic or non-artistic (e.g. information visualizations vs. AIVs, simulations, and cartoons); according to their depicted theme (e.g. temperature increase vs. weather events), or according to their form (e.g. photo vs. information visualization vs. cartoon). A combination of several logics was certainly possible. Moreover, an additional sorting logic could also emerge, adding to the theories and concepts identified by the researcher. A further scenario would be that no apparent sorting of visuals could at first be identified.

If the AIVs are positioned at the extreme points or in the middle, this last described part of the interview was already focused on them, and the interviewer was able to deepen the understanding of the perception of AIVs. The aim was to find out, what makes them superior (or inferior) to the other images in depicting climate change as a salient issue when a participant has placed them at the

extremes. In a similar vein, if they were accumulated around the middle, the researcher strived to find out what properties of the AIVs made the participant unsure about its position.

If the AIVs were scattered in different places on the sorting grid, the interviewer kept the last interview part about the other forms rather short to be able to have enough time for the investigation of the perception of AIVs. The researcher then asked the participants directly about his or her opinion of AIVs, and art's involvement with climate change communication. Thus, the interview evolves depending on how much participants agree with the AIVs and artistic visuals in general. Participants who are strongly (dis)agreeing with them were articulating their view in a more independent manner (i.e. with less input and asking from the researcher). In contrast, when participants scattered them across the sort, the researcher took a more active role in asking about their sorting. These participants were for example asked what they would advise the data artists to improve in their visualizations to initiate and hold the discussion about the AIVs.

Integrated into the interview process are questions concerning the participant's behaviour during the q-sort, provided that the researcher noted striking or unusual behaviour. The participant was then directly asked what s/he believes made him or her hesitate or quickly sort these certain images. Please also see the interview guide in appendix C for further information on the exact interview procedure.

The analysis majorly concerned the transcription of audiotapes and coding of observation notes (if applicable), of statements voiced by the participant during the sorting (if applicable), and *most importantly* the coding of the post-sorting interview segments. For the transcription of each participant's workshop audiotape, the website www.otranscribe.com was used. It eases the task of transforming verbal in written data by allowing adjusting the speed, inserting time stamps, and offering other useful functions. As the interview was preceded by a sorting task and participants made frequent references to visuals by pointing (i.e. without necessarily always articulating about which visual they were speaking), these references are inserted behind the statements in square brackets. The notation system depicted in appendix D, table D1, was used during transcription.

The process put forward by Creswell (2003) was followed to describe the steps in the data analysis of the raw survey, sorting and interview data. The raw data (transcripts) were first organized and prepared. It was read through the data to get a general impression of the information, and the overall meaning. Subsequently, they were inserted into the research software ATLAS.ti for further analysis. The following analysis procedure was used. First, the transcripts were roughly compared to each other, and recurring narratives and reasoning were identified for agreeing or disagreeing with the AIVs. The coding process started by pre-coding these segments. The pre-coding was then complemented by the use of other coding techniques, such as descriptive coding, and structural coding. Thus, the material was organized into meaningful information, and expected, surprising, and unusual codes around the sub-RQs were identified.

Concerning sub-RQ 1, participants' perceptions of the AIVs' capabilities for information provision and novelty and emotion were identified and coded. These were primarily voiced by the participants themselves, and at times directly asked by the researcher if the participant did not him-/herself provide

information on his or her opinion of these capabilities. When it became clear which reasons for (dis-) agreeing with the AIVs were used, the codes were created accordingly. A code list is included in appendix D, table D2. Furthermore a conception of the connection between RQs, concepts and codes is included in appendix E. Indeed, the voiced reasoning majorly complied with the identified concepts in the theory section. For instance, 'AIV – (not) understood' and 'AIV – (missing) connection to CC' referred to their (in)capability for information provision. Focus was hence put on participants' statements concerning AIVs and recurring statements were identified across the documents in a back and forth process. As frequent comparisons from AIVs to other visual forms – especially on the most agreed column – were made, these statements were also coded as they yielded insight into what participants were missing in the AIVs. The following are some of the codes, which were used for sub-RQ 1:

Positive descriptions/codes of AIV:

- AIV – liked (connected to interesting / nice / appealing / beautiful)
- AIV – clear connection to CC
- AIV – create curiosity
- AIV – novelty

Negative descriptions/codes of AIV

- AIV – not understood (connected: too abstract / not recognizable)
- AIV – not meaningful
- AIV – missing connection to CC
- AIV – not liked (no strong emotion)
- AIV – time-consuming

These positive and negative descriptions were confronted with each other in Code-Document Tables to analyse which codes are used by whom across the sample, or across certain groups of the sample. This allowed insights into participants' explanations for (dis-)agreement. Moreover, each AIV was analysed individually to identify if/what common codes were used for a particular AIV.

Sub-RQ 2 concerning the connection between the participant's interest and education in art, and sorting and reasoning of visualizations is also coded[12]. Some of the codes used are:

- (No) High interest in art
- (No) Art education
- Belief: Artistic background would increase understanding
- Belief: Influence personal background on perception

[12] This coding is also applied to the short survey, which indicates participants' interest in art, and level and field of education.

The third and last sub-RQ concerned the participant's opinion on art's involvement, as this was theorized to be connected to (dis-)agreement with artistic visuals on climate change. Amongst others the following codes were created:

- (Dis)Trust in art
- Trust in scientific community
- Trust in data artists
- Art should be involved
- Art's power doubted
- Art should not convince

The researcher to the best of her knowledge checked for reliability, validity, and generalizability issues of the conducted qualitative research. Reliability procedures such as transcript checks, and code crosschecking to check for accuracy of the findings were used. Validity strategies, for instance member checking, use of rich descriptions to convey findings, self-reflection on researcher bias, and presentation of discrepant information were employed. A regard for generalizability is only used in limited ways in qualitative research, and also here not the primary goal. It is a small-scale, non-random interview study; the inquiry and value lies exactly in this particularity rather than broad generalizability of the research (Creswell, 2003). The analytical coding process yielded descriptions and themes, which are used as major findings in the subsequent 'Results' chapter, where an interpretation or meaning of the data (comparison of findings to expectations from literature and theory, confirmation or divergence, new questions raised by the data) is conducted.

4. Results

First, the arrangement of visualizations, i.e. from the photographs of participants' sort, reveals how engaging the different visual types, and in specifics the artistic information visualizations (AIVs) were found (*how* engaging: first part of overall RQ). Second, participants' *general* recurring sorting criteria provide first broad insights into and understanding of their overall sorting reasoning (*why* engaging: second part overall RQ, and parts of sub-RQs). The third section sheds light on each visual type, with an emphasis on the AIVs being the focus of this Master thesis. It hence gives *detailed* insights into the sub-RQs, i.e. the *specific* reasoning for agreeing or disagreeing with the visual types about climate change.

4.1. Overall Visualization Sorting: Photos are Most and AIVs Least Engaging

The following table 4.1 depicts each visual type's number of images sorted in the three broad disagreement, undecided and agreement areas. This general overview shows that photos and AIVs are almost exactly mirroring each other's opposites. While the former was found most engaging, i.e. made participants feel climate change is important, the latter was found least engaging. In contrast, participants' arrangements were almost equally divided between agreement and disagreement for the artistic simulations, i.e. some made them feel climate change is important, others did not. Cartoons and information visualizations were also quite evenly spread across the spectrum, although with a stronger accumulation on the undecided column. The corresponding average scores are also indicated in table 4.1. Concerning the sorting behaviour, striking behaviour could mainly be observed for one of the five visualization forms, the AIVs. Most participants showed hesitating behaviour during the sorting, i.e. took more time to place them, looked at them repeatedly, and changed them around more often (the corresponding sorting rationales will be detailed in section 4.3.5 on AIVs).

A general answer to the first part of the overall RQ (how engaging) can be formulated: The AIVs were overall found less engaging in terms of feelings of salience than the other four visual types. Therefore, *in comparison* to the other visual types, they were least able to depict climate change as an important topic.

	This image makes me feel climate change is important.										
	-4	-3	-2	-1	0	1	2	3	4	Sum	Average
	Disagreement				Undecided	Agreement					(-4 to +4)
AIV	34				9	12				55	-1
INFO VIS	16				22	17				55	0
PHOTOS	12				8	35				55	+1
ARTISTIC SIM	26				2	27				55	0
CARTOONS	22				14	19				55	0
										275	

Table 4.1: Each visual type's count per disagreement, undecided and agreement areas (information visualizations abbreviated to 'info vis', artistic simulations to 'artistic sim')

4.2 Overall Sorting Reasoning: It is all about Clarity, Immediacy and Emotion

Certainly, several sorting criteria could have played a role leading to this arrangement. Participants' recurring sorting criteria for agreement across the whole sample were "clarity", "reality", and "facts". This could possibly be connected to nowadays' information society, the complex issue of climate change, and the need for evidence. "Immediacy" was also frequently mentioned, possibly connected to the perceived limited available time.[13] Moreover, the majority of participants preferred emotions in the communication of climate change; only one participants explicitly wished for a removal of emotions. Recurring sorting criteria for disagreement were lack of understanding the visual, insufficiency of connection to climate change, and either dearth or excess of felt emotion. Therefore, especially one of the three needs mentioned in the theory section above on climate change communication challenges (sub-section 2.2.2) was referred to by participants: the need for *understandable* depiction. The establishment of credibility was partly among the remarks. In contrast, a desire for novelty in the depiction of climate change was *not* voiced by anyone, while being emotionally touched was very important.

Furthermore, it needs to be clarified if participants preferred one or some of the five depicted topics in particular in the communication of climate change, and how much this was driving their sorting behaviour. Indeed, participants at times referred to certain topics as being especially salient for the issue of climate change. This led to the visuals depicting the topics of melting ice, air pollution and fossil fuels being mentioned in similar amounts on the agreement side (28, 27, 24 times respectively). In comparison, the visuals showing the topics of intensified weather, and increasing temperature were less represented on the agreement side (17, 14 times respectively). This occurred across almost all visual types, suggesting that overall some topics are simply found more important in the communication of climate change than others.[14]

A first general answer to the second part of the overall RQ (why engaging) can hence be formulated: Participants indeed made numerous references to the visual types' capabilities concerning their cognitive and emotional engagement (sub-RQ 1): clarity, immediacy, and emotional impact. Climate change topics also played some role during the sorting. The audience's interest or educational background in art (and science) was overall not important during the sorting, except, as theorized, regarding the AIVs (and information visualizations) (sub-RQ 2). Moreover, art's involvement in climate change (sub-RQ 3) was generally not opposed to; participants' opinions on it were *not* majorly driving the sorting behaviour. They did however have preferences on *how* the arts (and AIVs specifically) should be involved in climate change communication. The sub-RQs will be further discussed below in the next sub-section.

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[13] A word count across all transcripts revealed especially the importance of "clarity"/"clear" to participants; with 118 times named it constitutes the most dominant criteria mentioned. "Reality"/"realistic"/"real" amount to 108. "Immediacy" was mentioned 53, "facts" 43 times.

[14] More significantly agreed with in photos: air pollution', melting ice; artistic simulations: air pollution, fossil fuel, melting ice; cartoons: air pollution, melting ice. More significantly disagreed with in AIVs: temperature, weather; in information visualizations: air pollution.

4.3 Each Visualization Type's Sorting and Reasoning

The following investigation of the five individual visual types provides more insight into the above-mentioned sorting criteria and how they are connected to each of them. It starts with information visualizations, which were considered clear by some, but also not emotional enough by many. Second, photos were perceived as being especially clear and direct. Third, artistic simulations were seen as clear, but their dramatic depictions divided opinions. Fourth, cartoons were also found clear, but style and humour separated participants' perceptions. Thus, the discussion of these four types already yields first insights into sub-RQ 1 about cognitive and emotional engagement.

The last sub-section elaborates on the focal topic of this Master thesis, the AIVs. It will be explained how a majority of the AIVs were disagreed with, lacking clarity and emotion, but also what led some participants to (slightly) agree with some of them praising their clarity, aesthetics, and depicted topics. The last sub-section hence gives insights into *all* three sub-RQs, i.e. the specific *reasoning* for agreeing or disagreeing with the AIVs compared to other visuals about climate change.

4.3.1 Information Visualizations – Clear Scientific Proof vs. Lack of Emotive Power

The information visualizations were most often of all five visual types situated in the undecided column by participants (22 times, 40% of undecided column is represented by information visualizations across the whole sample). Left and right from the undecided column, on the disagreement and agreement side, participants sorted an almost equal amount. This yielded a mean score of zero. Information visualizations could hence *not* clearly be identified as depicting climate change as important, as advocated by several scholars (Johansson et al., 2010; O'Neill et al., 2013; Tominski et al., 2011). The following figure 4.2 illustrates this dispersion and accumulation of the information visualizations.

Colums (Dis)agree	-4	-3	-2	-1	0	1	2	3	4
1 Carla			Air pollution	Fossil fuel		Melting ice Temperat.	Weather		
2 Sam			Weather		Melting ice Air pollution Fossil fuel Temperat.				
3 Maarten					Air pollution		Melting ice Weather	Temperat.	Fossil fuel
4 Yvonne					Melting ice Air pollution Temperat.	Fossil fuel		Weather	
5 Pedro				Air pollution		Weather	Melting ice	Temperat. Fossil fuel	
6 Ling	Air pollution	Melting ice	Temperat. Fossil fuel Weather						
7 Jelena				Air pollution	Temperat. Weather Melting ice Fossil fuel				
8 Robin				Temperat.	Air pollution	Fossil fuel Melting ice Weather			
9 Kirsten				Fossil fuel	Air pollution Temperat. Weather Melting ice				
10 Marina		Melting ice	Temperat.	Fossil fuel	Weather Air pollution				
11 Arthur				Weather	Melting ice Air pollution Temperat.		Fossil fuel		
Counts per column	1	2	6	7	22	7	5	4	1
		Sum disagree	16			Sum agree	17		

Figure 4.2: Dispersion of information visualizations per participant per sort column

Information visualizations did not show a noticeable specific dispersion of topics except for 'Air pollution' (table 4.3), which was only sorted on the disagreement area and undecided column. It is unclear why this specific visual within information visualizations performed poorly (no explicit reasoning in post-sorting interview), while overall (across all visual types) 'Air pollution' performed quite strongly.

Information visualizations				
	Disagree	**Undecided**	**Agree**	**Sum**
Air pollution	4	7	0	**11**
Fossil fuel	4	2	5	**11**
Temperature	3	5	3	**11**
Weather	3	3	5	**11**
Melting ice	2	5	4	**11**
Sum				**55**

Table 4.3: The dispersion of information visualizations according to topic – 'Air pollution' not found to depict climate change as important (against overall topic sorting)

The reasoning concerning the information visualizations is mostly divided into two narratives. When agreed with –17 times–, cognitive deliberations were dominant for the sorting. In contrast, when disagreed with or undecided about them –38 times–, some participants used cognitive and most made affective remarks. Especially three (Carla, Maarten and Pedro) of the eleven participants explicitly and clearly engaged in the first narrative while explaining their agreement with the information visualizations. They praised this visual's capabilities for clarity, scientific proof, and objectivity. Moreover, they stressed their own personal background as a dominant reason for agreeing with this particular visual style. Maarten (Bachelor student, Sociology) for example commented "I— as a scientist, or as a wanne-be scientist […]. Cause, I'm […] sort of a numbers guy but, I don't think that […] graphs and bar charts work for everyone as well, as it does for me". In a similar vein, Pedro (Master student, Public Health and Research Policy) said, "This might be biased perception because of my scientific background. So I think I favour clearly the more graphical depictions. […]. They are more objective and clear. And then trustworthy ", and Carla (Master student, Information Management) remarked, "I can actually relate more to it that there is data, that there is an issue, something is going up". These three participants referring to their numeracy skills, and background in science strongly supports Kennedy et al.'s (2016) findings on the influence of people's decoding skills on their engagement with information visualizations. Maarten was however the only one of the *whole sample* who furthermore explained his sorting by referring to the utter importance of the *absence* of emotion in the communication of climate change: "If you remove the emotion from the whole […] issue […] it would be a better discussion, a more constructive discussion". This view was unique, as all the other participants of the sample, including Carla and Pedro at some point, referred to the importance of being touched to a certain extent by climate change visualizations.

Indeed, this need for emotions in climate change depiction was strongly mentioned by the people either disagreeing or being undecided about the information visualizations. Although, not

understanding or not having the time for understanding appeared among the explanations for disagreement[15], most participants *missed emotions* when viewing the information visualizations[16]. Sam (Master student, Health Care Management) for instance noted, "All these graphs and diagrams, they I guess you could say they don't really inspire that much emotion. […]. They are very cold you could say. Very logical, purely informative". Ling (Bachelor student, Arts, Culture and Society) said, "I think they are very trustworthy but they just don't have the power to remind people how serious the problem of climate change is". And Kirsten (communications manager) summarized the issue with information visualizations as follows, "I think this has also something to do with emotions and statistics that they are, ja, very— it's information, but it's just that".

The majority of participants making recurring references to their lack of emotion and power in depicting climate change as an important topic, supports the notion raised by several scholars: for a rational, scientific topic such as climate change, viewers do not only consider cognitive, but also emotional aspects (Moser, 2009; O'Neill & Smith, 2013). Concerning sub-RQ 1 it can be ascertained: Although facts are certainly important in climate change communication, to the majority of participant information visualizations were (a) not understandable or not considered worthy the time (cognitive), and most importantly (b) they were incapable to induce emotions. This latter point however was a decisive criteria for most participants concerning the engagement with climate change. Therefore, more than cognitive engagement is needed to engage viewers with climate change. As the next two sections will show, this was often evoked through the visual types of photos, and artistic simulations.

4.3.2 Photos – Clarity and Directness

As mentioned above, photos were by far the most agreed with visual of the five visual types in depicting climate change as important. They were sorted on the agreement side (plus one, two, three, four column) 35 times. This led to 32% of the agreement column across the whole sample and of all visual types being represented by photos. Considering the most agree column plus four, a photo was 7 out of 11 times chosen over the other four visual types as making participants most feel that it depicted climate change as important. This visual type has the highest average score of the five different visual types: plus one on the scale ranging from minus to plus four. On average, participants hence slightly agree with photos as depicting climate change as important. Thus, this result supports scholars' findings on photos depicting climate change as an important issue (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). The dispersion of photos across the columns and sample in figure 4.4 shows a clear skewed distribution towards the agreement columns. This strong agreement with "main stream photos" suggests that many participants possibly did not consider the concept of novelty in the depiction of the issue as important. This was theorized above as an important feature in climate change communication (Lorenzoni et al., 2007; Moser, 2009; O'Neill & Smith, 2013).

[15] Cognitive deliberations for disagreement: Ling and Marina.

[16] Affective deliberations for disagreement: Sam, Ling, Jelena, Kirsten, Arthur.

Colums (Dis)agree	-4	-3	-2	-1	0	1	2	3	4
1 Carla				Fossil fuel	Air pollution Weather		Temperat.		Melting ice
2 Sam					Weather	Temperat.	Melting ice	Air pollution	Fossil fuel
3 Maarten						Air pollution Fossil fuel Temperat.	Weather	Melting ice	
4 Yvonne					Fossil fuel Temperat.		Air pollution	Weather	Melting ice
5 Pedro					Fossil fuel	Weather	Temperat. Melting ice		Air pollution
6 Ling					Fossil fuel	Air pollution	Weather	Melting ice	Temperat.
7 Jelena				Weather Fossil fuel			Temperat. Melting ice	Air pollution	
8 Robin		Weather	Temperat. Melting ice	Fossil fuel			Air pollution		
9 Kirsten		Fossil fuel					Air pollution Weather	Melting ice	Temperat.
10 Marina				Melting ice Weather	Temperat.	Fossil fuel		Air pollution	
11 Arthur			Weather	Temperat.		Air pollution	Fossil fuel	Melting ice	
Counts per column	0	2	3	7	**8**	8	13	8	6
		Sum disagree	**12**			**Sum agree**	**35**		

Figure 4.4: Dispersion of photos per participant per sort column

Explanations for sorting the photos on the agreement side were recurring among all participants: "clarity", "reality", "directness", and "immediacy". The clarity of photos allowed participants to be especially cognitively engaged, i.e. understand what is happening in climate change, while their immediacy and directness also triggered affective responses (sub-RQ 1). The following comments serve as representative examples of these recurring criteria. Maarten (Bachelor student, Sociology) noted that "they are visual and they are clearly depicting of what's happening". Ling (Bachelor student, Arts, Culture and Society) said, "I immediately know what it is, I don't even need to think about it". Sam (Master student, Health Care) summarized, "as the saying goes 'A picture is worth a thousand words'". No explanations for disagreement were voiced, which suggests that participants held no strong opposition against photos in general in the communication of climate change. As the following table 4.5 reveals, especially 'Air pollution' and 'Melting ice' were found as depicting climate change as important. Explanation referred to both the importance of the depicted issue for the climate, and also to their strong clarity of depiction.

Photos				
	Disagree	**Undecided**	**Agree**	**Sum**
Air pollution	0	1	10	**11**
Fossil fuel	4	3	4	**11**
Temperature	2	2	7	**11**
Weather	4	2	5	**11**
Melting ice	2	0	9	**11**
Sum				**55**

Table 4.5: The dispersion of photos according to topic – 'Air pollution' and 'Melting ice' visual especially found important (in line with overall sorting of topics, and due to clarity)

4.3.3 Artistic Simulations – Clarity and Emotion vs. Extremism and Credibility Deliberations

Artistic simulations have the second highest agreement amount after photos across the sample. Although only two artistic simulations are situtaed on zero, their average score lies at zero, as the plus (27 times agreement) and minus columns (26 times disagreement) cancel each other out, illustrated in the pattern in figure 4.6.

Colums (Dis)agree	-4	-3	-2	-1	0	1	2	3	4
1 Carla		Weather	Temperat.			Air pollution Melting ice		Fossil fuel	
2 Sam			Weather	Melting ice		Temperat.	Fossil fuel Air pollution		
3 Maarten		Air pollution	Fossil fuel	Melting ice Temperat. Weather					
4 Yvonne	Temperat.	Weather Air pollution	Melting ice	Fossil fuel					
5 Pedro	Fossil fuel	Weather Melting ice		Temperat.		Air pollution			
6 Ling					Temperat.	Melting ice	Weather Fossil fuel	Air pollution	
7 Jelena	Temperat.					Melting ice	Weather	Air pollution	Fossil fuel
8 Robin			Temperat.				Air pollution Weather	Melting ice Fossil fuel	
9 Kirsten	Temperat.		Air pollution	Weather		Melting ice		Fossil fuel	
10 Marina						Weather Fossil fuel	Air pollution Melting ice Temperat.		
11 Arthur		Temperat.		Weather Air pollution	Melting ice			Fossil fuel	
Counts per column	4	7	6	9	2	9	10	7	1
		Sum disagree:	26			**Sum agree**	27		

Figure 4.6: Dispersion of artistic simulations per participant per sort column

This wide dispersion of the artistic simulations on either the disagreement or agreement side suggests that participants held strong opposing opinions on this visual type. There was no wider agreement as seen with the photos at 4.3.2. Instead there existed a larger controversy on this visual type's ability to depict climate change as important. Indeed, two opposing main narratives emerged in the post-sorting interviews.

Participants who sorted all (five) or four of the artistic simulations on the agreement side (four participants: Ling, Jelena, Robin, Marina) praised them for their capability for clarity, directness, strong and immediate emotion, and creativity. These criteria are illustrated by the following statements. Ling (Bachelor student, Arts, Culture & Society) for instance commented, "So, it makes me feel great, because it's a combination of both reality and imagination. And it makes you feel. This art makes you feel". Jelena (sports masseuse / illustrator) said, "They are realistic but in an artistic way. It's really clear because the subject is shown but in a clear way". And Robin (carpet store owner) mentioned, "These show me the seriousness of this problem. […]. I could see what is happening in the world, with the climate. And ja, the artistic pictures show me that". These comments also illustrate that when described in this way, the artistic simulations were not necessarily seen as apocalyptic (as expected by the researcher). Instead, most of the agreeing participants described them as rather realistic visualizations of the present state in certain parts of the world, or the near future.

Other participants dispersed some of the artistic simulations on the disagreement, some on the agreement area (four participants: Carla, Sam, Kirsten, Arthur). They employed similar agreement explanations as mentioned above. Sam (Bachelor student, Health Care Management), "I guess you could say it's the concept of it, the combination of artistry and of […] air pollution, it's something about this combination that tells me this is a real depiction that there is a problem of climate change". Kirsten (communications manager) in a similar vein said, "It's clear […]. I see this working on a billboard. I think this really shouts out the message".

As the following table shows, three topics were more agreed with than the other two topics. 'Fossil fuel' featured animals (polar bears) as the only visualization, which often triggered strong responses as it showed the impact of climate change on animals. The 'Air pollution', featuring a person (Mona Lisa), often led to comments concerning the impact on humans. This might s*uggest* that a visualized impact on humans and animals renders climate change more important.

Artistic simulations				
	Disagree	**Undecided**	**Agree**	**Sum**
Air pollution	4	0	7	**11**
Fossil fuel	3	0	8	**11**
Temperature	8	1	2	**11**
Weather	7	0	4	**11**
Melting ice	4	1	6	**11**
Sum				**55**

Table 4.7: The dispersion of artistic simulations according to topic – 'Air pollution', 'Fossil fuel' and 'Melting ice' visual especially vis-a-vis 'Weather' and 'Temperature' salient to participants (in line with overall sorting of topics, and due to perceived clarity and depicted content)

In contrast to the agreeing participants, participants who strongly *opposed* to all or almost all artistic simulations (three participants: Maarten, Yvonne, and Pedro), and participants who sorted some on the disagreement side (the four participants from above: Carla, Sam, Kirsten, Arthur) criticized them for being too unrealistic. They were perceived as being too extreme and dramatic depictions of the issue of climate change. When disagreed with, artistic simulations hence created credibility issues. Especially 'Temperature' and 'Weather' were more often disagreed with than the other three topics. Yvonne (Bachelor student, Fine Arts) for instance said about the 'Weather' artistic simulation, "It's so extreme that it's almost unbelievable that this would be the impact of climate change". Next to credibility issues, some participants even felt repulsion due to this visual's style. Pedro commented, "Visually it's just really tasteless […]. A really bad combination. […] Awful. […] Repulsive". Although perceived as clear, the artistic simulations were disagreed with due to their extremism and unreality. This criteria hence overrode the criteria of clarity, as Carla (Master student, Information Management) notes, "I kind of get, what the artist is trying to say, but um, I— yeah, I think it's a little too drastic".

The agreement and disagreement rationales illustrate how artistic simulations were perceived as clear both among agreeing and disagreeing participants. Moreover they were very much capable to appeal to the emotional side, however both in a positive and negative way. Thus, participants engaged both in cognitive (clear, able to depict climate change), and emotional deliberations (suitability of drastic depictions), while the latter divided opinions (sub-RQ 1).This shows that emotion is important in climate change communication, but also that there is a limit: when the visual is perceived as too extreme, this is counterproductive for the engagement with climate change, i.e. seeing climate change as important. Even the majority of the eight *agreeing* participants (except Jelena) indicated feelings of helplessness and sadness. This finding mirrors past studies on apocalyptic news photos of climate change. Although yielding feelings of importance, they also undermined participants' feelings of being able to *do* something about climate change (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009).

4.3.4 Cartoons – Clarity and Humour vs. Inappropriateness of Humour for Climate Change

The cartoons were almost evenly distributed on the agreement and disagreement side, while a significant amount also accumulated in the undecided column. This pattern can be seen in detail in figure 4.8 below. Cartoons, as the artistic simulations, also largely divided opinions not only between participants but also among the same participant concerning different cartoons. Not a single participant agreed with all cartoons. Among the most dominant reasoning narratives were the cartoons' clarity of depiction and sense of humour. The latter split participants' opinions, as some cartoons' humour was seen as a valuable addition to the serious climate change debate, and others found unsuitable.

Colums (Dis)agree	-4	-3	-2	-1	0	1	2	3	4
1 Carla				Fossil fuel	Air pollution Temperat.		Weather	Melting ice	
2 Sam			Temperat.	Weather		Air pollution Melting ice		Fossil fuel	
3 Maarten		Fossil fuel			Air pollution Melting ice Weather	Temperat.			
4 Yvonne			Fossil fuel	Melting ice Weather Temperat. Air pollution					
5 Pedro				Weather	Fossil fuel Melting ice Temperat.	Air pollution			
6 Ling		Temperat.		Melting ice Air pollution Fossil fuel	Weather				
7 Jelena				Air pollution	Weather	Melting ice Temperat. Fossil fuel			
8 Robin	Weather				Temperat. Melting ice Fossil fuel				Air pollution
9 Kirsten		Weather	Temperat.			Air pollution Fossil fuel	Melting ice		
10 Marina	Temperat.		Fossil fuel		Weather			Air pollution	Melting ice
11 Arthur	Weather	Temperat.				Fossil fuel Air pollution Melting ice			
Counts per column	3	4	4	11	14	12	2	3	2
		Sum disagree	**22**			**Sum agree**	**19**		

Figure 4.8: Dispersion of cartoons per participant per sort column

When cartoons were agreed with, especially either their clarity or their humour were praised, in some cases (three participants: Carla, Jelena and Kirsten) both were cherished equally. Especially the 'Air pollution' and 'Melting ice' cartons elicited agreement, in line with the overall preference of certain topics in the communication of climate change, but also connected to their perceived clarity (table 4.9).

Cartoons				
	Disagree	Undecided	Agree	Sum
Air pollution	3	2	6	**11**
Fossil fuel	5	2	4	**11**
Temperature	6	3	2	**11**
Weather	6	4	1	**11**
Melting ice	2	3	6	**11**
Sum				**55**

Table 4.9: The dispersion of cartoons according to topic – 'Air pollution' and 'Melting ice' visual especially salient to participants (in line with overall sorting of topics, and due to perceived clarity)

Across the whole sample, especially Jelena (sports masseuse / illustrator) strikingly and very strongly welcomed the use of humour in climate change communication. She commented:

> "It's really clear, it's really funny at the same time. Because it's funny it makes you open, makes you laugh. And say like 'Hey, actually yeah we should save the planet!' Humour breaks. A laugh breaks a person. A laugh makes you communicate easier with people. And touch easier because you feel touched. In a positive way. Positive wins positive."

In contrast, four of the eleven participants (Maarten, Yvonne, Pedro, Ling) were disagreeing or being undecided about all or most of the cartoons. Their reasoning showed strong aversions against this visual type's style and tone. Pedro (Master student, Public Health and Research Policy) said concerning the former, "[The cartoons] may simplify a bit the question and not so you know—. The pictures [the cartoons] are quite nice you know, depict in a nice way the topic but maybe too nice". Ling (Bachelor student, Arts, Culture and Society) noted regarding the use of humour, "And they were about light things, you know very kind of relaxing things. So when they [the cartoons] are connected to this serious topic of climate change […] I just didn't get used to it in connection with this serious topic of climate change".

When participants (mostly four: Carla, Kirsten, Marina, Arthur[17]) sorted cartoons across the different areas of disagreement, indecisiveness and agreement, they agreed when the cartoon was found clear. However, they drew boundaries when they perceived the cartoon's message or humour not suitable for the topic of climate change. Marina's and Arthur's statements are exemplary of this

[17] Sam and Robin are taken out of consideration here, as they sorted the cartoons almost entirely based on the depicted topics, and further explicit sorting criteria were not revealed.

reasoning. Marina (accountant), said, “When they put it in that way in a newspaper or in communication in general, it's clearer for all the people. […]. But I think this is about too much humour”. Arthur (art dealer/art café owner) noted, “Because this one for me says it all. You see the pollution […]. They show instantly what they shout. […] But this is like humour […]. Humour, like funny, and it's not a funny subject”.

These findings add to scholars who pointed towards cartoons’ important role in climate change communication (Manzo, 2012) in indicating certain *conditions*, as participants engaged in morality deliberations. When agreeing, the cartoons’ clarity and humour were mentioned. When disagreeing, their simplification, embellishment, humour, and cartoon message were not found appropriate for the serious topic of climate change. Hence, when a certain line in style and tone was crossed, cartoons were not found to depict climate change as important. Thus, participants engaged both in cognitive (clear, able to depict climate change), and emotional deliberations (suitability of humour), while the latter divided opinions (sub-RQ 1).

4.3.5 AIV – Lack of Clarity and Emotion vs. Aesthetics, Some Clarity and Topic Sensitivity

This section turns to the focal visualization type of this Master thesis, and sets it in relation to the preceding four visual forms. AIVs were by far the visual type the most disagreed with in depicting climate change as important. They have the lowest average score of the five different visual types: minus one; participants on average hence slightly disagreed with them. Most participants showed hesitating behaviour during the sorting, i.e. took more time to place them, or had a second glance. Figure 4.10 shows a clear accumulation of AIVs in the disagreement and undecided columns.

Colums (Dis)agree	-4	-3	-2	-1	0	1	2	3	4
1 Carla	Weather	Air pollution	Temperat.	Fossil fuel	Melting ice				
2 Sam *(moved AIV to left)*	Weather	Temperat. Air pollution		Fossil fuel Melting ice					
3 Maarten	Temperat.		Weather Fossil fuel	Air pollution	Melting ice				
4 Yvonne *(changed AIV)*						Temperat. Melting ice Air pollution	Weather Fossil fuel		
5 Pedro			Melting ice Temperat. Fossil fuel	Air pollution	Weather				
6 Ling				Temperat.	Air pollution Fossil fuel	Melting ice Weather			
7 Jelena		Weather Temperat.	Melting ice Fossil fuel Air pollution						
8 Robin *(changed AIV)*		Weather		Melting ice Air pollution	Temperat.	Fossil fuel			
9 Kirsten			Temperat.	Weather Fossil fuel	Melting ice	Air pollution			
10 Marina *(changed AIV)*		Temperat.	Weather	Melting ice	Fossil fuel	Air pollution			
11 Arthur			Temperat. Weather		Air pollution		Fossil fuel		Melting ice
Counts per column	3	7	13	11	**9**	8	3	0	1
		Sum disagree	**34**			**Sum agree**	**12**		

Figure 4.10: Dispersion of AIVs per participant per sort column

It can be observed that some topics vis-à-vis other topics were somewhat more represented on the agreement and disagreement side (table 4.11). This was first of all connected to the respective depicted topic in line with the overall preference of certain topics in the communication of climate change. At times it also referred to their specific visual properties: the degree of abstraction and thus clarity. 'Fossil fuel and 'Melting ice' (both by Jill Pelto, similar artistic style and clarity) were for instance by several participants described as being clearer depictions of climate change than 'Temperature' and 'Weather'. This suggest that some AIVs were perceived as being more suitable than other AIVs.

Five of the eleven participants disagreed with the AIVs depicting climate change as an important topic or were undecided about them. Six participants showed slight agreement with some of the AIVs, among them solely Arthur, who sorted an AIV in the most agree column. The disagreement and agreement rationales are described in more detail in the following two sections.

Artistic information visualizations				
	Disagree	**Undecided**	**Agree**	**Sum**
Air pollution	6	2	3	**11**
Fossil fuel	6	2	3	**11**
Temperature	9	1	1	**11**
Weather	8	1	2	**11**
Melting ice	5	3	3	**11**
Sum				**55**

Table 4.11: The dispersion of AIVs according to topic (in line with overall sorting of topics, and due to perceived clarity)

Criteria for Disagreement: Lack of Understanding and Emotion

The disagreement sorting criteria for the AIVs reveal that this visual type does not fulfil the overall criteria of clarity, reality and immediacy. This was mainly due to a lack of understanding them, and insufficiency of perceived connection to the issue of climate change (cognitive deliberations). The sub-RQ question concerning their capability for information provision in climate change communication (sub-RQ 1a) has hence to be negated, at least for a majority of AIVs.

However, disagreement did not necessarily only include negative descriptions. Even disagreeing participants (Carla, Sam, Maarten, Pedro, Jelena) found several positive descriptions outside of the cognitive spectrum of not understanding. For instance "nice", "interesting", and "beautiful" were mentioned. However, they were usually followed by a "but not understood", or "but no clear connection to climate change". Although people might like the AIVs, not understanding them hence became a dominant explanation, and overrode their aesthetic appeal, or interesting nature. This shows how aesthetic appeal and interest are not enough in climate change communication (except to some degree to Ling, see below). Recognisability and clarity are of extreme importance and an artistic style might be liked by itself, but does not alone guarantee people's agreement with it in depicting climate change as important. In contrast, several participants voiced their concerns about the artistic style of the AIVs as actually distracting from the climate change issue.

Next to a lack of understanding, another dominant criterion for disagreeing with the AIV was their incapability to create *strong* emotions. Kirsten (communications manager) for instance was among the few participants (as Carla, Pedro, Jelena) who said that she understood *some* of them. However, although she did like them for their aesthetic appeal, she was not sufficiently emotionally touched when connecting it to the climate change issue, "It's beautifully made but it's not really giving me that sense of emotion and impact". Similar remarks concerning a lack of emotion were articulated by other participants (especially by Sam, Ling, Jelena, Kirsten, and Marina). Ling (Bachelor student, Arts, Culture & Society) said, "It's just like I am kind of blank when I see these kind of pictures. Because it doesn't make me connect. […]. You cannot gather strong feelings about it". Furthermore, novelty – suggested in the theory section to be one possible major advantage of AIVs in the communication of climate change – was not a dominant sorting criteria. It was not articulated by a single participant him- or herself in the post-sorting interview. When asked by the researcher, some participants (Carla, Ling, Robin, Kirsten) then characterized the AIVs indeed as being novel depictions in the communication of climate change. However, this characteristic was not deemed important enough to render the AIVs agreeable. Following statements on "novel", usually these participants then also said "but not emotive enough", "but not meaningful enough", or "but not understood". Others (Jelena, Arthur) explicitly did not consider them novel. Thus, the sub-RQ question concerning AIV's capability for strong emotional responses and the importance of novelty in climate change communication (sub-RQ 1b) have also to be negated for the majority of AIVs.

In sum, among disagreeing participants, the AVIs appear to only score on either being liked in terms of aesthetics or interest, or in rare cases on being understood. Neither of them however was enough to engage the viewers, i.e. to make them feel climate change is important. The other visualization forms, especially photos and artistic simulations, appear to have fulfilled the clarity and emotion criteria better.

Criteria for Agreement: Aesthetics, Clarity, and Topic Sensitivity

Although the majority of AIVs were sorted on the disagreement side, the question arises why some people slightly agreed with the AIVs, and why one participant sorted one AIV on the most agree column. Across the sample, three scenarios emerged. Two participants (Ling, Kirsten) sorted one or two of them on the plus one column. Three participants (Yvonne, Robin, Marina) changed their sorting towards agreement after more explanations were given. Solely Arthur sorted an AIV in the most agree column. In the following it is fathomed what triggered these sorting behaviours.

Further investigation of the first sorting scenario reveals that although Ling (Bachelor student, Arts, Culture and Society) found them confusing, she majorly considered their aesthetic appeal, and less their suitability for climate change communication. She recognized herself that, "I think these are really good art works, but I focus more on the art work itself rather than what it represents. […]. I would focus on her work more than the problem of climate change itself". Kirsten (communications

manager) in contrast sorted the AIVs in the plus column majorly because of the depicted topic of air pollution, which had a high personal importance to her.

The second scenario illustrates how further information might increase agreement with the AIVs for at least some people (Yvonne, Robin, Marina), who were receptive to additional explanations. This is most striking for Yvonne's (Bachelor student, Fine Arts) sorting behaviour and reasoning. After being given explanations, she re-sorted four AVIs she had previously placed on the disagreement area. After the re-sorting, all the AIVs made her feel climate change is important. Of all participants she showed the greatest curiosity and interest in the AIVs. As re-sorting reasoning she indicated an increased understanding. She explicitly and strongly praised the mix of data and art (strikingly as *only* participant of the whole sample), "I really like how they […] use data in them to give the message of climate change. The way they combine the data with their art and their perception of it. […] Clever!". Furthermore, she deeply enjoyed the aesthetics, "I like the colours used in them and that there is like this serenity, this calmness".

Arthur (art dealer/art café owner) was the only participant of the whole sample who sorted an AVI in the most agree column. His sorting criteria proved to be three-pronged (topic-clarity-art): "It was really connected to the melting ice and fossil fuel. […] {They explain} instantly what they mean. So that's an advantage when they are clear. […] And when the art is with it, and it's instantly combining the problem, then that makes it stronger".

In sum, the following can be ascertained about the AIVs visual properties (sub-RQ 1a, 1b), based on participants' disagreement and agreement rationale. The theorized AIVs' potential in uniquely combining data and art – facts for cognition and credibility on the one side, and art for the emotional touch on the other– could *not* be determined[18]. The AIVs only in one case elicited references to their fact-based artistic tone. Frequent comparisons (largely *both* when agreeing and slightly disagreeing) were made to other visual types (mostly photos and artistic simulations). These were often found as more suitable in the communication of climate change than the AIVs, because of their clarity and emotion. Even the pragmatic information visualizations (although overall performing quite poorly themselves lacking the evocation of emotional responses) scored better than the AIVs. Only in rare cases were some AIVs agreed with and liked aesthetically (Ling), their combination of data and art explicitly cherished (Yvonne), and their power in clarity praised (Arthur).[19] Seeing how Ling, Yvonne and Arthur are all connected to an educational background in the arts, leads to the next section and sub-RQ question 2, how an arts background might be connected to the perception of the artistic visualizations.

[18] For the majority of participants *of this study* and for the investigated AIVs.

[19] Leaving out Robin, Kirsten, Marina because their reasoning was referring to *topic* criteria only.

Is Art Interest or Education Connected to Engagement?

Are the AIVs possibly in many cases not or little agreed with because participants are lacking sufficient interest or education in the arts to interpret them? As the short surveys revealed, a lack of interest in the arts *cannot* be identified across the sample. Not a single participant stated to be disinterested in the arts, and only two indicated a neutral opinion in the survey. The rest was slightly or even highly interested in the arts. At first glance, this hence does not appear to be driving the lack of agreement. However, possibly more than interest in the arts in the sense of free time occupation[20] is needed to engage people with the AIVs. Indeed, some participants (Carla, Pedro, Robin) stated they believed that someone with a stronger artistic background might be more capable to interpret the AIVs. These statements were not voiced regarding the other palpably artistic visualizations of artistic simulations, or cartoons. For AIVs it appears however that art expertise indeed is believed to have an influence. Carla (Master student, Information Management) for instance said, "I think people who are more into art might make more sense of them, um. What I could imagine is that they are more trained to look at specific details, simply because they know more about artistic styles, about drawing types, and collaging or whatever you want to call this". In a similar vein, Pedro (Master student, Public Health and Research Policy) stated that, "Possibly with an artistic background we would see […] possibly ja particularly this mad looking art to the right side, higher on the scale". And Robin (carpet store owner) commented, "I think my daughter who is doing arts, she has maybe a better view to see the meaning of the pictures [points at AIVs]".[21]

A closer look at the participants *with* arts education (Yvonne, Jelena, Ling, Arthur) first however reveals vastly different *sorting* behaviour and hence different reactions to the AIVs. A clear recurring pattern among arts experts *cannot* be identified in the sorts, for example that they all strongly agree with them. One (Yvonne) sorted all of them on the agreement side. Another (Jelena) disagreed with all of them. The third (Ling) was partly and slightly convinced, and the fourth (Arthur) was partly and strongly agreeing. However, the arts experts do appear on the agreement side quite dominantly when compared to art "novices"[22]. This becomes even more significant, when those agreeing participants are left out, who sorted according to *topic* rather than the AIVs' particular properties (Robin, Kirsten, Marina; all non-arts education). It is furthermore striking that the one person of the whole sample who agreed with all AIV (Yvonne) is indeed pursuing a Fine Arts degree, and that the most agreed AIV was sorted by a professional art dealer (Arthur).

Moreover, when one investigates the art experts' sorting reasoning in more detail, it becomes clear how art experts appear to show an increased understanding and pondering of aesthetics, even when

[20] See list of participants' interest in art in the appendix A, table A4.

[21] These comments were not made concerning a need for a scientific background to understand the AIVs better. As a possible reasons could be stated that AIVs were majorly simply not seen as a *combination* of data and art (except for by Yvonne), but mainly just as artistic works, even by participants with science background.

[22] Defining art experts as holding an academic education and training in the arts, while art novices are not educated in the arts, but might be *interested* in art and culture.

disagreeing with the AIVs, or when only slightly agreeing with them. Ling strongly focused on the AIV's aesthetic appeal, and although Jelena was disagreeing with all AIVs, she did claim to understand them very well. Her sorting criteria for not agreeing with them actually referred to a strong disapproval of their aesthetics. Yvonne as already elaborated upon earlier, strongly considered both aesthetics and cognition. Arthur praised clarity and art.

Among the art experts the opinion concerning the need for artistic expertise to make sense of the AIVs is split. Yvonne and Arthur believed that "they are pretty direct I think. And also because you have the caption below. It gives you a little bit of information and tells you what is depicted. Um. Like everybody's perception is different but I think that it's pretty clear that this is about climate change" and that "Everyone would understand it". In contrast, Jelena and Ling thought that not everyone will easily make sense of the AIVs.

Thus, the previous paragraphs allow responding to sub-RQ 2. They suggest (although very much with care given the small sample size) that an arts education background does appear to influence their engagement vis-à-vis people without arts education (but interest in the arts). Art experts do appear to be more involved with the AIVs (manifested through stronger opinions on aesthetics and understanding both when disagreeing and agreeing) than people without an educational arts background. This finding supports Silvia's (2005) appraisal theory and Bourdieu's (1979) conception of cultural capital. It might suggest that AIVs could be especially targeted at art experts (artistically educated audiences such as arts students and artists), rather than the general public. People with science background could not be connected to engaging more with the AIVs. As no participant was educated both in science and art, it is left open how they would engage with AIVs.

Audience Perceptions of AIV's Role in Climate Change Communication

The illustration of the visual type sorting above in section 4.1 already revealed that a clear cut between *artistic* and *non-artistic* visuals cannot be observed in the sorts across the sample. Seeing how another palpably artistic visual type – the artistic simulations – is spread across the whole agreement to disagreement spectrum suggests: the AIV's general accumulation in the disagreement column is *not* connected to a general opposition against art's involvement in climate change communication. Indeed, statements connected to this matter were *not* voiced by participants themselves in the post-sorting interview about their sorting criteria. This might hence not have been a *primary* reason during the sorting. It could certainly still have played a role without the participants explicitly voicing their opinion to the researcher. Therefore, questions concerning these themes were initiated by the researcher. This revealed: Not a single participant strictly opposed the arts in general to be involved in climate change communication. However, at times participants showed hesitation concerning art's involvement as art's power was doubted in actually *being able to change* something (Sam, Maarten, Yvonne). Furthermore, other entities were frequently voiced as more effective actors to be involved in climate change communication (task for science, task for politics), mostly due to artist's lack of scientific subject knowledge (Sam, Maarten, Pedro). Some few participants (Maarten, Pedro)

considered themselves as not receptive to art at all. This however did not translate into an opposition against art's involvement. They simply found art to be more suitable for other people.

Statements connected to how trustworthy the artistic sources were considered in climate change communication were also *not* voiced by participants themselves in the post-sorting interview about their sorting reasoning. Questions concerning these themes initiated by the researcher revealed: Overall, participants did *not* voice any general distrust in the arts communicating about climate change. However, when asked who they trusted (in general) in the communication of climate change, many participants (Sam, Maarten, Yvonne, Pedro, Ling, Kirsten, Marina) either indicated scientific entities, or environmental organizations. This is in line with Hagen et al.'s (2015) findings on the most trusted sources in the communication of climate change. Some compared the arts to these scientific or environmental entities, and although overall not distrusting the arts, certified the former a higher reliability. Pedro (Master student, Public Health and Research Policy) for instance said, "I would say [artistic visuals] are less reliable in their objectivity. […] They [information visualizations] are more objective and clear. And then trustworthy." Maarten (Bachelor student, Sociology) said, "People [communicators of climate change communication] with a scientific background, they are more able to understand the topic."

Moreover, although overall participants mentioned no trust issues in the arts in general, credibility remarks were voiced by participants themselves regarding certain visual types. This was very strong for half of the artistic simulations, as credibility concerns significantly influenced their sorting behaviour. These were however not connected to the *artistic sources* but to the depicted *content* being perceived as apocalyptic. This supports scholars' findings on the importance of trust for engagement with climate change communication (Hagen et al.'s, 2015). At times participants also engaged in credibility remarks (in a positive way) for the pragmatic information visualizations ("objective", "credible"). However, participants did not make themselves any remarks concerning how much they trusted (or doubted) the AIVs in the communication of climate change. They were neither praising them for their data focus, nor questioning the artistic style. Nevertheless, possibly they did not articulate these opinions. To rule out distrust being responsible for the sorting behaviour, the researcher initiated questions concerning this matter. When asked by the researcher, how trustworthy they were considered, the majority of participants, both agreeing and disagreeing with the AIVs, indicated to have (at least some) trust in them. This indication was however usually followed by a "but", hinting at other problems they had with the AIVs. Pedro (Master student, Public Health and Research Policy) said, "Maybe it's objective information but it's actually confusing". In a similar vein Sam (Master student, Health Care) said, "I guess she is a trustworthy source, even if she deals with it in a funny way of you know presenting the image". Ling (Bachelor student, Arts, Culture & Society) mentioned "I still have some trust in them [AIVs] but compared to the others I don't trust them as much". Jelena (sports masseuse / illustrator), "I think, five or six, if I give a number. Five, six [on a ten scale]. […] It's because it's just pure taste. It really doesn't attract me. It's really not clear in my eyes".

This shows how trust concerning AIVs cannot be an explanation for overall wide disagreement or indecisiveness with the AIVs. The restrictions after mentioning the trust (“but”, “even”) suggest how other explanations (sub-RQ 1 and 2 on visual properties and required arts education) appear to be connected to them, and that perceived trust could not make up for these.

In sum, art’s instrumentalization, loss of autonomy and trust considerations theorized in sub-RQ 3 were of no concern to the present sample. Art is hence across the whole sample not opposed to in the communication of climate change, adding to scholars’ debate on how effective the arts are in the communication of highly politicized topics such as climate change (Miles, 2010; Miles, 2014; O’Neill & Smith, 2013). Although participants’ opinions on art’s role in climate change communication (to be involved or to stay out) was not a driving sorting rationale, participants however articulated preferences on *how* the arts should be involved.

A majority (except Yvonne) of the sample referred to a clear, non-abstract, non-ambiguous, and self-explanatory artistic style. Mirroring participants’ stronger agreement with artistic simulations and cartoons, these visual types were mostly mentioned as how the arts should be involved in climate change communication (Carla, Sam, Yvonne, Ling, Jelena, Robin, Kirsten). Some striking statements were made by Jelena and Ling. Jelena (sports masseuse / illustrator) said, “If I am talking about a subject like climate change and I want it to be clear, I should not make it too abstract. […]. So you can be artistic, you can put humour in it, but don't step away too much from the facts”. Ling (Bachelor student, Fine Arts) commented:, “I think it's about communication between the artist and the audience you know. […]. Let me understand it. […]. You must let people understand it because you want them to get aware of it”.

Participants also had quite clear opinions on the AIVs in the communication of climate change. Some participants (Pedro, Ling**)** referred to possibly agreeing with them more in a different *context*, for instance when seeing the original works in a museum. Moreover, participants has some remarks on how the AIVs should be designed when they want to have a say in climate change communication. All participants (except Yvonne who wholeheartedly agreed with all AIVs) mentioned several improvements to the AIVs. In line with the recurring overall clarity criteria of climate change visuals, participants want the AIVs to be more understandable, for instance by being provided with additional legends on the side, indications and meanings. However, some participants (most notably Carla, Ling and Jelena) also question these needed improvements. Carla (Bachelor student, Information Management) for instance pondered this measure to be going against art’s nature, “My question would then just be: Does the art meets its target if it needs tremendous explanation and does not make *myself* [emphasis] think ‘Oh ok something is wrong here’”. Ling (Bachelor student, Fine Arts) did not want anyone to explain the visuals to her, “Because you know, if this is really important, I would have preferred to discover this, the data, by myself rather than have someone explain it to me”, and Jelena (sports masseuse/illustrator) noted, “I don't think they should change. Because every, um— that's the beautiful thing of being an artist, or making art, or wanne make art, wanne-be-artist [laughs]— the most beautiful thing is, there are no rules. So you can make what your heart desires for”.

5. Conclusion

The first section paints a general picture of the research findings, and links them to the employed theories and previous research. The second section focuses on a discussion of limitations concerning the sample diversity, visualization sets, and applied engagement definition. Along the limitation considerations, avenues for future research in climate change visualization and engagement are suggested. The last section then provides policy recommendations, i.e. practical implications for artists, and environmental entities.

5.1 Discussion of Main Research Findings and Implications for Theory and Research

This research focused on audience engagement with climate change visualizations, emphasizing artistic information visualizations (AIVs) and their capability to render the issue of climate change important. Therefore, the main RQ raised was the following:

> *How* engaging in terms of feelings of salience do viewers perceive artistic information visualizations on climate change, and *what reasoning* for felt salience can be identified?

The findings of this Master thesis are two-fold. Concerning the first part of the overall RQ (*how* engaging), the AIVs were found to be the least engaging i.e. their visualizations made participants least feel climate change is important.[23] AIVs to date have not been researched before in climate chance communication, making this the first study to situate them. In contrast, in revealing photos as the most engaging form, this thesis supports previous research in Australia, the United Kingdom and United States, which focused on photos as dominant visualization type depicting *different* climate change discourses (O'Neill et al, 2013; O'Neill & Nicholson-Cole, 2009). However, pragmatic information visualizations, in previous research indeed connected to feelings of salience, could for the Dutch context largely *not* be validated. Furthermore, both artistic simulations and cartoons divided participants' opinions on making them feel climate change is important. See figure 5.1 for an overview of these findings concerning the first part of the overall RQ.

[23] It is herewith stressed that "least engaging" means *in comparison* to the other visualization types, and by this research's particular sample. It is not meant to devalue the AIVs' per se in absolute terms. Moreover, the other visualization types were far from being perfectly able to make viewers feel climate change is important.

Overall discourse: Climate pollution and climate change impacts, i.e. a problem-focused discourse. **Themes:** Pollution, fossil fuel use, temperature increase, intensified weather events, melting ice.	
Visualization form	**Engagement in terms of feelings of salience**
Artistic information visualizations	Previous studies: Not existing This research: *Least* feelings of salience (12 of 55 AIVs engaging)[24]
Information visualizations	Previous studies: Feelings of salience shown in previous studies This research: Unsure about many (22) visuals (17 of 55 info vis engaging)
Photos	Previous studies: Feelings of salience shown in previous studies This research: *Most* feelings of salience (35 of 55 photos engaging)
Artistic simulations	Previous studies: Not existing This research: *Divided* feelings of salience (27 of 55 artistic simulations engaging)
Cartoons	Previous studies: Not existing This research: *Divided* feelings of salience (19 of 55 cartoons engaging)

Figure 5.1: Chosen visual forms, respective tones and resulting engagement with the climate change visualizations

This finding of only little engagement with information visualizations, and AIVs vis-à-vis other visualization types is striking. The latter being the focal point of this thesis were theorized to possess important valuable properties in the communication of climate change, further building upon their pendant, the pragmatic informative visualizations. However, the AIVs even made participants *less* feel to depict climate change as important than their pendant.

The second part of the RQ strived to fathom *why* particular visualizations did (not) make participants feel climate change is important, i.e. investigated their sorting *reasoning*. Given the answer to the first part of the RQ, the investigation of this part especially attempted to ascertain: Why did the AIVs perform *comparatively* poorly? Indeed, the theorized sorting rationales (sub-RQs) helped in understanding this matter. Cognitive and emotional deliberations (sub-RQ 1), and audience art expertise (sub-RQ 2) played a significant role during the sorting. However, a sorting according to an art versus non-artistic style did not emerge, and hence could not explain the little engagement with AIVs (sub-RQ 3). These findings and implications are summarized in the following three paragraphs.

First, it was ascertained that many AIVs for a majority of participants were lacking criteria desired in the communication of climate change. Most participants voiced clarity, immediacy, facts, and emotional impact as important properties, but could not find these in the AIVs. According to many participants, other visualization types, especially the photos, fulfilled these criteria better than the

[24] Meaning of the number indication: Number of visualizations across the sample, which were sorted on the agreement column concerning the statement "This image makes me feel climate change is important", i.e. feelings of salience (see section 4.1).

AIVs. As dominant sorting criteria, an incapability for information provision, and also a lack of evocation of emotions could be identified. Novelty was furthermore not a driving sorting behaviour and reasoning. The combination of art and data was neither mentioned nor largely cherished except by one participant (sub-RQ 1a, 1b). These sorting rationales could imply a need to adjust the theoretical concepts surrounding AIVs for this *particular* complex issue of climate change. AIVs' core competency in being able to show *any* degree of data focus and artistic freedom (Kosara, 2007; Lau & Moere, 2007) might indeed be somewhat limited in *climate change* communication. While for other (less complex) topics, AIVs could well be less representative of data, the issue of climate change might demand a need for certain recognizability, consequently constraining artistic freedom.

Second, this choice between data focus and artistic freedom might also depend on what audience the AIVs are targeted at. This Master thesis research could show that an education in art appeared to support meaningful engagement. These participants praised the AIVs' aesthetics, showed high interest, increased understanding, or acknowledged the clarity of some of the AIVs (sub-RQ 2). Thus, this research supports an art novice – art expert difference for the interest in, and understanding of complex artworks such as AIVs (Bourdieu, 1979; Silvia, 2005). In this way it contributes to theory and research seeing the audience not as a monolithic mass, but acknowledging different audience segments and their relations to the visual. A connection between audience characteristics and *pragmatic* information visualizations could also be ascertained, as especially participants with a science background and numeracy skills found them to depict climate change as important. This thesis could therefore support very recently voiced claims in the field of information visualization pointing toward the urgent need to integrate audience decoding skills into the study of peoples' perceptions of information visualizations (Kennedy et al., 2016). Their recent insights appear transferable to the AIVs for arts (but not for data or science) expertise.[25]

Third, a sorting according to an art versus non-artistic style did not emerge, and hence could not explain the little engagement with AIVs (sub-RQ 3). Although many AIVs were disagreed with, the majority of participants did trust them, and did not show an aversion to their specific role in climate change communication. The little engagement could hence be connected to other explanations mentioned above in sub-RQ 1 and 2. Art's role in climate change communication was mainly accepted. Climate change permeates society and art is an integral part of society. This shows how scholars could be less concerned about art's participation in the climate change debate, *or* abstaining from it, and more about *how* artists could be involved. While AIVs suffered from clarity issues, artistic simulations and cartoons, although performing better than AIVs, still faced problems. Artistic simulations and cartoons were seen as clear, but their dramatic depictions and suitability of humour respectively divided opinions. As theorized by some scholars (Dunaway, 2009; Hannah, 2013; Miles, 2010) artistic apocalyptic depictions might indeed be counterproductive in climate change

[25] Participants with science background did not engage with the AIVs. As no participant held both a background in art and science, it is unclear how they would have engaged with the AIVs.

communication for certain people. For a majority, they even undermined their perceived ability to *do* something about climate change. This adds to previous research on apocalyptic content in news photos leading to helplessness (O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). Cartoons' role in climate change communication is subject to morality deliberations concerning the appropriateness of humour. This finding adds to scholars who pointed towards cartoons' important role in climate change communication (Manzo, 2012) in indicating certain *conditions*: They were found capable to depict climate change as important, if found clear and/or if the humour was perceived as making the issue of climate change more accessible.

Certainly, other possible explanations beyond the sub-RQs have to be considered to fathom the sorting, i.e. the comparable little engagement with AIVs. AIVs were theorized of being a promising visual type in addressing three needs (understandable depiction, credibility, and novelty) in the communication of climate change. Participants however showed a strong occupation with only one of them (clear, understandable depiction). This could explain why the AIVs were performing worse than the other visual types in eliciting feelings of salience for climate change. Participants who would value all needs (understandable, *and* fact-based, and *novel* depiction) might possibly judge them vastly differently than the present sample. It is also important to note that a different context outside of the research setting might engage viewers much more with the AIVs (e.g. life in a museum).

5.2 Limitations and Suggestions for Future Research

Overall, the method used, consisting of a three-part research of survey, q-sort, and semi-structured interview, proved suitable to investigate the two-folded RQ about the how and why of engagement with AIVs.[26] The present research hence supported the suitability of previous scholars' methodological procedures used for climate change visualizations (Nicholson-Cole, 2004, O'Neill et al., 2013; O'Neill & Nicholson-Cole, 2009). Certainly, the design of this research – small-scale, non-random, non-quantitative – does not allow for generalizability. However, this was also not the purpose of this study. In fact, its value lies exactly in its exploration and particularity rather than broad generalizability of the findings. If generalizability is the aim, future research is needed, including a large-scale sample and quantitative considerations (Creswell, 2003; Patton, 2002). Several limitations could be identified concerning what this research strived to achieve, but was nevertheless restricted in. They mainly refer to the sample diversity, the set of visualizations, and applied engagement definition in terms of feelings of salience. These limitations are detailed throughout the following three paragraphs.

First, this research could not include extremely diverse opinions on climate change and interest in art. Not a single participant indicated slight or strong *disagreement* or *disinterest* with climate change

[26] Specifically, the sorting task allowed for a meaningful ranking of visualization types (first part of RQ) and eased participants' reasoning for (dis)agreeing with particular types during the interviews (second part of RQ). The short survey furthermore valuably added to the second part of the overall RQ by accounting for participants' backgrounds (interest in climate change, interest in art, field of education).

issues, or art. This could be connected to the rather homogenous nature of the sample (educated students, and workers in reputable positions). Therefore, future research is desirable. Certainly more viewpoints are needed, but also coming from more diverse social backgrounds (O'Neill et al., 2013) to account for a more complete picture of Rotterdam and Dutch society. This could for instance concern retirees, unemployed people, and low-income groups. Future research could also include participants with both a science and an art background. As the sample did not contain such participants, it is unclear how they would have decoded the AIVs.

Second, the visualizations created some limitations concerning their comparability, indication of sources, and representativeness. It was not always possible to have the exact *same* message depicted in the *different* visuals showing the *same* topic. This was most striking for the artistic simulations featuring animals and a person (animals or persons were not included in other visual types). Future research should hence strive for higher comparability. Furthermore, the visualizations' captions were clear-cut in that they indicated either artists, or environmental entities as communicators. Reality might certainly be more blurry. Future research could investigate a collaboration between artists and environmental organizations. Moreover, certainly, the visualizations cannot cover all topics surrounding climate change. Some participants missed topics important to them, such as meat consumption or deforestation. Thus, future research could include other salient topics. The individual visualization forms were furthermore clearly not representative of all styles available for that form. Some AIVs for instance were judged clearer and hence more agreed with than other AIVs, suggesting that some AIV styles might be more suitable than others. Consequently, future research focusing on AIVs could include d*ifferent styles* of AIV, i.e. a change of degree of abstraction and ambiguity, on the *same topics*. This would allow adding to insights concerning the struggle between data focus and artistic freedom (Kosara, 2007).

Third, this research focused on engagement in terms of feelings of salience, as an investigation of a behavioural shift, and hence long-term study, was outside the realm of feasibility of this Master thesis. A study of a behavioural engagement after exposure to climate change visualizations would however certainly be relevant to consider. Behavioural engagement goes beyond mere cognitive deliberations, and could manifest itself in a support for climate change adaptation and mitigation strategies to climate change (Miles, 2014; Miles, 2016; O'Neill & Smith, 2013). Future research could hence study the existence and nature of a connection between exposure to climate change visualizations and behaviour, for instance voting and consumption behaviour. Several different visualization forms, as this research showed, could be included to allow for meaningful comparisons. Questions to be addressed could refer to the following: Do visualizations which elicit feelings of salience also produce a willingness to change or actual behaviour change? What (artistic or non-artistic) visualizations trigger most action for whom?

5.3 Policy Recommendations

The research findings show practical implications especially for two groups: environmental organizations and artists. First, the findings have implications for communication strategies of environmental organizations. Based on this sample's preference, they would be advised to focus on photos to depict climate change as important. The dominant criteria of clarity, reality and immediacy mostly referred to this visual type. Given the audience research findings, information visualizations could be targeted at audiences with a scientific background and numeracy skills (e.g. workers in scientific fields, students in data management). Second, the findings could have implications for (data) artists interested in getting or being already involved in climate change communication. This research showed what kind of involvement of the arts most participants prefer in the communication of climate change: clear, non-abstract, direct, self-explanatory art. Thus, artists could communicate artistic simulations and cartoons, but should be aware of the potential controversies around a too extreme content or too much humour for the topic of climate change. Moreover, the desire for clear art illustrates how an interpretive or ambiguous artistic style of the AIVs is, at least by most of the participants of this sample, not preferred in the communication of the topic of climate change. Data artists could however differentiate between different audiences and the art works they expose them to. When targeted at the general public, they could provide more explanations to make viewers feel that AIVs depict climate change as important. When targeted at audiences with educational arts background (e.g. artists, arts students), data artists could show more abstract and ambiguous styles. These implications should however not be understood as *required* directions for (data) artists in climate change communication. They merely state what the participants of this thesis' sample preferred and could be taken as *possible* paths. Any artist, who is passionate about becoming involved in climate change communication to raise awareness, feelings of salience, or to motivate sustainable lifestyle changes, deserves encouragement, no matter what artistic style s/he aims to follow.

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Appendix

A. Overview of Respondents and Respondent Information

#	Date	Duration	Name	Age	Gender	Education	Resi-dence	Nationa-lity	Occupation	Interest & expertise art / Interest in climate change
6 students enrolled in different study programs:										
1	13.04	1:03:32	Carla	29	F	Current Master student in Information Management	Rotter-dam	German	-	Slight interest / Slight interest
2	15.04	57:12:00	Sam (=alias)	24	M	Current Master student in Health Care	Rotter-dam	Norwe-gian	-	Neutral interest / Slight interest
3	15.04	52:05:00	Maarten	27	M	Current Bachelor student in Sociology	Rotter-dam	Dutch	-	Slight interest / Slight interest
4	18.04	1:12:53	Yvonne	29	F	Current Bachelor student in Fine Arts	Rotter-dam	Dutch	Artist	Very interested (Arts education) / Slight interest
5	19.04	1:13:54	Pedro	26	M	Current Master student in Public Health & Research Policy	Rotter-dam	Portu-guese	Medical doctor	Very interested / Very interested
6	24.04	1:03:27	Ling	22	F	Current Bachelor student in Arts & Culture	Rotter-dam	Chinese	-	Very interested (Arts education) / Slight interest

6 workers in different fields with different educational backgrounds:										
7	26.04.	1:25:15	Jelena	38	F	Fine Arts Bachelor	Rotter-dam	Dutch	Sports masseuse / café worker / illustrator	Very interested (Arts education) / Slight interest
8	29.04	1:18:33	Robin	55	M	HAVO	Rotter-dam	Dutch	Carpet store owner and seller	Neutral / Neutral
9	29.04.	52:10:00	Kirsten	33	F	Media and Journalism Master	Rotter-dam	Dutch	Communica-tion manager	Slight interest / Slight interest
10	1.05	58:38:00	Marina	56	F	HAVO	Rotter-dam	Dutch	Accountant	Slight interest / Slight interest
11	3.05	1:09:59	Arthur	43	M	HAVO and art education	Rotter-dam	Dutch	Art dealer / store owner	Very interested (Arts education) / Very interested

Table A1: Overview of respondents

		Survey	Explanation	Sorting	Interview	Total
1	**Carla**	0:05:15	0:03:25	0:14:45	0:39:03	1:03:32
2	**Sam**	0:06:55	0:03:34	0:08:00	0:38:53	0:57:12
3	**Maarten**	0:04:32	0:03:25	0:06:33	0:35:27	0:52:05
4	**Yvonne**	0:05:50	0:03:00	0:10:18	0:51:17	1:12:53
5	**Pedro**	0:09:17	0:03:20	0:13:52	0:45:42	1:13:54
6	**Ling**	0:04:28	0:03:16	0:08:29	0:42:37	1:03:27
7	**Jelena**	0:08:13	0:04:34	0:27:19	0:43:26	1:25:15
8	**Robin**	0:08:23	0:02:32	0:10:50	0:51:52	1:18:33
9	**Kirsten**	0:03:43	0:01:40	0:04:21	0:38:11	0:52:10
10	**Marina**	0:04:55	0:02:34	0:06:15	0:42:49	0:58:38
11	**Arthur**	0:05:40	0:03:49	0:04:30	0:51:29	1:09:59
	Average	0:06:06	0:03:12	0:10:28	0:43:42	1:06:09
	Min	0:03:43	0:01:40	0:04:21	0:35:27	0:52:05
	Max	0:09:17	0:04:34	0:27:19	0:51:52	1:25:15
	Total					12:07:38

Table A2: Times needed for each task per participant, average, minimum and maximum

		CC policy priority	CC worry	CC threat	Interest CC	Interest art	Art education	Science education
1	**Carla**	4	4	5	4	4	No	Yes
2	**Sam**	4	5	5	4	3	No	Yes
3	**Maarten**	4	5	5	4	4	No	Yes
4	**Yvonne**	5	5	5	4	5	Yes	No
5	**Pedro**	5	4	5	5	5	No	Yes
6	**Ling**	4	3	5	4	5	Yes	No
7	**Jelena**	5	4	4	4	5	Yes	No
8	**Robin**	4	3	3	3	3	No	No
9	**Kirsten**	4	4	5	4	4	No	No
10	**Marina**	4	4	5	4	4	No	No
11	**Arthur**	5	5	5	5	5	Yes	No
	Average	4	4	5	4	4		
	Min	4	3	3	3	3		
	Max	5	5	5	5	5		

Table A3: Participants' indications in short survey (of climate change (CC) needing to be a policy priority, being worrying, a serious threat, interest in climate change and interest in art, and education**;** 3 = neutral, 4 = slightly 5 = very)

Participant	Art interest
Carla	Slight: Performances, exhibitions, film festivals, new/local "pop-up" events for arts.
Sam	Neutral: Sometimes I go to art galleries.
Maarten	Slight: I like to visit museums sometimes.
Yvonne	*Very: I am an artist myself and find myself deeply intrigued by senses and being in this world.*
Pedro	Very: Permanently listening to music, reading about the history of arts, and following the cultural agenda.
Ling	*Very: I like performing arts most, basically my focus is how performing arts contributes to the interaction between people.*
Jelena	*Very: Practise myself and look up artists or information about subjects that I need to know.*
Robin	Neutral: (field left empty), interview: "not enough time for the arts".
Kirsten	Slightly: Especially photography and performing arts.
Marina	Slightly: (field left empty), interview: "entertainment"
Arthur	*Very: It's my work and hobby/fun.*

Table A4: List of participants' occupations with art (participants with arts education in *italics*); from first part of research – short survey

B. Climate Change Visualizations

Artistic information visualizations

(artist source, present climate pollution and impacts/problem-focused)

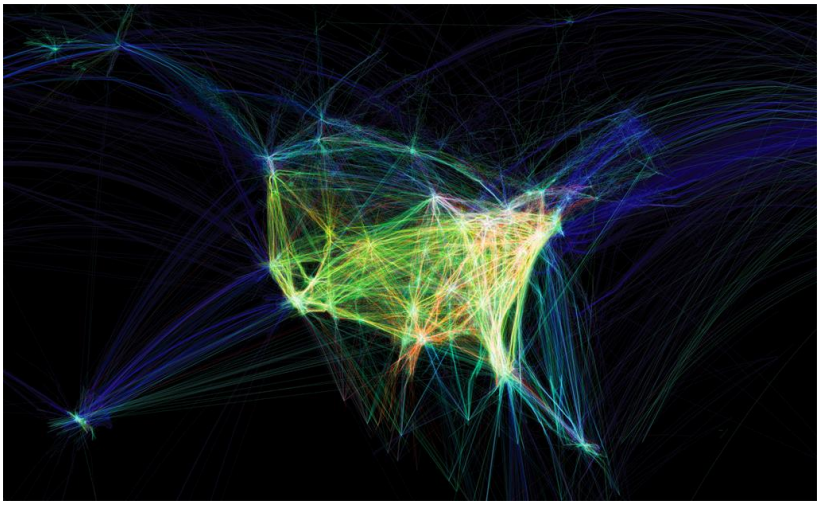

Figure B1: Flight traffic / air pollution (used by data artist in climate change communication)
Source: http://www.aaronkoblin.com/work/flightpatterns/

Figure B2: Increasing use of fossil fuels (grey line) (used by data artist in climate change communication)
Source: http://www.jillpelto.com/landscape-of-change

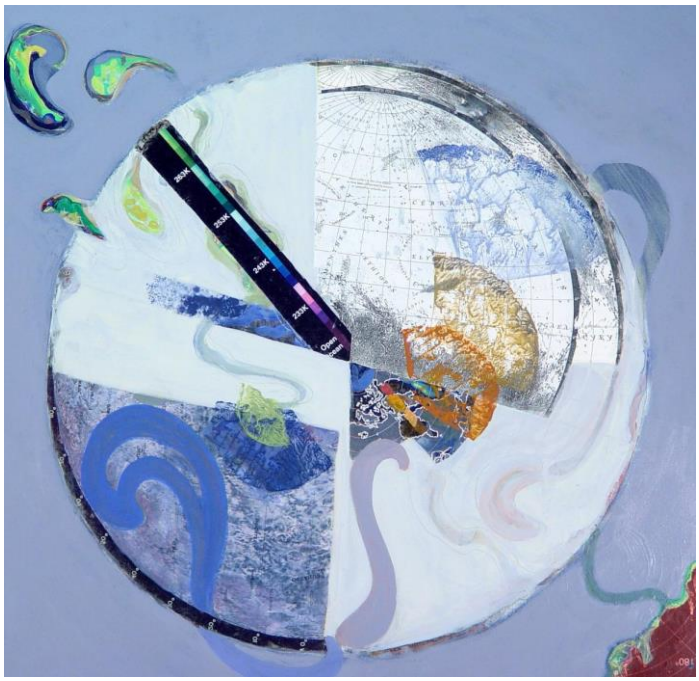

Figure B3: Increasing temperatures (used by data artist in climate change communication)
Source: http://thomwrightart.startlogic.com/?page_id=6

Figure B4: Intensified weather events (used by data artist in climate change communication)
Source: http://nathaliemiebach.com/gulf33.html

Figure B5: Melting ice pollution' (used by data artist in climate change communication)
Source: http://www.jillpelto.com/moments-of-observation

Information visualizations

(non- artist source, present climate pollution and impacts/problem-focused)

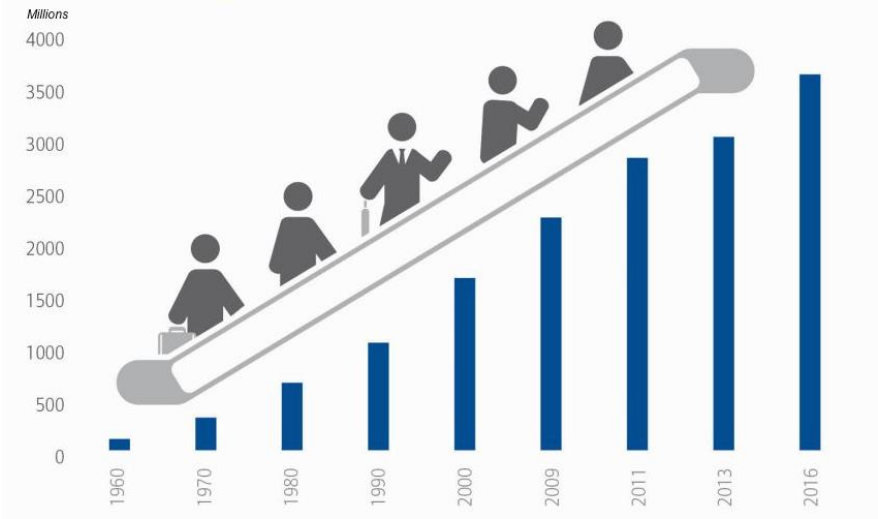

Figure B6: Flight traffic / impact on air (used by environmental organizations in climate change communication)
Source: http://www.agcs.allianz.com/insights/expert-risk-articles/how-aviation-safety-has-improved/

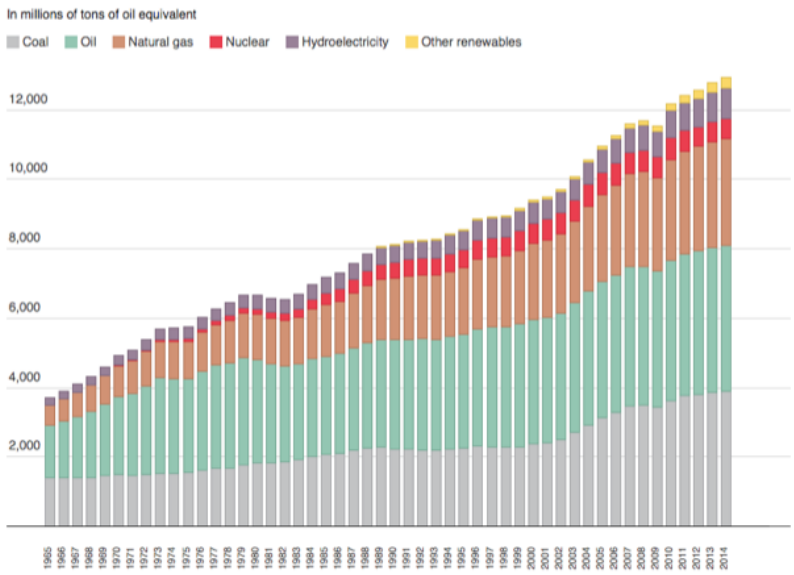

Figure B7: Increasing use of fossil fuels (used by environmental organizations in climate change communication)

Source: http://www.vox.com/2015/12/14/10121638/fossil-fuel-dominance

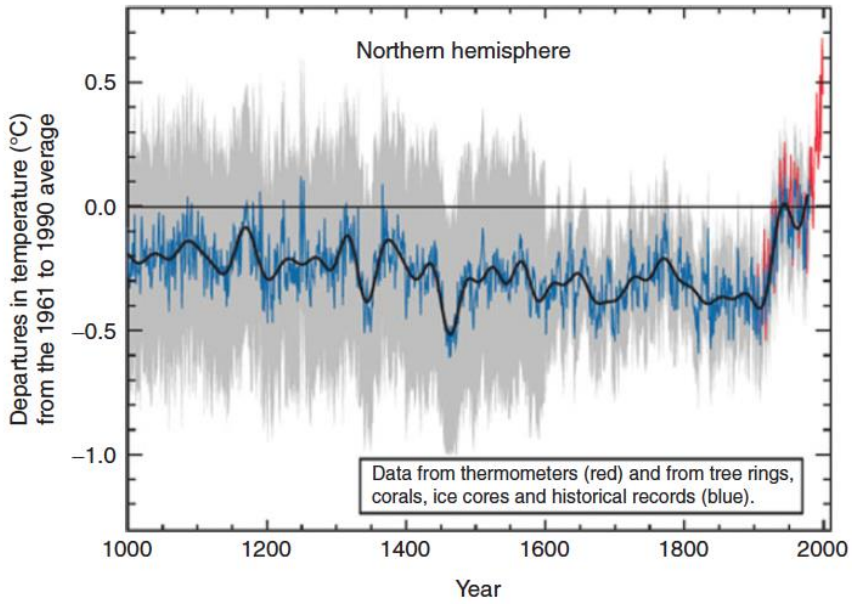

Figure B8: Increasing temperatures (used by environmental organizations in climate change communication)

Source: O'Neill & Smith (2013)

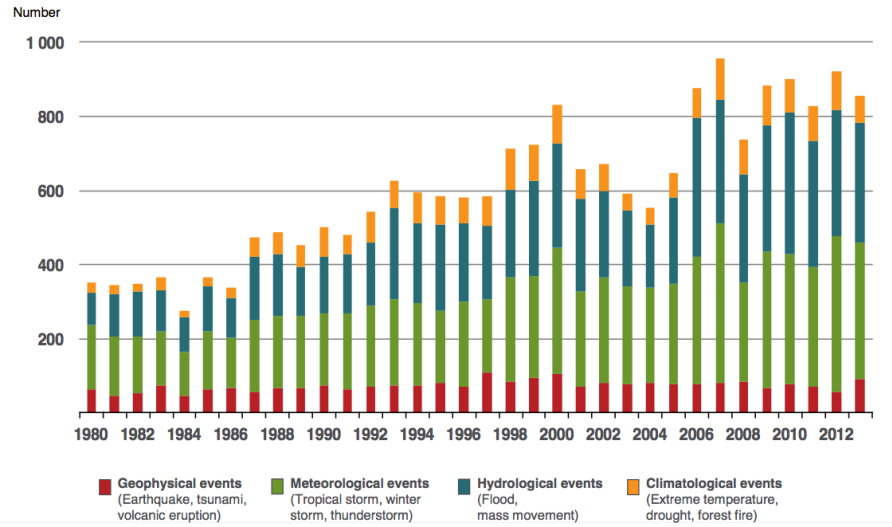

Figure B9: Intensified weather events (used by environmental organizations in climate change communication)

Source: https://thinkprogress.org/global-warming-linked-to-more-extreme-weather-and-weaker-jet-stream-13ddeb78d8fb

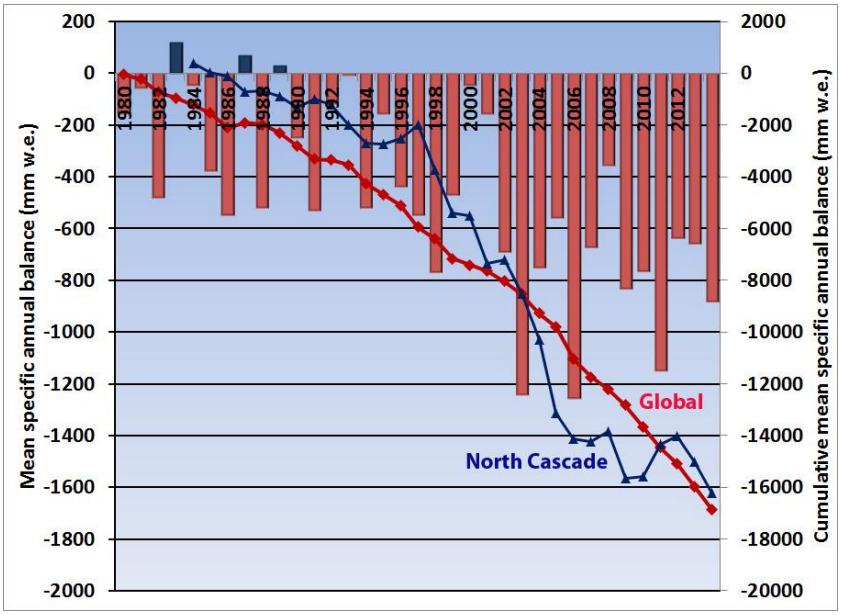

Figure B10: Melting ice (used by environmental organizations in climate change communication)

Source: http://blogs.agu.org/fromaglaciersperspective/2015/08/20/disastrous-year-for-north-cascade-glacier-mass-balance-snowice-economy/

Photos

(non-artist source, present climate pollution and impacts/problem-focused)

Figure B11: Flight traffic / air pollution (used by environmental organizations in climate change communication)

Source: https://www.emaze.com/@ALTQCTZZ/How-can-we-reduce-plane-pollution

Figure B12: Increasing use of fossil fuels (used by environmental organizations in climate change communication)

Source: http://www.theenergycollective.com/cutler-cleveland/2203396/why-divest-substantial-harm-fossil-fuels

Figure B13: Increasing temperatures (used by environmental organizations in climate change communication)

Source: https://www.motifinvesting.com/blog/opportunities-climate-change-green-investing

Figure B14: Intensified weather events (used by environmental organizations in climate change communication)

Source: http://www.mthurricane.com/hurricane_katrina.htm

Figure B15: Melting ice (used by environment organizations in climate change communication)
Source: http://blogs.agu.org/fromaglaciersperspective/2015/08/20/disastrous-year-for-north-cascade-glacier-mass-balance-snowice-economy/

Artistic projections or simulations

(artist source, future dramatic climate pollution and impacts/problem-focused)

Figure B16: Air pollution (used by artist in climate change communication)
Source: http://www.dailyo.in/arts/delhi-smog-air-pollution-art-iconic-paintings-mona-lisa-the-scream-the-lovers-american-gothic/story/1/13896.html

Figure B17: Increasing use of fossil fuels (used by artist in climate change communication)
Source: http://www.culturechange.org/cms/content/view/886/1/

Figure B18: Increasing temperatures (used by artist in climate change communication)
Source: http://www.london-futures.com/

Figure B19: Intensified weather events (used by artist in climate change communication)

Source: http://www.4artgarden.com/art-by-julianez.html

Figure B20: Melting ice (used by artist in climate change communication)

Source: https://www.pinterest.com/explore/global-warming-drawing/

Cartoons

(artist/cartoonist source, climate pollution and impacts/problem-focused)

Figure B21: Cartoon 'Flight traffic / air pollution' (used by cartoonist in climate change communication)

Source: https://scottthong.files.wordpress.com/2007/12/baliemissions.jpg

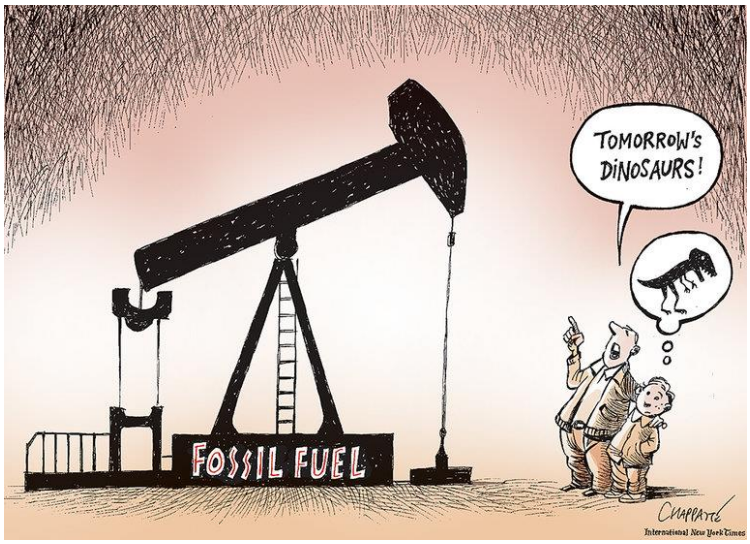

Figure B22: Increasing use of fossil fuels (used by cartoonist in climate change communication)

Source: https://www.nytimes.com/2015/12/04/opinion/cartoon-chappatte-on-climate-change.html

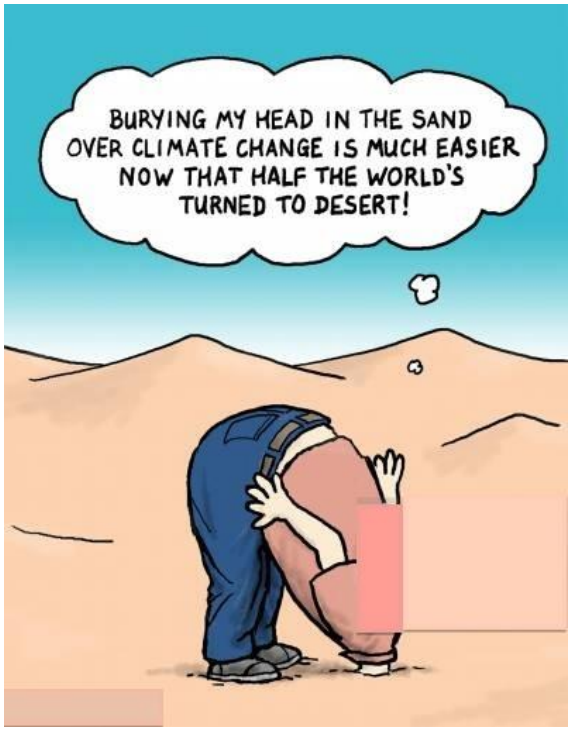

Figure B23: Increasing temperatures (used by cartoonist in climate change communication)

Source: http://www.earthaction.org/protect-our-climate-1999.html

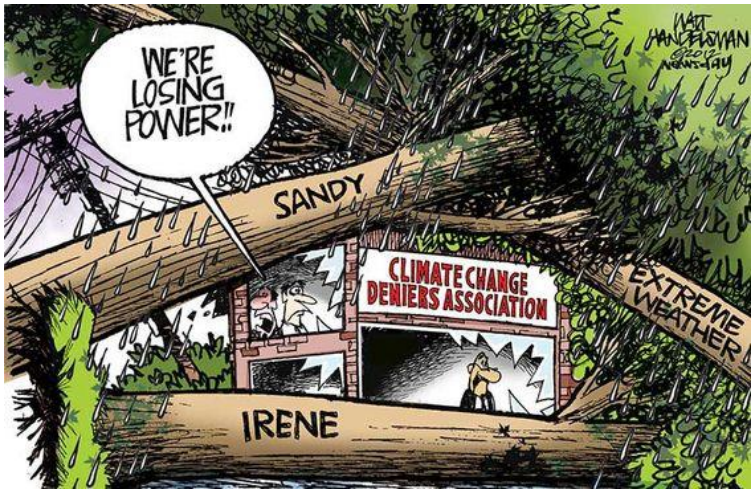

Figure B24: Intensified weather events (used by cartoonist in climate change communication)

Source: https://www.usnews.com/cartoons/energy-policy-cartoons?slide=101

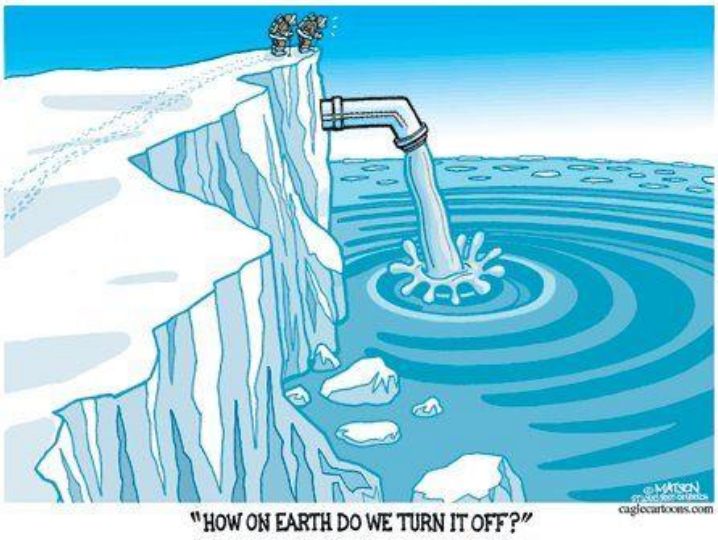

Figure B25: Melting ice (used by cartoonist in climate change communication)

Source: https://de.pinterest.com/pin/109775309637287218/

C. Survey, Q-sort and Interview Guide

RQ: Individual engagement with climate change visuals (Elaborate version)

How engaging do viewers perceive artistic information visualizations on climate change (in terms of feeling of salience: "This image makes me feel climate change is important"), vis-à-vis non-artistic information visualisations, non-artistic photos, artistic simulations and cartoons, and what reasoning for felt salience can be identified (with a specific focus on artistic information visualization's capability to address climate change, and art's involvement in climate change)?

Participants:

Six students enrolled in different study programs, and five workers employed in different areas. All participants are living in Rotterdam, but are not necessarily of Dutch nationality

Approaching participants:

Participants are approached to take part in a Master thesis research, which studies peoples' thoughts about climate change visuals (comparably to the way O'Neill, Boykoff, Niemeyer, & Day (2013) approached their participants semi-openly about the intent of their research). They are informed that the study takes between 45 minutes and one hour. The researcher makes clear that she is a Master student at Erasmus University Rotterdam.

Participants' consent:

Before the research starts, potential subjects are asked for their consent by providing them with a 'Consent Request' to be signed or orally confirmed (one copy kept by participant, one copy for researcher). Amongst others, they are informed about the nature of the study, their voluntary participation, and they are asked if they prefer their identity to be included (mentioning participant's name) or excluded (fictitious name instead) in the thesis.

The process of the research:

The research consists of three parts. First participants are asked to fill out a short survey about their background and interests concerning climate change and the arts. Then they are invited to participate in the q-sort. The q-sort is followed by an in-depth, semi-structured interview. The whole process takes approximately one hour per participant, totalling between 10 to 15 hours of research consisting of the survey, q-sort and interview. These three parts are detailed in the following three sections.

First part: Short survey about participant's interests and backgrounds

Goals of including a short survey: To identify the diversity of the sample; to verify if and how audience characteristics are connected to engagement with the visuals (Kennedy's et al., 2016; Silvia, 2005). Remarks in [ ] -brackets will not appear in actual survey for participants.

Approximate time: 3-5 minutes

Remarks: Questions about climate change based on existing research O'Neill, Boykoff, Niemeyer, and Day (2013). Questions about background based on Methodological Guidelines Thesis Research (2016).

1. Please fill in the following information:

Name or alias: _____

Age: _____

Gender: _____

Education: _____

Place of residence: _____

Nationality: _____

Occupation: _____

Please circle an item from the scale concerning the following statements/questions:

[Climate change attitude:]

2. The Dutch government should treat climate change as a very important policy priority. [Political saliency]

Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree

3. How worried are you about climate change? [Worry]

Not at all worried | Slightly unworried | Neutral | Slightly worried | Very worried

4. How serious a threat do you consider climate change? [Perceived risk]

Not very serious | Slightly unserious | Neutral | Slightly serious | Very serious

[Interest in climate change and related issues:]

5. How interested are you in the topic of climate change (manifested through certain behaviour/lifestyle and/or engagement with climate change information)?

Not at all interested | Slightly uninterested | Neutral | Slightly interested | Very interested

Please shortly provide an example of how you are interested in climate change (or leave empty if chosen "Not at all interested"): _____

6. How would you define 'climate change'?

_____

[Interest in the arts:]

7. How interested are you in the arts (this could concern any art genre –visual art, literary, performing arts etc.– and any level of culture –highbrow, middlebrow, lowbrow–)?

Not at all interested | Slightly uninterested | Neutral | Slightly interested | Very interested

Please shortly provide an example of how you are interested in art (or leave empty if chosen "Not at all interested"): __

Second part: Q-method

Goal of the q-sort: Practical involvement of participants; meaningful sorting on a scale from most disagree to most agree, i.e. *what* image gets sorted *where* (addresses first part of RQ).

Approximate time: 20 minutes

Remarks: Participants are supposed to complete the sort without the researcher's input.

Procedure:

1. *Providing materials:* Participants are provided with 25 colour images of postcard size, and a sorting grid on a poster in the form of a Normal distribution (see figure 1).

2. *Explaining the q-sort approach:* The q-sorting approach is explained to the participants, as they might not be familiar with the approach. Participants are instructed to both consider the image and the accompanying image captions when making their sorting choices.

3. *Shortly explaining the images:* The images are shortly explained: "These are 25 images showing different relevant themes of climate pollution and climate change impacts: traffic/air pollution, fossil fuel use, temperature increase, intensified weather event, and melting ice. They are depicted in different ways. Please sort them according to the following statement: *This image makes me feel climate change is important* (feelings of salience)." The statement is provided above the sorting grid for participants to see while they are sorting.

4. *Participants make piles:* Before sorting the images on the grid in a form of a normal distribution ranging from most disagree -4 to most agree +4; undecided or unsure in middle at zero), participants can first create three piles: 1) "These visuals make me feel climate change is not important", 2) "I am undecided about these visuals", and 3) "These visuals make me feel climate change is important". The pile sorting will ease the further, more detailed distribution in the normal distribution grid.

5. *Participants' sorting:* While the participants are sorting the images, the researcher's role is not passive. In contrast, she will attentively (but in an attempt to be inconspicuous) observe the subjects, and make notes, keeping these two questions in mind: 1. Do they hesitate with the sorting of certain images? 2. Which images are quickly sorted?

6. *After the sorting:* After the participants have sorted the images, a picture of the sort is taken.

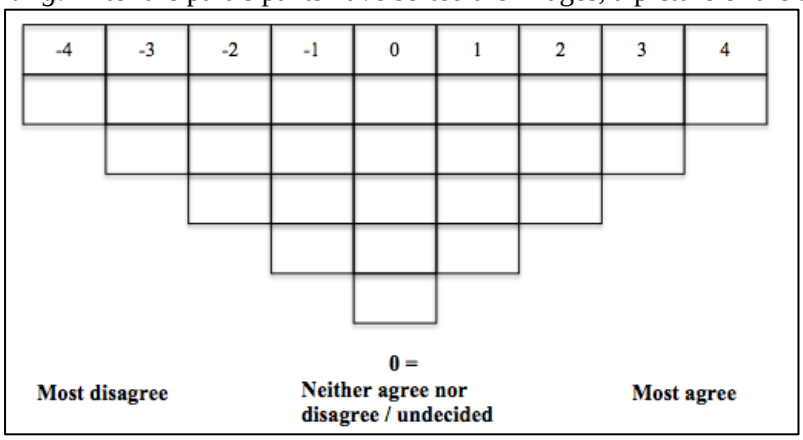

Figure C1: Logic of the q-sort: 25 images to sort from -4 to +4, rows for each column 1, 2,3,4,5,4,3,2,1

Third part: Post-sorting semi-structured in-depth interview

Goal of the interview: Reveal reasoning of the sorting; uncover *why* participants sorted the images in the way they did; important follow-up step to the q-sort as the interview advances the data richness and quality of the q-sort (Watts & Stenner, 2013). Addresses second part of RQ.

Approximate time: 30 to 45 minutes

Remarks: Participants may change their sorting while giving their reasoning. In that case a picture of the new sort will be taken.

Interview guide:

The topic-based interview guide	**The question-based interview guide**
Topics / subtopics and sub-RQ	**Interview questions**
A. Overall sorting *places* Goal: Initiating the discussion about the image sorting.	*1. "Could you first please explain to me shortly how you have sorted the visuals, i.e. what visuals you have sorted where?"*
B. Overall sorting *reasoning* by participant Goal: Letting the participant first reflect upon the sorting without giving away any possible reasoning topics. When participants have verbally revealed their reasoning, the researcher reacts with follow-up questions to deepen the understanding of the participant's own sorting reasoning. As participants might not articulate their sorting scenarios completely, the researcher further asks about reasoning if it is apparent in the physical sorting but not addressed by the participant him/herself. Possible reasoning scenarios: (See next page)	*2. "Could you please now reflect on your sorting criteria for sorting the images in this particular way?* *You can first focus on the images with which you most agree making you feel climate change is important (then most disagree; then those about which you are unsure).* *Think first of the dominant reasoning that you followed while sorting, and please reflect on this.* *What second consideration did you take into account while sorting? What third?"*

<u>Scenario 1:</u> Visuals are mainly sorted according to their capability for cognitive and emotional engagement (fact-based, apocalyptic, funny) Corresponding sub-RQ 1: Cognitive and emotive engagement *1a: How are the fact-based artistic information visualizations on climate change perceived in terms of cognition compared to other visuals (cognition)?* *1b: How are the fact-based artistic information visualizations on climate change perceived in terms of their capability for novelty and eliciting affective responses (emotion) compared to other visuals?*	*3. "Could you please explain how these visuals make you feel that climate change is important?"* *(possibly: "evidence", "emotive")* *"Could you please explain how you disagree with these visuals making you feel that climate change is important?"* *(possibly: "unrealistic")* *"Could you please explain how you are unsure about these visuals?"* *(possibly: artist's works)* If artistic information visualizations are sorted at extremes, or middle, further questions, if not already mentioned by participant (if artistic information visualizations scattered across Normal distribution, see part C. below): *4. "What do you think about the artistic information visualization's ability to depict climate change information?"* *5. "What do you think about the artistic information visualization's ability to depict climate change in a novel way, eliciting emotional responses?"* *6. "Could you learn something from the artistic info vis? Did you like them?"* *7. "How would you prefer artistic information visualizations to be – rather abstract, room for interpretation, or rather clear? What do you (dis)like about the artistic info vis?"* *8. "Please reflect on the artistic information visualization that makes you most/least feel that CC is important."* *9. "If you compare the artistic info vis to the other visual forms, the photos, cartoons, and simulations, how are they superior or inferior to them?"*

	PLUS: Jump to questions of scenario 2 below. If apocalyptic visuals make the viewer feel climate change is important (identified in previous research as especially eliciting attention and feelings of salience): *10. "These images make you feel that climate change is important. What other feelings come to your mind when you look at these visuals?" (*helpless, distanced, overwhelmed)
<u>Scenario 2:</u> Visuals are sorted depending on if they are artistic or non-artistic. Corresponding sub-RQ 3: *How is the role/involvement of (and AIVs specifically) in the communication of climate change perceived (trust issues, instrumentalization, loss of autonomy, expertise for scientific topic of climate change)?*	*<u>Participant's perception of art's involvement concerning climate change</u>* *11. "What were your sorting criteria for sorting the (non-)artistic visuals on the … extreme / middle of the distribution?"* *12. "What is your opinion of an involvement of the arts in climate change communication?"* *13. "Would you agree: Art should be involved in societal debates, art should be critical of society, art should question social values. [aesthetic disposition = critical]. (Or: would you prefer art to stay out of societal debates)?"* *14. "How trustworthy do you perceive (data) artists as sources of climate change communication?"* *15. "How trustworthy do you perceive artistic information visualizations in communicating climate change?"*
<u>Sub-RQ 2</u> *How does a background in the arts (education and/or interest) influence the viewers' engagement with the artistic information visualizations on climate change?* <u>Scenario 3:</u> Visuals are mainly sorted according to their depicted theme (e.g. especially fossil fuel images are put on the right extreme).	*<u>Participant's art interest and education</u>* (if artistic visuals sorted on right extreme:) *16. "You sorted the artistic visuals on the right extreme of the distribution. Do you believe your personal general interest in art might be connected to this?"*

Scenario 4: Combination of several reasoning strategies. Scenario 5: Additional sorting logic not yet included in theory section. Scenario 6: No apparent sorting reasoning / random sorting.	**Jump to C.** **Jump to C.** **Trying to reveal a sorting logic in the conversation.**
C. Combination of reasoning, additional reasoning or no apparent reasoning Goal: If the participant's sorting does not involve a dominant logic concerning the visual's capabilities, or does not show an art – non-art distribution, the researcher asks the corresponding questions directly to get an understanding of the participant's opinion of these matters. Corresponding sub-RQ: **Sub-RQ 1** about cognitive and emotional engagement **Sub-RQ 3** about art's involvement / (dis)trust in source and message	*17. "What is your opinion about rather realistic versus apocalyptic or rather funny tones in the visuals?"* *18. "What is your opinion of an involvement of the arts in climate change communication?"* *19. "How trustworthy do you perceive artists as sources of climate change communication?"* *20. "Would you agree: Art should be involved in societal debates, art should be critical of society, art should question social values. [aesthetic disposition = critical]. Or would you rather prefer art to stay out of societal debates?"* *21. "What do you think about the artistic information visualization's ability to depict climate change information?"* *22. "What do you think about the artistic information visualization's ability to depict climate change in a novel way eliciting emotional responses?"* *23. "Could you learn something from the artistic info vis? Did you like them?"*

	24. "How would you prefer artistic information visualizations to be – rather abstract, room for interpretation, or rather clear? What do you (dis)like about the artistic info vis?" *25. "Please reflect on the artistic information visualization that makes you most/least feel that CC is important."* *26. "If you compare the artistic info vis to the other visual forms, the photos, cartoons, and simulations, how are they superior or inferior to them?"* *27. "How trustworthy do you perceive data artists as sources of climate change communication?"* *28. "How trustworthy do you perceive artistic information visualizations in communicating climate change?"*
<u>Sub-RQ 2</u>	If the participant is highly interested in art, but has not arranged the artistic visuals on the most agree extreme: *29. "You are generally interested in art. Yet, the artistic visuals are not arranged on the right extreme of the distribution. What properties of these visuals made you arrange them not on the right extreme?* If the participant is not interested in art, and has not arranged the artistic visuals on the most agree extreme: *30. "You are generally not interested in art. The artistic visuals are not arranged on the right extreme of the distribution. Do you believe this sorting reflects your general disinterest in art, or would you say it is mainly connected to the visual's properties? Or both?"*
D. Questions about participant's potential unusual observed behaviour during sorting (time spent with the sorting / process of making sense of certain images) <u>Goal:</u> Sorting behaviour might reveal additional information about the sorting reasoning (possibly not verbally addressed by participant him/herself) These questions need to be integrated into the interview depending on any observable unusual or striking behaviour.	*31. "I recognized you hesitating with the sorting of this/these particular images. Why do you think did you hesitate sorting these images?"* *32."I recognized you sorting of this/these particular images very quickly. Why do you think did you sort these images quickly?"*

D. Notation System and Code Lists

Element	Usage
,	Every slight pause
.	End of sentence
?	Questioning sentence
—	Incomplete sentence, false starts, repetitions
-	Interruption by other person
[…]	Cut material
Er, Um, hm heh Mm-hmm [assent]	Nonverbal sounds: - Stalling - Confirming - Assenting
[laughs] [laughter]	Laughter one or more than one person
[pause 2 sec.]	Pause, indication of time
{}	Overlapping speech
Italics	Words in foreign language
[ ]	Added information on pointing, specific behaviour, non-verbal expressions etc.
‘ ‘	Titles of visuals
“ “	Direct speech
[Emphasis]	Emphasis added
[?]	After a word about which the researcher is unsure about that the participant has used
[inaudible + … words]	Inaudible expressions plus indication of number of inaudible words

Table D1: Notation system based on Powers (2005).

Table D2: Excerpt of code list

Sorting criteria	
	Sorting criteria - engaging
	Sorting criteria - unengaging
	Sorting criteria - undecided
Artistic information visualizations (AIVs)	
AIV – unengaging: (same for AIV – undecided)	
AIV – not understood	
AIV – not recognizable / clear	
AIV – missing connection to CC	
AIV – too abstract	
AIV – not emotive	
AIV – not liked	
AIV – not taken seriously	
AIV – not confronting enough / not immediate	
AIV – requires second glance / time-consuming	
AIV – not meaningful / significant enough	
AIV – only about topic	
AIV – understood but …	
AIV – quite recognizable but …	
AIV – liked but …	
AIV – novel but …	
AIV – objective but …	
AIV – combi data & art not aware	
AIV – combi data & art interesting but …	
AIV – combi data & art do not work for participant	
AIV – more descriptions do not change sorting or perception	
AIV – more descriptions do not change sorting but somewhat perception	
AIV – needed improvements	
AIV – in (neg.) comparison to other visuals	
AIV – Engaging:	
AIV – bec. graphs/ combi data & art	
AIV – bec. liking / aesthetics	
AIV – bec. understood / clarity	
AIV – in (pos.) comparison to other visuals	
AIV – more descriptions change sorting / perception	
AIV – within comparisons	
AIV – per topic:	
AIV - Air pollution	
AIV - Fossil fuel	
AIV - Temperature	
AIV - Weather	
AIV - Melting ice	
Information Visualizations	
Info vis – engaging:	
Info vis - clear	
Info vis – fact-based	
Info vis – topic	
Info vis – unengaged: (same for Info vis – undecided)	

Info vis – not understood
Info vis – not emotive enough
Info vis – topic
Photos
Photos – engaging:
Photos – clear
Photos – immediate
Photos – topic
Artistic simulations
Art. sim. – engaging:
Art. sim. – clear
Art. sim. – emotive
Art. sim. – topic
Art. sim – unengaging: (same for Art. sim. – undecided)
Art. sim. – too extreme
Art. sim. – unbelievable
Cartoons
Cartoons – engaging:
Cart. - clear
Cart. - funny
Cart. – topic
Cartoons – unengaging: (same for Cartoons – undecided)
Cart. – inappropriate humour
Cart. – simplification
Audience skills / audience background
(No) High interest in art
(No) Art education
Belief: Artistic background would increase understanding
Belief: Influence personal background on perception
Art's involvement in climate change
Trust in scientific community
Trust in data artists
Art should be involved
Art's power doubted
Art should not convince

E. Connection between Research Questions, Concepts and Codes

<table>
<tr><td colspan="3">*Main RQ: How* engaging in terms of feeling of salience do viewers perceive artistic information visualizations on climate change, and *what reasoning* for felt salience can be identified?</td></tr>
<tr><td>Engagement in terms of feelings of salience</td><td>(Sorting)</td><td>Engaged, not engaged or undecided about AIVs and other visualization types
- Q sort (photo): most agree, most disagree – Excel</td></tr>
<tr><td colspan="3">*Sub-RQ: Adding to second part of main RQ – Reasoning*
- Voiced comments during sorting
- Behaviour (observation notes): quick sorting or hesitation of certain visuals
- Statements in interview/reasoning – coding (see below)</td></tr>
<tr><td>Concept</td><td>Code</td><td>Excerpt of some examples</td></tr>
<tr><td rowspan="4"><u>Sub-RQ 1</u>

Visual properties/ capabilities for cognitive and emotional engagement</td><td>AIV –(not) understood; (not) clear; (missing) connection to climate change</td><td>“I don’t understand it”
“It’s not fully clear to me”
“Not directly related to climate change”</td></tr>
<tr><td>AIV – (no) Liking / In(capability) for novelty, emotion , aesthetics</td><td>“Interesting”
“Nice illustration”
“Quite interesting but you have to understand it”</td></tr>
<tr><td>AIV - Needed improvement</td><td>“If they go into that topic maybe make sure that that topic comes across”</td></tr>
<tr><td>Other form or tone preferred & reasoning
- photos
- pragmatic information visualization
- artistic simulation
- cartoons

(Reference to most agreed visual)
(Comparison AIV to other visual types)</td><td>“I can actually relate more to it that there is data [information visualizations]”
“I am more appealed to the facts than the impressions”</td></tr>
<tr><td><u>Sub-RQ 2</u>

Participant’s background in science and art</td><td>- (Dis)interest in art
- (In)expertise with art

- Belief that more artistic background is needed

- Participant background</td><td>“I think people who are more into art might make more sense of it”
“They are more trained to look at specific details”</td></tr>
</table>

<u>Sub-RQ 3</u> Art's role in climate change communication (involvement, trust)	Involvement of art (dis)agreed with - Art should be involved - Art's power doubted - Art should not convince	"I think they should definitely be in" "It's important because it triggers people's thoughts"
	(Dis)trust in (data) art - Trust in art - Trust in scientific community - Distrust in art - Trust in data artists - Distrust in data artists	"Too dramatic to be trustworthy [artistic simulations]" "Trustworthy for me as long as I feel they are portraying the information" "Data artists are most likely to be the most correct ones"

Table E1: Connection between research questions, concepts and codes