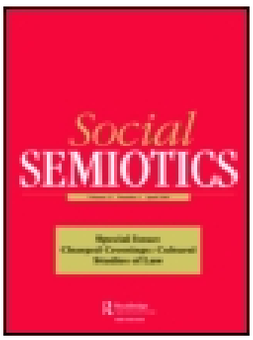

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Optimism and alienation – colour schemes and soundscapes as means for the social construction of risk in climate education videos

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ABSTRACT

While the field of climate change communication has become increasingly interested in visual representations, there has been a lack of research that attempts to capture the breadth and variety of semiotic resources being drawn upon in the contemporary media landscape. In this paper, social semiotic theory is drawn upon for investigating how colour and sound may contribute to the social construction of risk in a sample of four professionally produced Norwegian educational videos, all of which are aimed at explaining the reality and danger of anthropogenic climate change. The results indicate that the colour schemes and soundscapes of the videos contribute meaning potentials with affective resonances apt for the social construction of risk, and that the videos construe the risk differently. The authors suggest that in two of the sampled videos, the uses of colour and sound are apt for attenuating the risk perceived by the viewer, while in two other videos they are used in a manner apt for amplifying the perceived risk. Implications of these results are discussed in light of previous research on multimodal climate communication.

KEYWORDS

Climate change; risk; multimodality; sound; colour; music

Introduction

In contemporary discourse, climate change has become inextricably tied to the concept of risk – essentially, what dangers await us in the future if this or the other path is followed. However, while the dangers of climate change – and the need to take action – are quite clear from a scientific perspective (Powell 2015; Cook et al. 2016; IPCC 2018), human perception of the risks these dangers represent is greatly influenced by their socio-culturally shaped values and beliefs (Leiserowitz 2006; Hulme 2009; Kahan, Jenkins-Smith, and Braman 2011; Linden 2017). Building on the social theory of risk amplification (Kasperson et al. 1988), climate researcher Mike Hulme has suggested that social actors use symbols and metaphors to rhetorically amplify or attenuate the risk suggested in a message about climate change, in order to align the message with their own values and interests (Hulme 2009, 203). According to Hulme, this leads to contemporary media being rife with

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different constructions of the risks inherent to climate change, ranging from naïve optimism to apocalyptical alarmism, and serving a myriad of different purposes. According to Hulme, people are often oblivious to these many variations, and while the claims of a climate denialist may be easily distinguished from those of an advocate, other nuances may be overlooked, leaving social actors free to re-construe climate risk in manners which may or may not be productive or desirable (Hulme 2009, 28). It is therefore vital that researchers in communication, discourse, and semiotics generate knowledge of how climate change is being reconstructed and recontextualized, in order to denaturalize current representations and contribute to opening a discussion around alternatives.

While any semiotic resource might, in principle, be drawn upon when construing an aspect of an environmental issue, the field of climate communication research has largely concerned itself with the study of language and iconography (Hansen and Machin 2013). Drawing inspiration from multimodal theory and the field of social semiotics, there has been a repeated call for research that captures the breadth and variety of semiotic resources drawn upon in contemporary communication, in particular *sound* and *colour* (Hansen 2017, 15; Hansen and Machin 2013, 159). This call, however, has remained largely unanswered throughout the past decade. In this paper, we have sought to contribute to filling this gap, by presenting an analysis of how colour and sound contribute to the social construction of risk in a selection of Norwegian educational videos about climate change. The research questions we have pursued are:

RQ1: What characterizes the colour schemes and soundscapes of the videos?

RQ2: How may the colour schemes and soundscapes be interpreted as means for social amplification and attenuation of risk?

In the following, we first review relevant previous research on climate change communication, before presenting the theoretical conceptualization of sound and colour we draw upon in this paper. Subsequently, we describe our material and analytical model, before presenting the results of our analyses. Finally, the implications of the results are discussed in light of previous research in multimodality and on climate change communication.

Climate change communication and multimodality

Over the last two decades, the field of climate communication research has become increasingly interested in visual communication. Particular attention has been given to the different affordances of *scientific* and *non-scientific* images for creating engagement and identification with a given issue. As scientific images typically lack local and cultural anchoring, it has been hypothesized that these are less apt to create identification and provoke affective responses in the general public than images with clearer and more concrete cultural anchoring (Doyle 2009; Leiserowitz 2006; Joffe 2008). A growing body of research has sought to map the uses of different types of images in print and broadcast news media representations of climate change (Manzo et al. 2010; Manzo 2010; Doyle 2009; O'Neill and Smith 2013; O'neill 2013; Nicholson-Cole 2005; Culloty et al. 2019; Wessler et al. 2016). Research on audience reception has also indicated that non-scientific images are superior to scientific images with regards to engagement and identification, at

least within the contexts studied (O'neill et al. 2013; O'neill and Hulme 2009; O'Neill and Nicholson-Cole 2009; Metag et al. 2016). While this research is highly valuable, it has been pointed out that in moving forward, the field would benefit from a broader perspective on what different kinds of semiotic resources may contribute to the social construction of climate change (Green 2018; Hansen and Machin 2013). In particular, the use of colour and sound as semiotic resources in climate change communication has been emphasized as deserving closer attention (Hansen 2017, 15; Hansen and Machin 2013, 159).

From the perspective of social semiotics, analysing the use of such semiotic resources as colour and sound in climate change communication seems imperative if the field is to develop new knowledge of how climate change is being socially construed in global digital media. Both of these semiotic resources are now being used in new contexts and novel ways, significantly challenging long established notions of what and how semiotic resources are typically drawn upon in a given type of text (Kress and Van Leeuwen 2001, 2–3; Ledin and Machin 2018, 29–30). Traditionally, a *scientific explanation* would involve language either spoken, or written in a black typeface on white paper, accompanied by stylized line drawings with minimal use of colour, intended to give a functional representation of spatial relations and graduation (Daston and Galison 1992; Lemke 1998), and using music in a scientific explanation has been exceedingly rare. Today however it is quite common to see scientific explanations realized in the form of videos that feature vibrant colour schemes and musical soundscapes. Drawing on the rhetorical definition of genre developed by Carolyn Miller (Miller 1984), one can say that the norms regulating scientific explanations have shifted significantly. Granted, contemporary realizations of the genre will necessarily still draw significantly on language and scientific images, as the conventionalized precision of these modes is necessary in order to present the specialized meanings inherent to a scientific issue. Nevertheless, the addition of background music and coordinated colour schemes should by no means be treated as empty decoration. Among other things, they provide affective resonance (Ledin and Machin 2018, 49; Van Leeuwen 2011, 60), which may make them important resources for the social construction of climate risk.

Colour schemes and soundscapes as means for the social construction of risk

Gunther Kress and Theo Van Leeuwen have argued that in contemporary communication, the use of colour and sound is not governed by systematic cultural conventions, and that the meaning these create may therefore be conceptualized as pre-modal (Kress and Van Leeuwen 2001, 2002; Van Leeuwen 2014, 2017, 2011). Central to pre-modal creation of meaning is the innate human ability to metaphorically connect new sensory impressions with previous bodily experiences, as described by George Lakoff and Mark Johnson in *Metaphors We Live By* (1980). These universal metaphorical connections are then further interpreted within cultural frameworks, filling them with cultural specificity (Ord 2017, 204; Van Leeuwen 2011, 50). In this way, colour and sound are used in contemporary communication to create meaning through what Kress and Van Leeuwen has termed *experiential metaphor* (Kress and Van Leeuwen 2001, 10). These experiential metaphors lacks the precision and specificity afforded by cultural convention, and the meaning potentials of colour and sound are broad, vague and often contradictory – they can connect the representations in a text with experiences of things such as warmth, night or the bodily

reactions to an emotional state, but they cannot form explicit arguments. However, because of their ultimate foundation in bodily experience, and because they may be narrowed down by the context of use, their meanings are not indefinite; a particular use of sound or colour cannot reasonably be taken to mean just anything (Way and Mckerrell 2018, 3; Van Leeuwen 2011, 58). In the following, we present the features of colour and sound that we have focused on in our analyses, and explain how some of the meaning potentials these features carry may suggest either danger or safety and either alienation or familiarity, thus providing means for the social amplification or attenuation of risk. In doing so, we have not sought to capture the full meaning potential of the different colour and sound features – only those that we suggest makes them apt for the social construction of risk.

Colour schemes

In analysing colour schemes, we considered the *proportionality* of different gradations in the three parametric features *value*, *saturation* and *temperature*.

Value: Value measures the brightness of colour. Its two extremes are pure black and pure white, and in between these the parameter moves through different shades of a given hue (Van Leeuwen 2011, 60). In his seminal work on rhetorical metaphors, Michael Osborn argued the archetypal nature of light and dark as metaphors, based on their prevalence in rethorical discourse and foundation in human sensory experience (Osborn 1967). Using Dreyfus and Rabinow's (1983) concept of bodily invariants, one may say that our bodies have certain inbuilt, invariant features that affect how we perceive and attribute meaning to light and dark: our vision is significantly dependent upon light, and the sinking temperatures usually following sundown challenges our need to maintain body temperature. Because of this, the night is generally both more dangerous and less familiar to humans than the day, giving it a meaning potential Osborn attempts to capture in the following evocative description:

> In utter contrast is darkness (and the night), bringing fear of the unknown, discouraging sight, making one ignorant of his environment – Vulnerable to its dangers and blind to its rewards. One is reduced to a helpless state, no longer able to control the world about him. (Osborn 1967, 3)

In later writings, Osborn has moderated earlier claims regarding the absolute cultural and temporal universality of the light/dark metaphor, as most of his primary evidence was taken from canonical western speeches:

> This canon certainly spanned a considerable culture, but it was not all cultures—not all races nor genders! So the issue of whether all humans—by virtue of their humanity—share the same symbolic predispositions remains open to argument and I would assert it less confidently. (Osborn 2009, 82)

Nevertheless, the fundamental importance of light for human experience makes value a central semiotic resource in most cultures (Wierzbicka 1996), and, according to historian Michel Pastoureau, the association of the colour black with night and its accompanying dangers seem to be among the few chromatic referents "encountered in almost every society" (Pastoureau 2008, 24). As means for the social construction of risk, we have

therefore interpreted low value as suggesting danger and alienation, thus amplifying risk, and high value as suggesting safety and familiarity, thus attenuating risk.

Saturation: Saturation measures the fullness of a colour and ranges from chromatic grey to the richest and most intense realization of a hue. The meaning potential of saturation lies in the gradual cline from intense to toned-down, which may be interpreted very differently depending on the context: High saturation may be festive or vulgar, low saturation may be subtle or dull and depressed (Van Leeuwen 2011, 61). For this paper, we have interpreted saturation as an intensifier – through highly saturated colours, the suggestion of danger, safety, alienation or familiarity in a colour scheme may be intensified, whereas the proportional dominance of low saturation in a colour scheme will tone down such suggestions.

Temperature: Temperature in colour ranges from red to blue (Van Leeuwen 2011, 63). One manner of analysing temperature, which we apply in this paper, is to use a colour wheel, which organizes hues in a circle, running clockwise from the top as follows: red, orange, yellow, green, light blue, blue, purple, and magenta. Light blue represents the centre of the cold half of the wheel, while red represents the centre of the warm half. The hues between these are gradual transitions to the opposite temperature. Osborn suggests that the metaphorical meanings of heat and cold are related to the light/dark archetype through its motivational basis in the same bodily experiences (Osborn 1967, 8). As a means for the social construction of risk, we have interpreted colour temperature as being dependent upon other features – through different levels of saturation, a warm colour may be made either intensely warm, thus suggesting danger, or just mildly so, suggesting safety.

Soundscapes

The term *soundscape* refers to the sonic environment of any particular context (Schafer 1994) and may be divided into different levels of salience (Machin 2010, 115). In the videos we have analysed, speech is naturally the most salient element, given the genre and purpose of the videos. What makes the soundscapes of these videos different from the soundscapes produced in similar types of texts, however, is the addition of *background music*, and this is where the main research interest of this study lies. In analysing these soundscapes, we used the terms *connectivity, pitch level,* and *material qualities*.

Connectivity: We use the term connectivity to distinguish between soundscapes dominated by measured time and clearly separated sounds, and ones wherein time is unmeasured or where notes seem to glide into each other. This distinction may be considered as central to human experience as light. Things like clocks, tools, and doors provide rhythms that structure secular life, and rhythm also keeps the body and soul together. Life is dependent on the regular beating of our hearts, and the steadiness of our breath (Van Leeuwen 1999, 52–53). The fundamentality of these rhythms creates a strong foundation for metaphorical association, which we for this paper have interpreted in terms of familiarity and alienation: low connectivity may suggest familiarity – the grounded, near, human and worldly. Conversely, high connectivity in sounds may suggest alienation – the airy, distant, non-human, and otherworldly.

Pitch: The metaphorical potential of pitch level is closely associated with what humans, using our own biological and cultured bodies as points of reference, consider normal

pitch levels. As a resource for the social construction of risk, pitches that fall well outside normal pitch ranges may suggest danger or alienation, building on various different sources of metaphor. One such may be derived from how the bodies of large animals typically produce deep pitches, thus, very deep pitches may be associated with danger. Emotional states are another relevant source – the pitch of the human voice will typically rise when experiencing fear and anxiety, and thus very high pitches may also suggest danger, by representing the reaction to the danger rather than the danger itself. The range of pitches a soundscape moves through over time may also carry relevant meaning potentials; the way our bodies go tense when we are afraid may be metaphorically associated through narrow pitch ranges, while the relaxed sensation of safety may alternatively be suggested through broad pitch ranges.

Pitches that fall on the far extremes of or outside the human register may lastly carry meaning potentials similar to those of high connectivity, challenging our notion of the worldly and human (Van Leeuwen 1999, 108–109; Machin 2010, 100). We have interpreted such pitch levels as suggesting alienation, and pitch ranges falling within normal human pitch level as suggesting familiarity.

Material qualities: This term refers to the tonal qualities not captured by the concept of pitch alone, often called timbre or texture in musicology. Phillip Tagg suggests that, as the sonic components that make up a timbre is produced in a matter of milliseconds, it is most practically described in terms of syn-aesthetic descriptors of materiality such as roughness or sharpness (Tagg 2012, 305). In analogous music, such material qualities typically arise from the physical instrument being used and the space in which the music is performed. In the digitally synthesized background music typically used in contemporary communication, these qualities are mimicked through manipulation of sound parameters, leaving the producer free to echo the material qualities of any given sound. As means for the social construction of risk, we have focused on four such material qualities: tenseness, roughness, vibration and reverb. The metaphorical potential of tenseness is similar to that of a narrow pitch range described above – as being tense is a common response to threat, tense sounds may be used to suggest danger, while low-tension sounds suggest safety (Van Leeuwen 1999, 130). Roughness, in turn, may suggest the danger itself, such as sickness or the growling of wild animals (Machin 2010, 122), while vibration may be related to the physical state of trembling, another physical reaction we associate with fear (Van Leeuwen 1999, 134–135). Lastly, reverb is often used as an intensifier, as it gives an impression of vastness (Machin 2010, 125–126). In this sense, reverb in sound may, in our opinion, be compared to saturation in colour as a resource in the social construction of risk.

Methodology

Selection of materials

As criteria for selecting materials, we decided that all videos should be:

- Suited for use as educational resources in a school context.
- Produced by professional institutions, such as broadcasting corporations, non-profit organizations, or film-production companies.

- Aimed at explaining how humans are currently causing climate change.
- Instantiations of *scientific explanation* as a rhetorical genre.

Two of the videos we have included in the material were produced by the Norwegian Broadcasting Corporation (NRK), one by a production company called Snöball, and one by the Norwegian branch of Save the Children. Since both the videos produced by the NRK are relatively short and structured as one unified and contained scientific explanation, we have analysed the full videos. With regards to the longer video by Snöball, we have analysed the second of three subsections, each of which functions as a separate scientific explanation. The video by Save the Children is also longer, and its overall aim is to explain the injustice of climate change. From this video we have analysed a subsection wherein anthropogenic climate change is explained, which is comparable to the other materials in both rhetorical aim and generic structure. Table 1 provides an overview of the material.

Structure and content of videos

All four videos are primarily concerned with giving scientific explanations of the physical and chemical processes that govern climate change and stability. These explanations are presented through oral language, supported by scientific images such as diagrams and graphs. As the goal of this paper is to explore how colour and sound may be used for the social construction of climate risk, we have not engaged in extensive semiotic analyses of the grammatical or lexical features of the language used, or of composition in the images or film, as this would be to move beyond our present purpose. Nevertheless, we have deemed it necessary to provide a general overview of the content and structure of the videos as communicated through spoken language and image, in order to make it clear what sort of videos the soundscapes and colour schemes we analyse are contributing in.

All four videos are structured as progressive, step-by-step explanations. Anthropogenic climate change is first introduced and defined, before the phenomenon is explained in stages through spoken language accompanied by scientific models, as well as short photographic or animated clips and elements that illustrate some particular aspect of the issue, such as prehistoric causes of climate change, rising seas, wind blowing, or rain falling. Although the details of these explanations vary, all can, at a general level, be divided into two primary stages: First, climate change is explained as an entirely natural feature of the earth-weather system; thereafter, human pollution is presented as the cause of current, observed changes. In Videos 1 and 4, this effect is explained by

Table 1. Overview of material.

Video sample	Original name	Producer	Total length	Sampled section
Video 1	*What is Anthropogenic Climate Change* (2015)	Norwegian Broadcasting Corporation (NRK)	01:17	(full video)
Video 2	*Selda Puts Things in Perspective* (2015)	Norwegian Broadcasting Corporation (NRK)	03:20	(full video)
Video 3	*The Climate System* (2012)	Snöball production company	09:21	04:05 - 06:29
Video 4	*The Climate Changes* (2016)	Save the Children Norway	7:06	02:45 - 04:56

contrasting the general and the added greenhouse effect, while in Videos 2 and 3 it is explained through comparing prehistoric and contemporary correlations in CO_2 and temperature. Finally, in each of the four videos, a conclusion is presented, pointing to how these processes will affect humanity and/or the planet in the future. In videos 1,2 and 3, the risk inherent to climate change is only made verbally explicit in these conclusions. In video 4 the risk is also made explicit in the introduction. The two explanatory stages that form the major part of all four videos however are not concerned explicitly with the risk of anthropogenic climate change. For a more detailed look at the content and structure of the videos, confer Tables 2–5 below, where we have provided translated transcriptions of the oral language of all four videos, together with illustrative screenshots. Additionally, all four videos may be viewed following the URL's provided at the end of the paper.

Analytical model

Our analytical model consists of three layers: (i) analysis of colour schemes and sound qualities; (ii) interpretation of the meaning potentials of these colour schemes and

Table 2. Outline of structure and content of video 1 (NRK).

Step	Timespan	Translated transcriotion of oral language	Representative screen capture
Introduction	00:00-00:19	Anthropogenic climate change is the little, gradual changes which we are now noticing in the climate around us, which is caused by our emissions of greenhouse gasses and some other things into the atmosphere.	
Stage 1 – The general greenhouse effect	00:19-00:41	Approximately how much does it rain where you live? How hot is it? How often are there storms? The average of this over time is what we call a climate. And the climate on earth is governed by how much radiation is coming in from the sun, and how much heat the earth reflects back again. Usually, equal amounts go in and out,	
Stage 2 – The added greenhouse effect	00:41-00:56	But because we have released a lot of greenhouse gases into the atmosphere, a little more heat is now held back. Because of this, the atmosphere is slowly but surely getting warmer.	
Conclusion	00:56-01:17	This affects rain, storms, and how easy it is to grow food. These gradual changes are what we call anthropogenic climate changes.	

Table 3. Outline of structure and content of video 2 (NRK).

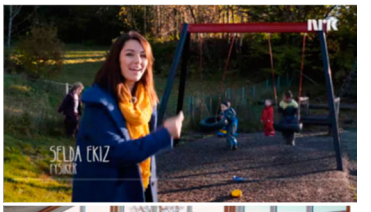
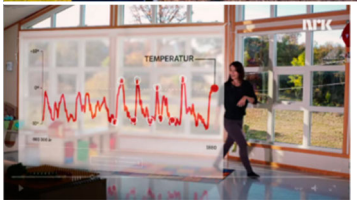
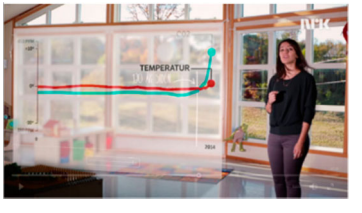
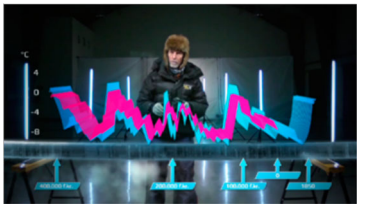
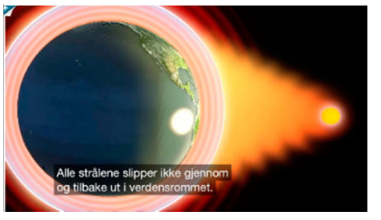
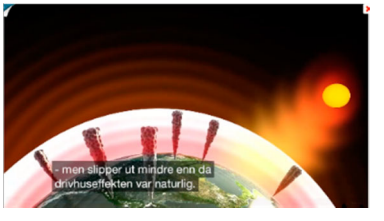
Step	Timespan	Translated example of oral language	Representative screen capture
Introduction	00:00-00:17	What world will these children live in, when they are older? What does the climate look like then? The tale of the future climate begins in the past.	
Stage 1 – Prehistoric climate change	00:17-01:37	We are headed far back in time. 800 000 years in fact. This here represent time, and the axis going up, shows temperature. Throughout these 800,000 years, the temperature on earth has gone up and down. And because the earth's orbit around the sun varies, we have had ice ages and interglacial periods. And this here, this is completely natural. Here, the first modern human showed up. About 200 000 years ago. And 100 000 years ago, the earth was several degrees warmer than it is today. Much of the ice on Greenland started melting, and the seas rose, and rose, and it did not stop until it was as much as 10 metres higher than today. Luckily, there wasn't that many people living on earth back then. Now lets draw a second line. This one shows how the co2 content in the air has been throughout the same period. And as you can see, it and the temperature are really good friends. For when it is hot, there is also lots of co2 in the air.	
Stage 2 – Current climate change	01:37-02:40	But, let's have a look at the last 130 years. Never before has there been this much CO_2 in the air. And the explanation lies mainly in combustion of coal, oil, and gas. And the temperature, it follows along. In the last 130 years, the earth has gotten 0.8 degrees warmer. It might not sound like much, but the temperature has not risen that fast ever before.	
Conclusion	02:40-03:20	Now let us head into the future. What can these children expect? Well, we know that co2-emissions will continue to increase. As much as this. Unless we do something. Ideally, we could be reducing our emissions as of today. But either way, temperature will follow after. It may increase a lot, or less. That depends upon how large our co2-emissions will be. There is a lot we do not know about the future, but calculations indicate that it might become warmer than it was 100 000 years ago. So, if co2-emissions continue as they do today, the climate of the future will be something humans never before have experienced. And these children here are the ones who are going to have to live with the consequences. Good luck!	

Table 4. Outline of structure and content in video 3 (Snöball).

Step	Timespan	Translated example of oral language	Representative screen capture
Introduction	04:00-04:15	We study historical climate development to understand contemporary changes better. For this, we use ice cores, among other things. When the snow is pressed into ice, air is hermetically sealed into little bubbles in the ice. When later we analyse the content of these bubbles, we get a picture of the composition of the atmosphere at the time when the ice was formed, including co2. When we then additionally analyse the chemical content of the ice, we get a picture of temperature.	
Stage 1 – Prehistoric climate change	04:15-05:40	There is no doubt that temperature has varied throughout time. Just look at the blue temperature curve appearing now. It swings like a rollercoaster through cold and warm periods, and if we look at the last ice age we see many quick and big swings by up to 10 degrees in just a few hundred years. There may be many reasons for the temperature going up or down. Volcanic eruptions that fill the atmosphere with particles may lower the temperature. Changes in solar activity may also reduce or increase temperature on earth. Meteors strikes may also once in a while cause dramatic changes in the climate.	
Stage 2 – Current climate change	05:40-06:25	We can also use the ice core to say something about what is happening to the climate today. See now what happens if we lay the curve for CO_2 concentration over the curve for temperature. Sometimes it appears that co2 increases before temperature, other times temperature increases before co2. So interplay between the two is close and complex. We stopped the curve before 1850, just before the industrial revolution, and before we started burning oil, coal and gas in large amounts.	
Conclusion	06:25-06:29	We know that CO2 concentration in the atmosphere and temperature are closely connected, and we know that the amount of CO2 in the atmosphere has increased a lot in recent years, there is no disagreement on this. The consequences may be dramatic.	

soundscapes based on experiential metaphor; and (iii) categorizing these meaning potentials according to their contribution in the social construction of risk. These three layers were not consecutive steps, as the analytical process was characterized by iterative movements between the different layers, forming and reforming provisional hypotheses

Table 5. Outline of structure and content in video 4 (Save the Children).

Step	Timespan	Translated example of oral language	Representative screen capture
Introduction	02:36-02:54	Now I will explain what it is that makes earth so special, and what humans are doing that is making the earth sick. You see, our planet is the only planet in the solar system which isn't too hot or too cold for humans or animals. It is placed at just the right distance from the sun, and then we have something called 'the greenhouse effect'.	
Stage 1 – The greenhouse effect	02:54-03:56	A greenhouse is a building with roof and walls of transparent glass or plastic, which is used for growing plants like vegetables, fruit and flowers. The greenhouse functions as a sun catcher. When the sun shines, the walls and roof let heat rays from the sun in, and traps much of the heat inside the house so that the plants have warmth and safety to grow. The earth is surrounded by a layer of gasses called greenhouse gasses. These gasses come from nature, and are completely natural. This gas layer is called the atmosphere. The atmosphere has the same effect as the walls and roof of a greenhouse. Solar rays are let through the atmosphere, but when the solar rays are reflected back into space, the atmosphere holds some of the warmth back. This is called the natural greenhouse effect. If it weren't for the natural greenhouse effect, the earth would have been ice cold.	
Stage 2 – The added greenhouse effect	03:56-04:16	But when humans pollute, we emit more of the gasses that are already there in the atmosphere, and that makes the greenhouse effect stronger. Pollution rises up into the atmosphere, and as it does, the greenhouse still lets as much solar radiation in as before but releases less back out than when the greenhouse effect was natural.	
Conclusion	04:16-04:56	This makes the earth warmer. And what does that mean for us here in Norway? It does not mean warmer summers with lots of sun. Those who study the greenhouse effect rather think we will have much more rain. All over the world, storms, floods, and droughts will be more common.	

inductively through constant comparison and deviant case analysis (Silverman 2011, 378). This analytical model draws substantially on the social semiotic approach described by Theo Van Leeuwen in *Introducing Social Semiotics* (2005). The primary purpose of this

form of analysis is to establish an overview of the semiotic resources drawn upon in an instance of multimodal discourse, which in turn forms a basis for semiotic interpretation. Through this interpretation, one can gain insight into the inventory of different meaning potentials contributed by these semiotic resources (Van Leeuwen 2005, 4). Our purpose is therefore not to predict how viewers will react to the videos, but rather to explore how the videos suggest that the viewer should react.

In order to exemplify our analyses of colour schemes for RQ1, we have supplied colour maps generated from screenshots representative of each video (see Figures 1–4). These were made using a free browser-based software for colour analysis developed by geomatics researcher Laurent Jégou (2014), as part of his thesis work on the use of aesthetical and semiotic principles in cartographic methodology (Jégou 2013). The colour maps

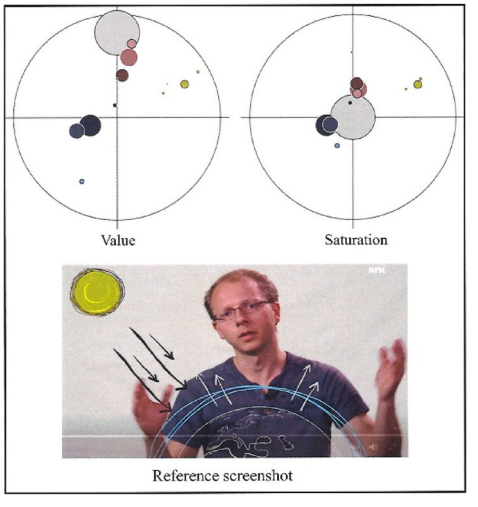


Figure 1. Colour maps for video 1.

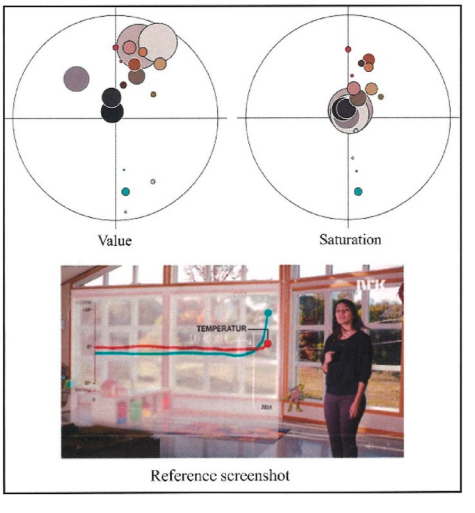


Figure 2. Colour maps for video 2.

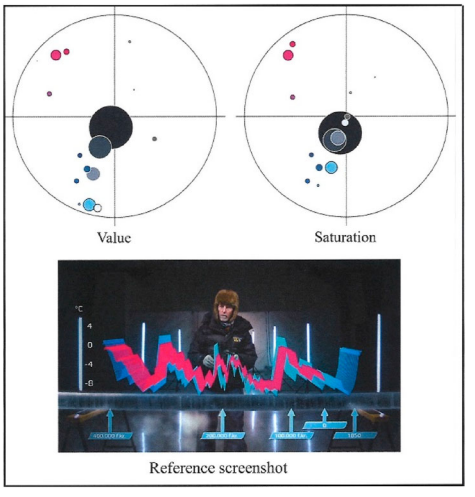


Figure 3. Colour maps for video 3.

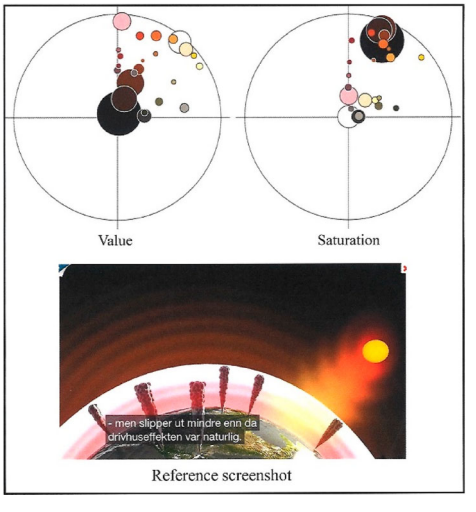


Figure 4. Colour maps for video 4.

visually organize screenshots' colouring according to three principles. First, colours are plotted as dots, with the sizes of the dots indicating their relative proportionality in the colour scheme. Second, these dots are organized parametrically from the centre of the circle outwards towards the edges, with the centre representing either low value or low saturation and the edge of the circle representing high value or saturation. Finally, the dots are organized around the circumference of the circle by their hue, according to the colour wheel described above under *temperature*.

For exemplifying pitch level and connectivity in soundscapes, we have produced approximate parametric transcriptions of short sequences from each video (see Figures 5–8). Note here that our transcription of pitch level is based in relative and not absolute pitch, and we do not use exact enumeration. After all, our ability to distinguish between high and low pitch and to perceive them as meaningful does not hinge upon our ability to relate these to an absolute scale, but rather on our ability to compare them with other sounds we have experienced.

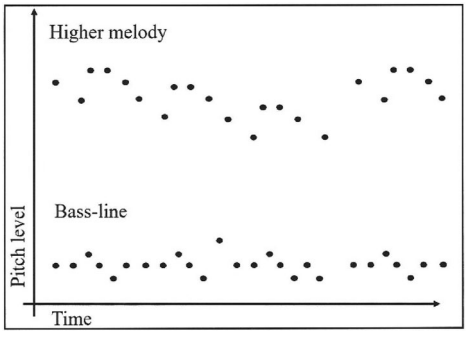


Figure 5. Pitch and connectivity in video 1.

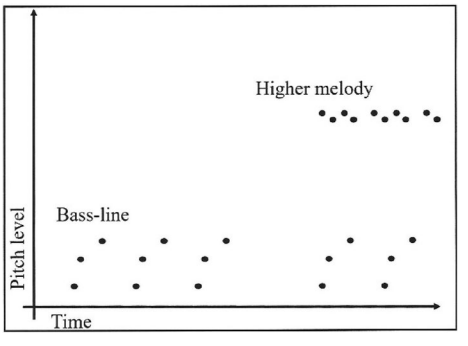


Figure 6. Pitch and connectivity in video 2.

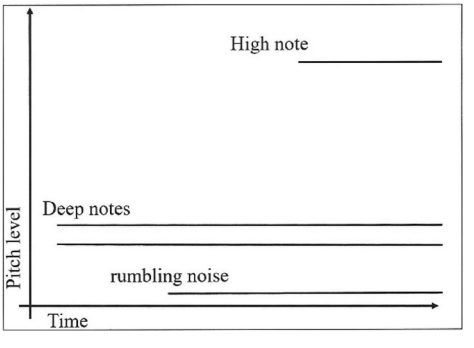


Figure 7. Pitch and connectivity in video 3.

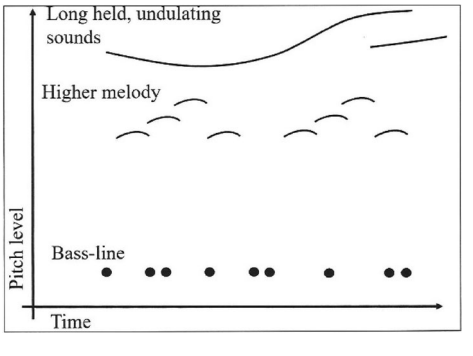


Figure 8. Pitch and connectivity in video 4.

Results

RQ1 - What characterizes the colour schemes and soundscapes of the videos?

Colour schemes

Table 6 summarizes the most essential characteristics of the colour schemes in the videos.

Additionally, we find that all four films feature significant outliers in terms of value, which provide contrasts. In Videos 1 and 2, contrast is provided in the clothing of the narrators, which are lower in value than the background. In Videos 3 and 4, essential elements of the scientific models have high values, which contrast with the low-value background. In the following, we exemplify these results using colour maps (see Figures 1–4).

The colour maps in Figures 1 and 2 exemplify the colour schemes in Videos 1 and 2, which may be summarized as follows:

- High value is proportionately dominant.
- Both videos contain contrasting elements in low value, primarily represented by the clothes of the narrators.
- Overall saturation is low.
- Both colour schemes are warm.

The colour maps in Figures 3 and 4 exemplify the colour schemes in Videos 3 and 4, which may be summarized as follows:

- Low value is proportionately dominant.
- Both videos contain contrasting elements in high value, which are used in representing the scientific models.
- Overall saturation is higher than in Videos 1 and 2.
- The colour scheme of Video 3 is cold, while the colour scheme of Video 4 is warm.

Table 6. Essential characteristics of colour schemes in the videos.

Video	Value	Saturation	Temperature
1	high	low	warm
2	high	low	warm
3	low	high	cold
4	low	high	warm

Soundscapes

In all four videos, the soundscapes primarily consist of the voice of the narrator accompanied by background music. The vocal styles of the narrators are all in an even, middle pitch with clear articulation and natural variations according to age and gender. The videos' background music, however, varies. In Videos 1 and 2, the music is characterized by low connectivity, pitch levels within the human vocal range, and soft, smooth material qualities arising from faithful synthetizations of real instruments. By contrast, Videos 3 and 4 are characterized by high connectivity, pitches far outside the human vocal range, and extensive use of reverb, as well as sharp, glassy, and rough material qualities. In the following, we will describe these qualities in more detail.

Figures 5 and 6 give approximate illustrations of pitch level and connectivity in the soundscapes of Videos 1 and 2, which may be summarized as follows:

- Sounds are characterized by low connectivity, as is denoted by the use of clearly separated dots.
- The background music in both videos use low and high pitch ranges, creating space for the middling pitch of the narrator.
- In Video 1, both the bass line and the melody run continuously, with neither being dominant over the other. In Video 2, the bass line runs on its own for most of the video, with the melody only appearing between 01:50 and 02:40 (see Figure 6).
- Both melody lines in Video 1 rise and fall in quite complex patterns, while in Video 2 they are more constricted and monotonous, characterized by two or three alternating notes.
- Pitch levels remain within the limits of the human vocal range.

Figures 7 and 8 give approximate illustrations of pitch level and connectivity in the soundscapes of Videos 3 and 4, which may be summarized as follows:

- Connectivity is most pronounced in Video 3, which features no measured time or even melody whatsoever, only unwavering notes, some of which are held for minutes at a time, produced by drone and glass synthesizers (illustrated in Figure 7 using continuous lines).
- Connectivity is achieved in Video 4 using undulating sounds lasting between three and six seconds (illustrated in Figure 8 using wavy lines), as well as a simple melody where each note glides into the others (illustrated using shorter, curved lines).
- In Video 3, the low pitch is dominant. The deep notes last longer than the high notes, which appear and fade out at shorter intervals.
- In Video 4, high pitches are dominant. The bass line is very simple, and its volume is indistinct compared to the higher sounds, making it less salient.
- While the rumbling noise in Video 3 is extremely deep and far below the human vocal range, the undulating, high sounds in Video 4 sometimes soar above the human vocal range.

Table 7 summarizes the material qualities drawn upon in the background music of the four videos.

Table 7. Significant uses of material qualities in the soundscapes.

Video	Material qualities
1	Soft
	Smooth
2	Soft
	Smooth
3	Mild reverb
	Roughness
4	Mild reverb
	Strong sharpness and vibration

The soundscapes in Videos 1 and 2 are primarily soft and smooth, produced through very convincing synthetizations of instruments such as bassoon, xylophones and piano, as well as contrabass and first violin being played in a plucking manner (pizzicato). Video 3 features a significant element of roughness in the lowest sound heard, making it particularly rumbling, while the high and undulating sounds in Video 4 are sharp and vibrating. Videos 3 and 4 both also feature a mild reverb.

RQ2 – How may the colour schemes and soundscapes be interpreted as means for social amplification and attenuation of risk?

Based on the meaning potentials of sound and colour described in the section *Colour schemes and soundscapes as means for the social construction of risk* above, we have interpreted the colour schemes and soundscapes of these videos as providing amplification or attenuation of risk by suggesting either safety or danger, and either alienation or familiarity.

We have interpreted the colour schemes of Videos 1 and 2 as suggesting safety and familiarity. We furthermore found the soundscapes to suggest familiarity, but while the soundscape of Video 1 also serves to suggest safety, the soundscape of Video 2 has some elements that rather suggest danger, resulting in a more complex expression. In Videos 3 and 4 on the other hand, we have interpreted both the colour schemes and soundscapes as more exclusively amplifying risk, through strong suggestions of danger and alienation. Overall then, we interpret the colour schemes and soundscapes of Videos 1 and 2 as primarily being oriented towards the attenuation of risk, and the colour schemes and soundscapes of Videos 3 and 4 as being primarily oriented towards its amplification, as summarized in Table 8.

We have arrived at these interpretations by considering the different features of colour and sound in coordination, viewing them as delimiting, qualifying and focusing each other. In the following, we will explain and exemplify our interpretations in more detail, beginning with the suggestion of danger and safety, then moving on to the suggestion of familiarity and alienation.

Table 8. Summary of meaning potentials and primary risk construction in the material.

Video	Colour schemes	Soundscapes	Primary type of risk construction
1	safety, familiarity	safety, familiarity	attenuation
2	safety, familiarity	danger, familiarity	attenuation
3	danger, alienation	danger, alienation	amplification
4	danger, alienation	danger, alienation	amplification

Safety and danger

The colour schemes of both Videos 1 and 2 are coordinated in a manner that, through experiential metaphor, provides meaning potentials that we have interpreted as suggesting safety, thereby moving emphasis away from the dangers represented by climate change, and thus functioning as a form of risk attenuation. Through the proportional prevalence of high values, the positive meaning potential of daylight is made available, while the use of warm colours supplies the ambiguous meaning potential of warmth. However, this warmth and positivity is toned down through the coordination of these features with low saturation. This, we would suggest, has two functions: firstly, the ambiguity of warmth is reduced, making moderate warmth a more plausible interpretation than intense heat, meaning that the high temperature may support the high values in suggesting safety. Secondly, toning down the sense of positivity may ensure that the videos do not appear inappropriately positive in light of the seriousness of the subject at hand. We have interpreted the contrasting low values provided by the clothes of the narrators in these colour schemes as primarily serving to draw attention to the narrators, and not to come in conflict with the overall attenuating orientation of the colour scheme.

In the soundscape of Video 1, we have interpreted the coordination of soft and smooth sounds with both broad and varied pitch movement as providing further suggestions of safety. By contrast, the soundscape of Video 2 is dominated by deep pitches and constricted pitch movements, which we have interpreted as primarily suggesting danger. However, as this soundscape is also characterized by soft and smooth material qualities, we would argue that the effect is somewhat blunted.

By contrast, we have interpreted both colour schemes and soundscapes in Videos 3 and 4 as providing strong suggestions of danger, thereby emphasizing the risks inherent to climate change, and thus serving as a form of risk amplification. With regards to the colour schemes, the proportional prevalence of low values contribute the negative meaning potentials of the night, and the combination of either very high or very low colour temperature with high saturation, provides metaphorical associations to temperatures of dangerous intensity. In the soundscape of Video 3, danger is further underlined through the same dominance of deep pitches as used in Video 2, combined with rough material qualities. In the soundscape of Video 4 on the other hand, danger is suggested through the dominance of high pitches combined with narrow pitch movement and sharp, vibrating sounds. In both videos, the suggestions of danger is intensified by being coordinated with a mild reverb.

Familiarity and alienation

The colour schemes and soundscapes of both Videos 1 and 2 are coordinated in manners that, through experiential metaphor, provides meaning potentials that suggests familiarity. A central feature is the degree of connectivity in the soundscapes. In the context of climate change, we would suggest that the low connectivity in the soundscape of Videos 1 and 2 casts climate change as something worldly and manageable, essentially familiar. This then counters the notion of climate change as something abstract, global, and notoriously unmanageable. This familiarity is further strengthened

through the use of classical instruments with soft and smooth material qualities as well as human pitch ranges, and the toned down warmth and brightness of the colour schemes.

In Videos 3 and 4 however, the high degree of connectivity and use of pitches outside human vocal range may suggest alienation. In the context of climate change, we have interpreted this as amplifying risk, by placing emphasizing upon the vast, abstract, and unmanageable nature of climate change – the invisible threat. We have also interpreted the low values of the colour schemes as providing further support to the suggestion of the unknown, through its metaphorical association with the night.

Conclusion

These results have demonstrated how four professionally produced videos, which share the common rhetorical aim of explaining anthropogenic climate change, and which all have similar generic structures, nevertheless feature vastly different colour schemes and soundscapes, which we have interpreted as construing risk in very different ways.

In Videos 1 and 2, both produced by the Norwegian Broadcasting Corporation (NRK), the colour schemes are bright, low in saturation, and generally warm, which we have interpreted as suggesting safety through experiential metaphor. In Video 1, we have interpreted the softness, smoothness and broad pitch movement of the soundscape as further supporting this, while in Video 2 there are elements with meaning potentials that rather suggest danger – the proportional dominance of deep pitches and narrow pitch movements. We have also interpreted the colour schemes and soundscapes of both these videos as suggesting familiarity, based on the meaning potentials of low connectivity as well as bright and warm colours.

In contrast, Video 3, made by the production company Snöball, and Video 4, produced by Save the Children, have colour schemes that are dominated by dark colours, with contrasting elements in either very cold or very warm hues that are high in both value and saturation. In this manner, the meaning potentials of night and intense temperatures are provided through experiential metaphor, which we have interpreted as suggesting danger. Furthermore, the soundscapes support this through either rough, deep pitches or sharp, high pitches. We have also interpreted the colour schemes and soundscapes of these videos as suggesting alienation, through the coordination of melodic connectivity and extreme pitch levels with low value colours.

Overall then, our interpretations indicate that, in terms of risk construction, the colour schemes and soundscapes of Videos 1 and 2 are primarily oriented towards the attenuation of risk, while the colour schemes and soundscapes of Videos 3 and 4 are primarily oriented towards the amplification of risk. It should be noted that the soundscape in Video 2 contradicts this to some degree, as it contains substantial elements suggesting danger. These elements should be considered minor, however, in comparison with the more emphatic suggestion of danger in Videos 3 and 4.

The validity of these interpretations should be considered in light of how colours and sound function as semiotic resources. Because both make meaning based on experiential metaphor, as opposed to systematic cultural conventionalization, their meaning potentials lack precision – they are inherently broad, fleeting and contradictory (Van Leeuwen 1999, 2011). We therefore do not wish to imply that the colour schemes and soundscapes

somehow function as precise propositions of risk, with no other meaning potentials. As an illustration, the meaning potentials of low value may be examined further. While we have interpreted it as a means for the social amplification of risk, based on experiential metaphors suggesting danger and alienation, we do not wish to claim that the low values used in Videos 3 and 4 can come to mean nothing else than this in a context of use. For example, Michel Pastoureau has stressed the ambiguity of the dark – in both Hellenic, African, Asian and Norse mythology, darkness is often a primordial, fertile matrix, yet at the same time one that both imprisons and is the haunt of monstrous beings (Pastoureau 2008, 21–22). The many negative associations that form part of the ambiguous meaning potential of darkness, makes low value apt for the social amplification of risk, and less suited for the social attenuation of risk. At the same time however, the experiential basis that these negative associations build on – the invariants of our bodies that makes night less travelled by humans than day – also lends it meaning potentials of a more positive nature, such as mystery, daring and exploration. The context of anthropogenic climate change does not in our opinion erase these meaning potentials. On the contrary, we would suggest that ambiguity remains.

So in interpreting the colour schemes and soundscapes of the videos as being a means for the social construction of risk, we do not claim that this is their only function. The interpretations we have offered here exhaust neither the full meaning potentials of the colour schemes and soundscapes in the videos, nor how other individuals may interpret them in empirical contexts of use. Nevertheless, they do indicate that the colour schemes and soundscapes of the videos have significant elements that are apt for the social construction of climate risk, and furthermore that the different manners in which colour and sound is used is apt for construing climate risk in distinctly different ways.

These results demonstrate how colour and sound both are and may be used as powerful tools of expression in climate communication. Previous research in climate communication has both hypothesized and demonstrated how *non-scientific visualizations* may be a resource for provoking affective responses to the climate issue (Culloty et al. 2019; Doyle 2009; Leiserowitz 2006; Joffe 2008; O'neill et al. 2013; O'neill and Hulme 2009; O'Neill and Nicholson-Cole 2009; Metag et al. 2016). Based on our interpretations, we would suggest that colour and sound may be employed rhetorically for similar purposes, though with at least two significant differences.

Firstly, in contemporary communication, these semiotic resources need not be employed separately from a scientific visualization. As our analyses have illustrated, they may form part of the design of a scientific visualization, and thus instil it with the kind of affective meaning potential that climate communication research has suggested is lacking in scientific visualizations. In the videos we have analysed, coordinated colour schemes fill the outline of the visual models, while soundscapes immerse them. Though all the models are very scientific, colour and sound provide them with a wealth of additional meaning potentials that carry strong affective resonances. Secondly, we would argue that colour and sound may provide wider grounds for facilitating engagement and identification than more specific depictions do. Our analyses have illustrated how the meaning potentials colour and sound contributes are very broad, even after being focused through coordination in colour schemes and soundscapes.

For educators and teachers who wish to incorporate digital media content like the videos analysed here in educational programs, our analyses illustrates how climate

change may be construed in many different ways, even in videos that explicitly argue the reality of anthropogenic climate change and the need to take action. Any of these four videos could fill the need for a scientifically founded and professionally produced general introduction and explanation of anthropogenic climate change. However, as the videos differ in how they suggest that the viewer perceive their inherent risk claims, educators will have to reflect upon what sort of representation is relevant for their purpose, and how the chosen video should be treated within the educational program more broadly. A video that amplifies the risks of climate change may necessitate very different discussions before and after viewing than one that attenuates these risks.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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