Audience segments in environmental and science communication: recent findings and future perspectives

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Abstract: People differ. Not only do they vote for different parties, buy different products, have different hobbies and use different media. They also differ in their interest in, attitudes on, and behavior towards scientific and environmental issues. This has been shown for people's general assessments of environmental issues (e.g. Eurobarometer, 2017) and of science and research (for an overview see Besley, 2013). It has also been demonstrated for people's attitudes towards more specific topics such as global warming (for an overview see Nisbet Myers, 2007), nuclear energy (e.g. Kristiansen, Bonfadelli, Kovic, 2016), nanotechnology (e.g. Scheufele, Corley, Shih, Dalrymple, Ho, 2009), or biotechnology (e.g. Bonfadelli, 2017). These differences are not randomly distributed across populations. Researchers from the social and behavioral sciences have identified the organizing logics that underlie this diversity, and identified factors which help explain the variation of people's attitudes. They have shown, for example, that perceptual and behavioral differences with regards to scientific and environmental issues are related to people's education, their age, gender, or socio-economic status, among other factors (see, e.g. Besley, 2013; Kawamoto, Nakayama, Saijo, 2013; Nisbet Myers, 2007; Research Councils UK, 2008).

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Audience Segments in Environmental and Science Communication. Recent Findings and Future Perspectives

Introduction to a Special Issue of "Environmental Communication"

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1. The Aims and Uses of Segmentation Analyses

People differ. Not only do they vote for different parties, buy different products, have different hobbies and use different media. They also differ in their interest in, attitudes on, and behavior towards scientific and environmental issues. This has been shown for people's general assessments of environmental issues (e.g. Eurobarometer, 2017) and of science and research (for an overview see Besley, 2013). It has also been demonstrated for people's attitudes towards more specific topics such as global warming (for an overview see Nisbet & Myers, 2007), nuclear energy (e.g. Kristiansen, Bonfadelli, & Kovic, 2016), nanotechnology (e.g. Scheufele, Corley, Shih, Dalrymple, & Ho, 2009), or biotechnology (e.g. Bonfadelli, 2017).

These differences are not randomly distributed across populations. Researchers from the social and behavioral sciences have identified the organizing logics that underlie this diversity, and identified factors which help explain the variation of people's attitudes. They have shown, for example, that perceptual and behavioral differences with regards to scientific and environmental issues are related to people's education, their age, gender, or socio-economic status, among other factors (see, e.g., Besley, 2013; Kawamoto, Nakayama, & Saijo, 2013; Nisbet & Myers, 2007; Research Councils UK, 2008).

Even with these additional insights, however, the existing perceptual, attitudinal, and behavioral differences are "a significant challenge for scientists, policy makers, and others tasked with effective communication[, as c]ertain types of messages may be enthusiastically embraced by some members of the general public, but elicit indifference or outrage from others" (Hine et al., 2014, p. 441). Therefore, one approach aiming to tease out the larger patterns lying behind differences in individual attitudes across populations has gained prominence in research on environmental and science communication: segmentation analysis.

The overarching goal of segmentation analyses is to analytically "divide the general public into relatively homogeneous, mutually exclusive subgroupings" (Hine et al., 2014, 442). To do so, they employ three general steps (see Fig. 1):

Their *starting point*, firstly, is a *population that is diverse in characteristics which are seen as analytically relevant*. Implicitly or explicitly, researcher define two aspects at this step: They define the relevant population, and even though many segmentation analyses work with national populations, the relevant population can vary considerably in size. Researchers also define the characteristics of these populations which are of interest, and those can vary between sociodemographic characteristics, psychological traits, attitudes or people's behavior.

The *second step* of is the *collection of data* on this diverse population. This can be done with qualitative or quantitative methods of social-scientific research, using interviews or survey techniques, real-life

observation, as well as behavioral trace data taken from media use or social media analysis. This data is then analyzed with appropriate strategies of data analysis.

Based on these analyses, *thirdly*, *segments of the population are identified* which are homogeneous in the characteristics defined as analytically relevant – be it their sociodemographic characteristics, their attitudes, behavioral variables, or others. It is important to note here that the resulting segments do not have to be – and, in fact, often are not – real-world communities that know each other and interact with one another; they are often merely clusters of individuals with similar characteristics.

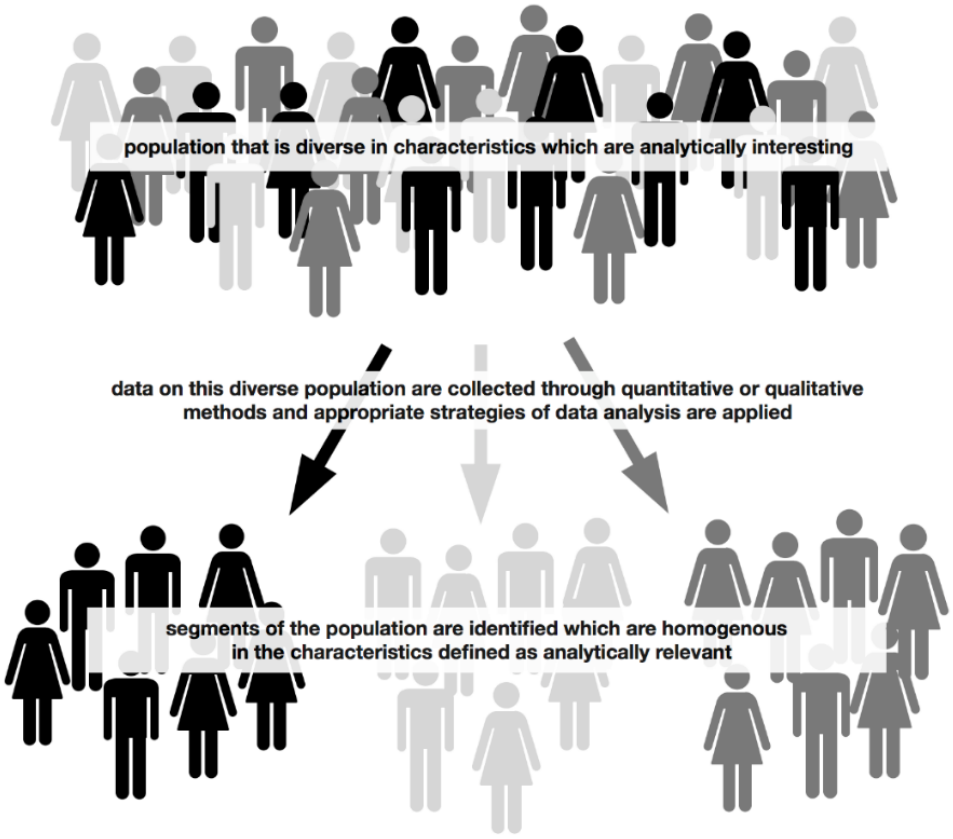

Fig. 1: The General Logic of Segmentation Analyses

These three steps constitute the core of segmentation analyses. Subsequently, the resulting segments are often used to describe additional of their characteristics, for example to develop marketing or communication strategies specifically tailored to them (Slater, 1996).

This general logic applies to all kinds of segmentation analyses. But existing studies have employed a broad range of methods and used different kinds of data (see, e.g., Hine et al., 2014). There are, however, some common variants of segmentation analyses. These variants differ in the characteristics they consider to be analytically relevant and, accordingly, in the variables they select for the different steps described above. Three common variants of segmentation analyses have been identified in the scholarly literature (see also Table 1):

The first variant, which was often used early on, are *sociodemographic segmentation analyses* (cf. Dibb & Simkin, 2009). These studies "discriminate[d] between audience or market groups on the basis of easily accessed variables, such as demographics (education, race, income, gender) and geographic

location" (Slater, 1996, p. 269). Thus, they constructed sociodemographically homogeneous groups and subsequently assessed the attitudes of these groups and behavioral variables such as media use. These approaches were criticized, however, as their usefulness was restricted to the few cases where people's sociodemographic characteristics functioned as strong predictors of attitudinal or behavioral variables (Yankelovich & Meer, 2006, 123f.).

Accordingly, segmentation analyses moved away from sociodemographic segmentation towards two other, more recent approaches (cf. Lotenberg, Schechter, & Strand, 2011). Many of them are *"psychographic" segmentation analyses* (Wind, 1978, 319f.). They base their segmentation on people's attitudes towards a given topic or object and aim to reconstruct segments which are homogenous in these attitudes. This kind of segmentation analysis has been used widely, for example in fields like health (Noar, Benac, & Harris, 2007), energy (Sütterlin, Brunner, & Siegrist, 2011), or global warming (Hine et al., 2014). A criticism towards these analyses is their limited predictive power for people's behavior – "psychographic" homogeneity may be connected to different behaviors, such as different patterns of consumption or media use (cf. Yankelovich & Meer, 2006, p. 124).

Trying to deal with this criticism are proponents of a third variant: of *"behavioral" segmentation analyses*. These analyses segment populations around behavioral and consumption data (Yankelovich & Meer, 2006, 125f.), including patterns of information and media use (cf. Lotenberg et al., 2011). They stem mostly from the fields of advertising and (social) marketing research.

	«Sociodemographic» Segmentation Analyses	**«Psychographic» Segmentation Analyses**	**«Behavioral» Segmentation Analyses**
Analytically relevant variables	segment on "demographics (education, race, income, gender)" which are then "crosstabbed with media use[,] involvement and behavior" (Slater, 1996, 268f.)	segment on attitudes towards a topic and then link them to sociodemographics & behavioral variables (Wind, 1978)	segment on behavioral variables (e.g. consumption patterns) or channels of communication (Yankelovich & Meer, 2006)
Application and limitations	used in early segmentation analyses; limited to (few) cases where sociodemographics are strong predictors of attitudinal or behavioral variables of interest (123f.Yankelovich & Meer, 2006)	used in health communication, environmental psychology, climate change communication (Hine et al., 2014; Noar et al., 2007; Sütterlin et al., 2011) ; predictive power for behavior limited (Yankelovich & Meer, 2006)	used in marketing & advertising research (Lotenberg et al., 2011)

Table 1: Common Variants of Segmentation Analyses

2. Segmentation Analysis in Environmental and Science Communication

In recent years, segmentation analyses have increasingly been applied to scientific and environmental issues. A number of them have focused on *people's general attitudes towards science*. Several such studies were conducted in the early 2000s by the British Office of Science and Technology (OST), partly in cooperation with the Wellcome Trust (OST, 2005; OST & The Wellcome Trust, 2001; OST & Wellcome Trust, 2000). Based mostly on representative surveys and partly supplemented by qualitative studies,

the OST studies relied on people's science-related attitudes to segment them "psychographically". Relying on a combination of factor and cluster analysis, they constructed six "attitudinal groups" from the "confident believers" and the "technophiles" over the "supporters" all the way to the "concerned", the "not sure" and "not for me" groups (OST, 2005, 5ff.). Similar segmentation analyses using general attitudes towards science were conducted in Japan (Kawamoto et al., 2013), Switzerland (Schäfer, Füchslin, Metag, Kristiansen, & Rauchfleisch, 2018), and South Africa (Guenther & Weingart, 2017), all of them describing a spectrum of population segments ranging from (almost) unconditional support towards science to criticism or skepticism.

In addition, several studies have focused on *specific fields of science*, mostly related to medicine and health (see also the meta-analysis of Noar et al., 2007). Maibach et al. (Maibach, Weber, Massett, Hancock, & Price, 2006), for example, used US survey data and hierarchical cluster analysis to identify population segments that differ in their preferences towards health information and their own health decision-making. Their four segments are the "independent actives", the "doctor-dependent actives", the "independent passives" and the "doctor-dependent passives". Nisbet and Markowitz (Nisbet & Markowitz, 2014), also based on a survey in the US, split the population into four audience groups which differ in their attitudes towards the relation between science and society, and in a subsequent step, lay out how these groups differ in their approaches towards public engagement and controversies surrounding biomedical science.

A field where segmentation analyses have been particularly prominent is the analysis of perceptions of and attitudes towards *global warming* (for an overview of the respective studies see Hine et al., 2014). Arguably the most prominent works in this field are the "Global Warming's Six Americas" studies conducted by Yale University's "Program on Climate Change Communication" (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013; Leiserowitz, Maibach, Roser-Renouf, & Smith, 2010). These studies, again based on representative surveys in the US, identified six audience segments with different attitudes towards climate change: the "Alarmed", who are most engaged about global warming; the "Concerned", who believe that global warming exists but are less involved; the "Cautious", who are not as certain and do not think climate change is a threat to them personally; the "Disengaged", who have not thought about the issue much; the "Doubtful", who doubt either that climate change exists and/or that it is caused by human activity; and the "Dismissive", who firmly believe that global warming is not happening. Inspired by the example of "Global Warming's Six Americas", similar studies sprung up in other countries, partly in collaboration with the US team. Such studies exist for Australia (Ashworth, Jeanneret, Gardner, & Shaw, 2011; Morrison, Duncan, Sherley, & Parton, 2013), Germany (Metag, Füchslin, & Schäfer, 2017), India (Leiserowitz, Thaker, Feinberg, & Cooper, 2013), and Singapore (Detenber, Rosenthal, Liao, & Ho, 2016). These studies complement their segmentation analyses with different outcome variables ranging from climate-related behavior (Maibach, Roser-Renouf, & Leiserowitz, 2009) to patterns of media and information use (Detenber et al., 2016; Metag et al., 2017).

In addition, segmentation analyses are available for several *other environmental issues*: For example, Hefner (Hefner, 2013) identified six types of Germans with different attitudes and behaviors towards environmental protection – from people who are strongly concerned but do not behave accordingly to people who are not concerned at all – who also differ in their communicative behavior and information gathering. Sütterlin et al. (Sütterlin et al., 2011) analyze the Swiss' views on energy consumption, also identifying six segments based on energy-related behaviors – from the idealists who excel in energy-saving to indifferent consumers who value convenience and are largely ignorant about the increase in energy consumption. And Vicente & Reis (Vicente & Reis, 2007) distinguish three

segments of the Portuguese with regards to attitudes towards recycling, one being positive about it and the other two being reluctant or indifferent.

3. Challenges and Gaps in Segmentation Analysis

Although a number of segmentation analyses exist which focus on populations' perceptions and attitudes towards scientific and environmental issues, they exhibit a number of biases and gaps. A first one is that many of these studies do not analyze to what extent population segments differ in their patterns of media and information use. For scholars of science or environmental communication, however, this is a crucial question. After all, it is well established that media are important for forming individual opinions and attitudes, especially with regards to science and environmental issues. Legacy media as well as online media are the most important sources for people to inform themselves about these issues (Brossard, 2013; Fischhoff & Scheufele, 2013). At the same time, the uses and effects of science-related information and media use differ considerably between, for example, age groups, gender, and educational levels (Chang, Kim, Kang, Shim, & Ma, 2017; Nisbet et al., 2002). Therefore, it is reasonable to assume that population segments would also differ with regards to their patterns of media and information use.

Second, many segmentation analyses on science and environmental issues are "psychographic" analyses (see Table 1). And while these studies are certainly worthwhile, they should be complemented by other types of segmentation analyses. Until now, however, there are hardly any segmentation studies in science or environmental communication that use "behavioral" approaches and segment the population based on their media and information use.

Third, the scope of existing segmentation analyses differs. This concerns the respective analyses' topical scope, i.e. the questions about which the population is surveyed. Many studies are based on people's general attitudes towards science (e.g. OST & The Wellcome Trust, 2001) – but even those differ in their exact wording, with some of them asking, for example, for attitudes towards "science and research" (Schäfer, Füchslin, Metag, Kristiansen, & Rauchfleisch, 2018) and others for attitudes towards "science and technology" (Kawamoto, Nakayama, & Saijo, 2011). Furthermore, studies on more narrow topics base their analysis on questions about specific scientific and environmental topics, such as climate change (Leiserowitz, Maibach, Roser-Renouf, Feinberg, & Howe, 2013; Metag, Füchslin, & Schäfer, 2017). These differences often prevent comparisons of segments found in different studies. In addition, the geographical scope of existing segmentation analyses is often limited. Most of them only focus on one country, and cross-national comparisons are missing. More importantly, the countries they focus on are mainly "Western" – mostly North American and Western European – countries. Among the few exceptions are the global warming segmentation studies in India (Leiserowitz, Thaker, Feinberg, & Cooper, 2013) and Singapore (Detenber, Rosenthal, Liao, & Ho, 2016). Last, the temporal scope of segmentation analyses is rather narrow. Most studies are based on people's attitudes assessed at one specific point in time. Not much is known about whether and how segments change and develop over time. The only study which allows for comparisons over time is the Global Warming's Six Americas study which has been first conducted in 2008. By now, the authors are able to track how the Six Americas segments have changed between 2008 and 2016 (Roser-Renouf, Maibach, Leiserowitz, & Rosenthal, 2016).

Third, there are several methodological issues that need to be taken into account when conducting a segmentation analysis. Most studies in the field rely on quantitative data, and only few studies tease out segments based on qualitative data. For example, Lorenzoni and Hulme (2009) complement their quantitative survey with qualitative discussion groups in their study on attitude segments with regards

to socio-economic and climate scenarios. The study on climate change segments by Horton and Doron (2011) is completely based on focus groups data. Those quantitative studies referred to above also profoundly vary in their logic of data analysis. The segments are identified based on cluster analysis (e.g. Metag et al., 2017), latent class analysis (e.g. Leiserowitz, Maibach et al., 2013; Schäfer et al., 2018), or latent profile analysis (Hine et al., 2013). This, again, hampers the comparability of the segments found in the different study.

Another methodological challenge arises from the fact that most of the surveys used for segmentation analysis in science and environmental communication include many items and rather long item batteries. Since not every researcher is able to include the same number of items and/or the exact same items, most studies are based on different sets of variables. This problem has been acknowledged by Maibach, Leiserowitz, Roser-Renouf, and Mertz (2011) as well as Swim and Geiger (2017), trying to develop shorter survey tools or even single item measures to identify audience segments which can be incorporated in more surveys, allowing for higher standardization and comparability.

4. Broadening the Scope of Segmentation Analysis in Environmental and Science Communication: Introducing the Special Issue

This special issue tackles these challenges and gaps – at least some of them. The contributions included here broaden the topical scope of segmentation analyses by studying relevant cases and countries. They use a variety of designs, methods, and types of data analysis and thus contribute to filling the outlined research gaps.

The first study by *John Besley* (2018) combines a "sociodemographic" with a "psychographic" approach to segmentation analysis. It segments U.S. citizens based on a set of demographic variables as well as ideology and attitudes towards science and technology. He demonstrates that the US public can be segmented into six groups, ranging from "Disengaged" to "Liberal Sciencephiles" and "Conservative Sciencephiles". The study advances other segmentation analyses in that it uses latent profile analysis to identify the segments and employs post-hoc analyses to show that group-based analysis can result in more nuanced findings compared to variable-focused analyses – an important finding for crafting suitable messages appealing to different groups.

Being also based on a "psychographic" approach and data on U.S. citizens, the study by *Kristin Runge, Dominique Brossard and Michael Xenos* (2018) provides a post-hoc segmentation analysis. By using secondary data, they identify five population segments with regards to their knowledge and attitudes towards science, from the "Protective Progressives" to the "Distrustful Traditionalists". Employing regression analysis, they can show that an important characteristic describing one segment, e.g. media affect for "Unengaged Moderates" may not be important for another one, e.g. media affect for the other segments. These additional tests of segments solutions help researchers identifying an optimal solution.

Compared to the first two papers in this special issue, *Lars Guenther, Peter Weingart and Corlia Meyer* (2018) take a different approach to audience segmentation. It goes beyond the state of research in two ways – first, by studying segments and their attitudes towards science in a non-Western country, i.e. in South Africa, and, second, by using qualitative data from semi-structured interviews to do so. By drawing on the theoretical concept of cultural distance to science, the authors identify three segments of the South African public which range between being culturally close and culturally distant to science.

Another study that identifies audience segments not solely based on quantitative data is provided by *Jennifer Bernstein and Brian Szuster* (2018). Using a multi-method design including survey and repertory grid interviews, they show that contemporary environmentalists can be differentiated into sub-groups based on their attitudes towards nature's resilience, locus of control, catastrophism, and faith in technology. Thus, the study contributes to existing segmentation analyses by demonstrating that "even within groups who can broadly be understood as pro-environmental, there is a significant divergence of worldviews" (ADD CORRECT PAGE NO. HERE WHEN ARTICLES ARE FINALLY SET).

The fifth manuscript in this special issue, by *Julia Metag, Michaela Meier, Laurits Bromme, Tobias Füchslin and Mike S. Schäfer* (2018), deals with two challenges of previous segmentation analyses in science and environmental communication. First, the paper does not rely on a "sociodemographic" or "psychographic" approach but conducts a "behavioral" segmentation analysis: It segments people's based on their patterns of media and information use with regards to scientific issues. Second, it is one of the very first studies to analyze audience segments in a cross-national comparison. Drawing on comparable survey data from Germany and Switzerland, it shows that people in both countries can be differentiated into similar segments. Both in Germany and Switzerland, there is a group which actively seeks for or consumes scientific information frequently as well as a group which hardly uses scientific information at all. Through the focus on science-related media use, the authors contribute to the state of research by outlining what kind of media repertoires exist in the two European countries.

The last two papers included in this special issue are concerned with methodological challenges of segmentation analyses in science and environmental communication. Both studies aim at developing and testing a short scale for identifying audience segments. *Tobias Füchslin, Mike S. Schäfer and Julia Metag* (2018) develop a short survey scale for segmenting people with regards to their attitudes towards science. By reducing the number of survey items from originally 20 to 10, the final scale enables researchers to save survey time and to improve the standardization of survey instruments.

In contrast, the paper by *Breanne Chryst, Jennifer Marlon, Sander van der Linden, Anthony Leiserowitz, Edward Maibach, and Connie Roser-Renouf* (2018) deals with the issue of climate change. Based on the Global Warming's Six Americas segmentation analyses - which originally require a set of 36 survey items - the authors identify a subset of four questions which can be used to segment respondents into the "Six America's" categories. In addition, they also employ an innovative method by using machine learning algorithms to identify the items necessary for categorization. With these two contributions, short scales for identifying segment with regards to their scientific attitudes in general as well as with regards to a specific environmental issue, global warming, exist and can be implemented in future studies.

Concluding the special issue, *Dietram A Scheufele* (2018) delivers a comment on the seven research articles. He emphasizes that while scholars of environmental and science communication have long said that their audiences can not be seen as monolithic, comparatively little work has actually reconstructed these diverse audiences empirically. The advantage of such work is, argues Scheufele, that it can help communication with people outside the "proverbial choir" (ADD CORRECT PAGE NO. HERE WHEN ARTICLES ARE FINALLY SET). At the same time, he calls for future segmentation analyses to take differences between issues, cultural contexts and stages of the issue cycle into account, and to build a strong theoretical foundation for such analyses as well.

5. The Way Forward: Perspectives of Segmentation Analyses

The contributions to this special issue demonstrate the advantages of segmentation analyses with regards to environmental and science communication, and fill a number of research gaps. But, of

course, they cannot tackle all the gaps and biases of the research field, and a number of challenges will remain for future studies.

First, most of the studies presented here rely on the "psychographic" approach – like most studies before. This, of course, has the advantage that distinct groups with similar attitudes towards science and environmental issues can be differentiated. But it neglects "behavioral" segmentation analyses, which would be fruitful as well. After all, Metag et al. reveal that segments with distinct media repertoires seem to exist when it comes to science communication. And these media repertoires differ from people's media and information use when other issues, such as everyday news, are concerned. Future studies should therefore make use of the behavioral approach more often, particularly from a science and environmental communication perspective. Since media are the most important sources for information about science and the environment, identifying which segments in the public exist with regards to media repertoires can be of immense theoretical and practical value.

Second, the contributions to this special issue broaden the scope of segmentation analyses by segmenting publics with regards to different topics (e.g. general science and research vs. global warming or environmental values) and by including a non-Western country and a cross-national comparison. However, segmentation analyses still have not reached their full potential. The analysis of audience segments in non-Western countries still needs to be broadened. As Guenther et al. show, culture can play an important role in the formation of audience segments. It would thus be insightful to extend segmentation analyses in science and environmental communication to other countries, particularly ones whose culture differs from Western countries. Metag et al. demonstrate that cross-national approaches can be useful in segmentation studies to detect whether there are homogeneous segments that are even comparable across countries. Cross-national comparisons between countries with greater differences than the two European countries studied by Metag et al. would enrich what we know about science-related audience segments worldwide.

The current lack of comparative segmentation studies might also be due to the fact that many surveys use different items as the basis for segmentation. Therefore, thirdly, the methodological advances provided by the final two papers in this special issue may prove valuable. They provide shorter survey scales that can be used to segment audiences around their attitudes towards science and climate change. However, these scales still need to be tested in other countries and a general effort for more standardized, comparable surveys about science and the environment in different countries needs to be made.

It was also clear that qualitative approaches can be useful to identify population segments. Future studies should be open to complement quantitative approaches with qualitative approach in the process of identifying segments. Alternatively, one could follow up on segments that have been identified based on a quantitative survey by, in a second step, researching people belonging to these segments with qualitative approaches. This way, more detailed information, e.g. about how people belonging to a specific segment get in contact with information about science or environmental issues in their everyday life, how they evaluate this information, and how this relates to their attitudes, can be generated.

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