JCOM

Effects of opinion statements on laypeople's acceptance of a climate engineering technology. Comparing the source credibility of researchers, politicians and a citizens' jury

Geraldine Klaus, Lisa Oswald, Andreas Ernst and Christine Merk

Abstract

To examine the influence of different actors' fictitious statements about research and deployment of stratospheric aerosol injection (SAI), we conducted an online survey in Germany. Participants assess researchers and a citizens' jury to be more credible than politicians. Credibility has a strong positive effect on SAI acceptance in both pro-SAI and contra-SAI conditions. Reading the statement against SAI-deployment led to significantly lower acceptance scores compared to reading the pro-statement. However, the difference between messages was unexpectedly small, indicating that the message content was not fully adopted while underlying traits and attitudes mainly shaped acceptance even despite, or because of, low levels of knowledge.

Keywords Environmental communication; Public perception of science and technology

DOI https://doi.org/10.22323/2.20010203

Submitted: 8th August 2019
Accepted: 3rd November 2020
Published: 25th January 2021

Introduction

Anthropogenic climate change and its consequences pose one of the biggest threats to humanity today [Guterres, 2018]. Emissions of greenhouse gases such as CO_2 have already led to a global mean temperature rise of one degree Celsius since the beginning of the industrialization [IPCC, 2018]. If no comprehensive measures are taken, extreme impacts on humans and nature are expected. Despite the political and social efforts to take action and some countries slowly beginning to rethink, achieving the well below 2°C target as set in the Paris Agreement in 2015 [UNFCCC, 2015] seems a long way off.

For this reason, so-called climate engineering (CE) technologies are increasingly discussed and investigated in computer models [Horton, Keith and Honegger, 2016; National Research Council (U.S.), 2015], while the societal perspective is assessed in surveys and qualitative research projects, e.g. involving focus groups and citizens' juries [see Burns et al., 2016, for an overview; Merk, Pönitzsch and

Rehdanz, 2016; Bürgerforum Climate Engineering, 2018]. CE technologies are described as large-scale interventions into the climate system with the goal to slow down global mean temperature rise. One main category of CE approaches is solar radiation management (SRM), which targets the Earth's potential to reflect sunlight back into space [Shepherd, 2012]. The most prominent approach is 'stratospheric aerosol injection' (SAI). It deals with the injection of aerosols such as sulphur particles into higher layers of the atmosphere to reflect sunlight back into space and thus cool the Earth [Crutzen, 2006; Keith, 2013]. SAI is intensively discussed in expert circles because of its advantages, such as low-cost and potentially rapid deployment, and at the same time its manifold ethical, political, social, economic and technological risks and uncertainties [Baatz, 2016; Keith and Irvine, 2016; Mahajan, Tingley and Wagner, 2019; Ming et al., 2014; Robock, Jerch and Bunzl, 2008; Robock, Marquardt et al., 2009]. It certainly has some advantages over mitigation but also great disadvantages like unpredictability and moral concerns [Mahajan, Tingley and Wagner, 2019] and it does not address the problem of high atmospheric greenhouse gas concentrations.

The applicability of a technology like SAI is difficult to assess and involves many known and unknown risks; this adds to general difficulties of communicating the large uncertainties to societal stakeholders and laypeople. Risks must be weighed against advantages and benefits, considering losers and winners at a complex global scale.

The risks have not yet been investigated comprehensively enough; the uncertainties are very high, which is why e.g. the Convention on Biological Diversity (CBD) agreed on a temporary moratorium in 2010, which states that no large-scale climate engineering measures should be carried out until sufficient scientific data is available [Convention on Biological Diversity, 2010].

When it comes to a discussion about further research or even the deployment of solar radiation management technologies, the lay public plays a decisive role. Not only due to the inherent complexity of communicating uncertain risks, it is a difficult but necessary task to inform the public about CE technologies. Relevant actors involved in the communication process are politicians, researchers, private sector and industry actors as well as public sector organisations. With a low level of prior knowledge, laypersons are vulnerable to framings of the (un)desirability of such technologies [Chebat, Limoges and Gélinas-Chebat, 1998; Converse, 1970; Huffman et al., 2007; Jin and Han, 2014]. The source of information also influences respondents' perception of the content, with credible sources often being more persuasive than less credible sources [Grewal, Gotlieb and Marmorstein, 1994; Pornpitakpan, 2004]. We aim to investigate how different actors influence laypeople's opinions on SAI and how these actors are evaluated.

In this context, the credibility of political and scientific actors is a crucial factor. If institutions and communicators in a democracy are not thought of as trustworthy and competent, communication with the lay public will hardly be constructive and even beneficial measures have no chance to be implemented. In addition to the perceived credibility of a statement's content, particularly the credibility of the person making the statement seems to be of high importance [Eagly and Chaiken, 1993; Terwel et al., 2009]. The perceived credibility of a source or messenger is often used by people as a 'heuristic or information shortcut when they have to form attitudes or decide whether to accept a message or not' [Weingart and Guenther, 2016, p. 7; Brewer and Ley, 2013; Nisbet and Scheufele, 2009; Petty and Cacioppo, 1986]. Previous acceptance research in related fields like renewable energies or carbon capture and storage (CCS), already highlights the importance of trust in involved actors for laypeople's attitude formation on SAI [Liu et al., 2019; Terwel et al., 2009].

Should the deployment of a technology like SAI be considered seriously, communication with society will be crucial for the outcome in democratic countries. The extent to which the perceived credibility of various types of communicators then plays a role in public acceptance is investigated in this study. To better understand laypeople's reactions to SAI related information, we conducted an online survey combined with an experimental variation of hypothetical public statements from fictitious researchers, politicians and a citizens' jury.[1]

Even though surveys in Germany indicate, that German laypeople are aware of the problem of climate change and state that they would accept necessary political or economic measures against climate change [Schipperges, Holzhauer and Scholl, 2018], in reality political and individual changes lag behind those intentions [Howlett and Kemmerling, 2017; Juvan and Dolnicar, 2014; Kollmuss and Agyeman, 2002; Young et al., 2010]. Bell, Gray and Haggett [2005] analysed, what they called "social gap" for the case of wind power, one example where opinion polls indicate great support, whereas there are lower implementation rates. In the following survey, we investigate what message and which information source is relevant for opinion formation for the case of SAI.

Theoretical background

Public acceptance of stratospheric aerosol injection

Even though CE already looks back on two decades of research and scientific interest, the lay public lacks substantial knowledge about technologies like SAI [Braun et al., 2018; Merk, Pönitzsch and Rehdanz, 2016; Scheer and Renn, 2014].

A series of public acceptance research projects was conducted on laypeople's attitudes about SAI within the last years. Particularly in deliberative settings like focus groups or citizens' juries, strong rejection of SAI deployment was found [Bellamy, Chilvers and Vaughan, 2016; Bürgerforum Climate Engineering, 2018]. In surveys, the rejection was less strong, especially when asking about the acceptance of researching SAI. In addition, people seemed to be quite uncertain about their opinion concerning deployment [Braun et al., 2018; Mahajan, Tingley and Wagner, 2019]. In focus groups, this ambivalence towards deployment and research was also evident, with the acceptance of the latter being influenced, among other things, by predictability [Asayama, Sugiyama and Ishii, 2017].

Acceptance of CE technologies not only depends on risk and benefit perception but also on affective responses and trust in decision makers [Mercer, Keith and Sharp,

[1]Citizens' juries consist of citizens who are randomly selected and work voluntarily over a period of several days to help making decisions on specific issues. For this purpose, the participants receive all relevant information — as defined by the organizers — and the citizens can ask for additional information. All expenses are covered. The results are summarised in a so-called citizens' report.

2011; Merk and Pönitzsch, 2017]. Affect mediates the influence of stable psychological variables, like values and attitudes, on acceptance and directly affects the perception of risks and benefits in the case of SAI [Merk and Pönitzsch, 2017]. Trust in institutions, which according to Mercer, Keith and Sharp [2011] differs strongly between institutions and actors, also influences affect [Merk and Pönitzsch, 2017]. In this context, Mercer, Keith and Sharp [2011] found high levels of perceived trustworthiness for university researchers, environmental organizations, and friends and family, while they found rather low levels of perceived trustworthiness for the US federal government, religious leaders, private companies and industry, as well as for media and reporters. Important actors from politics, science and society are perceived differently by the lay public and are therefore likely to influence the discourse to varying degrees.

Public discourse on climate engineering — framing and the role of science communication

The discourse on CE differs from the climate change mitigation discourse to the extent that there is currently no scientific consensus on the "desirability" of technologies such as SAI [Long and Cairns, 2019; Anshelm and Hansson, 2014; Anshelm and Hansson, 2016]. Therefore, there is no "right" or preferred strategy on the part of science communication, which is advocated in the public discourse. Sound science communication is essential here to close gaps in knowledge and dispel misconceptions [Fischhoff, 2013]. Nevertheless, for this step of information provision it is important to know how people perceive these information. Empirical studies are essential for this. How and to what extent are laypersons influenced by statements from important actors who might fail to adequately point out the large uncertainties of the topic? CE is a good test case to investigate the channels through which science communication is received and interpreted and how this affects the perception of science and researchers [Fischhoff, 2013].

As current levels of knowledge are low, opinions might be more susceptible to different framings. Studies have already been carried out from different angles, for example to explore the influence of local cultural factors [Buck, 2018] or the influence of decision rules and different forms of public deliberation [Bellamy, Lezaun and Palmer, 2017]. Corner and Pidgeon [2015] found that framing CE-technologies as analogues to natural processes increased acceptance. Nevertheless, the way "nature-frames" influence the debate is quite complex, as Corner, Parkhill, Pidgeon and Vaughan [2013] pointed out. Participants in their deliberative workshops discussed the "messing with nature"-argument (the interference of the technologies with natural processes) without coming to an agreement about whether this was good or bad. A quite frequently mentioned frame is the "emergency frame" [Corner, Parkhill and Pidgeon, 2011] which is used in particular to underpin the need for further research [e.g. Caldeira and Keith, 2010]. It is also found to be relevant for laypersons "to accept — either willingly or reluctantly — the need for 'more research' on geoengineering" [Asayama, Sugiyama and Ishii, 2017, p. 87]. Metaphors and framings, as often used by newspapers, can be problematic for communication, as Luokkanen, Huttunen and Hilden [2014] pointed out, because they can lead to unintended associations [Klamer and Leonard, 1994] and misinformation [Pigliucci and Boudry, 2011]. Luokkanen, Huttunen and Hildén [2014] for example, examined metaphors and storylines used in newspapers in the context of CE and found that the more neutral the reporting, the less metaphors were used. On the other hand, framings are important for laypersons to make sense of the information and communicate and discuss with each other about the topic [Wibeck et al., 2017]. Depending on how the topic is framed, very different assessments are possible, which previously led to a trend towards "unframing", especially within deliberative research, in order to find out the supposedly "true" attitude [Bellamy and Lezaun, 2017]. Naturally, also Science communication is not free of metaphors and framings [Nisbet and Scheufele, 2009], thus it is highly relevant to understand how society perceives and reacts to different framings of CE.

Who participates in the public discourse on climate engineering?

Until today, a public debate about CE or especially SAI has not yet emerged. At the same time, public acceptance might play an important role when it comes to the question of deployment. In Germany, there are still very few public opinion statements from scientists and even fewer from policy makers. In the scientific domain, some experts publicly advocate field research on SAI and its possible deployment; however, emphasizing that SAI should not be seen as a simple technological fix that saves humankind from the need to cut CO_2 emissions. Most researchers that argue for more research, clearly state that CE could only be a 'supplement to reducing sources of greenhouse gas emissions and increasing our ability to cope with the effects of climate change' [Ackerman et al., 2017]. Through their specific framing, scientists build the foundation for further political and societal debates [Anshelm and Hansson, 2016; Gunderson, Stuart and Petersen, 2019; Huttunen and Hildén, 2014]. In February 2019, the Union of Concerned Scientists released a statement on solar radiation management technologies [Union of Concerned Scientists, 2019]. They clearly state their disapproval of solar radiation management deployment and large-scale field experiments but supported further computer modelling. Forums like the Solar Radiation Management Governance Initiative (SRMGI[2]) and the Carnegie Climate Governance Initiative (C2G) aim for a global debate about the scientific and ethical implications of CE, especially focussing on the future governance [Carnegie Climate Governance Initiative, 2019].

The political and societal debate lags behind the scientific discussions, as few political actors have made statements about such technologies, the media coverage is still limited and it draws hardly any public attention judging by the low share of people who indicated that they have heard about CE before [e.g. Braun et al., 2018]. The German Environment Agency, for example, published a background paper on *Geo-Engineering* as information for the wider public, which has hardly been updated since 2011 [Umweltbundesamt, 2011]. This is also an example of the low level of involvement of political decision makers in the debate. With the impacts of climate change increasing, SAI might attract more attention. Stakeholders, like politicians, public interest groups, NGOs and civil society will then join the discourse, as it happened in a similar way for other technological developments, like genetic engineering or nuclear energy [Scheer and Renn, 2014].

Against the backdrop of the very ambitious targets of the Paris Agreement, the European Green Deal and the prominent yellow vest movement in France,

[2]See www.srmgi.org for information about the Solar Radiation Management Governance Initiative.

governments try to include citizens at the stage of policy making to integrate public concerns early on and thus hopefully increasing the climate policies' legitimacy. Recent examples are the *French Convention Citoyenne pour le Climat*, the *UK Climate Convention* or the German *Bürgerdialog zum Klimaschutzplan 2050*. These forums of selected citizens are convened by the respective government to formulate recommendations or provide input for climate policy. Such a format has not yet been used for the issue of CE. However, as part of a research project in Germany, a citizens' jury, consisting of 21 participants, met on three weekends in early 2018 to discuss CE [Bürgerforum Climate Engineering, 2018; Merk et al. 2019]. They were informed about CE by experts and intensively discussed a possible future research on and deployment of SAI and bio-energy with CCS. The outcome was a jointly written citizens' report that assessed the technologies and was addressed to political and scientific leaders. Citizen involvement has been shown to increase issue knowledge and the support for decisions among participants. It remains however unclear whether it also increases the support for policies among citizens that did not participate in the engagement process [Curato and Böker, 2016; Michels, 2011; Niemeyer, 2014].

The stakeholders that will potentially be involved in the discourse on CE are very diverse, with respect to their expertise, their credibility and their reputation among the general public. Thus, the same statement about CE made by different actors, i.e. information sources, might influence the citizens' perceptions of CE differently. We investigate to what extent different sources influence laypeople's perceptions of positively or negatively framed statements about deployment and research of SAI.

Source credibility

The perceived credibility of actors could be a reason for differences in the evaluation of statements from different sources. Psychological research indicates that the higher people's belief in the competence and trustworthiness of an information source, the more likely they are to accept the message content [Eagly and Chaiken, 1993; Zhang and Buda, 1999]. This phenomenon occurs especially under certain conditions, such as lack of knowledge [Kumkale, Albarracín and Seignourel, 2010] or low task involvement [Wilson and Sherrell, 1993].

Source credibility can be described as the perceived ability of a source to provide accurate and truthful information [Tormala and Petty, 2004]. 'Accurate' and 'truthful' refers to the repeatedly identified, most important determinants of source credibility: trustworthiness and competence [Eisend, 2006; McCroskey and Teven, 1999; Pornpitakpan, 2004; Sternthal, Phillips and Dholakia, 1978]. 'Competence' here refers to the perception of a source to be able to make a valid statement about a topic. 'Trustworthiness' describes the perception of a source as being willing to tell the truth [Hovland, Janis and Kelley, 1953].

The construct of source credibility has initially been investigated in persuasion research with a broad consensus that in many situations, more credible sources are also more persuasive [Petty and Wegener, 1998; Pornpitakpan, 2004]. In addition, this depends on the specific source [Brewer and Ley, 2013] as well as on the respective social context [Lang and Hallman, 2005].

These definitions show parallels to the constructs of integrity-based and competence-based trust that have been found to predict acceptance of CCS. High competence-based trust and low integrity-based trust towards organizations dealing with CCS, affected participants' risk and benefit perception and their subsequent acceptance most [Terwel et al., 2009]. For new technologies in general, previous research indicated that perceived risks and concomitant acceptance are influenced by the perception of scientists' trustworthiness [Lee, Scheufele and Lewenstein, 2005; Priest, 2001; Siegrist, 2000].

Empirical investigation of statements, information sources and source credibility in the climate engineering context

Most of the recent surveys provided more or less neutrally framed information on CE and deliberately refrained from expressing judgements [Braun et al., 2018; Merk and Pönitzsch, 2017]. Other studies looked at the impact of climate change information with and without additional CE information made by a fictional scientific body but did not vary the source of the CE messages [Kahan et al., 2015].

Attitudes towards CE are not really differentiated and are formed under high uncertainty [Burns et al., 2016]. Providing opinion statements as an additional quality of information could influence acceptance more strongly. When people cannot rely on their own knowledge, persuasion by third parties can occur, depending on the situation [Kumkale, Albarracín and Seignourel, 2010]. This of course depends on personal and situational factors, as opinions can sometimes be strong even though knowledge is low. Additionally, people might think they have enough knowledge, even though they do not, and vice versa [Brucks, 1985]. Since knowledge about CE technologies like SAI among the lay public is very low and most people have probably not formed stable opinions yet, pro or contra statements are likely to be persuasive. Concerning new emerging technologies, people can be ambivalent especially as the trade-offs are manifold and uncertain. Despite the ambivalence, people can lean towards one side or the other. This survey analyses those tendencies for SAI. Hence, the first aim of this study is to assess the influence of pro and contra statements on laypeople's acceptance formation in the context of emerging technologies. Moreover, the acceptance of SAI after receiving a statement by a source probably varies depending on the perceived credibility of that source. We investigate the moderating role of source credibility in order to broaden the understanding of factors relevant for SAI acceptance.

In the SAI context, various groups will be involved in the future public discourse; most certainly scientists, policy makers and the lay public will be among them. The spectrum of both, trustworthiness and competence, within these groups with regard to climate change and technology is broad. Prior research suggests that people tend to trust scientists more than governmental actors or informal sources, like news media, neighbours or religious leaders, when it comes to topics like climate change or information about the environment [Brewer and Ley, 2013; Ipsos MORI, 2016; Sanz-Menéndez and Cruz-Castro, 2019; Sleeth-Keppler, Perkowitz and Speiser, 2017]. Thus, the second aim of our study is to investigate laypeople's perception of the credibility of potentially relevant actors in the SAI debate. Furthermore, we analysed the moderating role of source credibility, as the credibility of a message source was found to interact with the message framing [Jones, Sinclair and Courneya, 2003; Kim and Kim, 2014].

We therefore propose the following three hypotheses to guide our research:

H1: The level of acceptance differs between the statement conditions: Acceptance of SAI is highest in the pro-deployment, then the pro-research, then the contra-deployment condition. In addition, after receiving the pro-SAI statement, acceptance is higher than in the control group without statement. After receiving the contra-SAI statement, acceptance is lower than in the control group without statement.

H2: Researchers, politicians and citizens' juries are perceived differently regarding the two facets of source credibility: trustworthiness and competence in the context of SAI. Researchers are perceived as more trustworthy and competent than participants of a citizens' jury and politicians.

H3: The level of source credibility influences the level of acceptance. The higher the source credibility, the higher the acceptance in the pro-SAI condition; the higher the source credibility, the lower the acceptance in the contra-SAI condition, because laypeople tend to follow the source's opinion and in turn adjust their own opinion on the topic in the direction of the source's attitude.

Method

Sample

We conducted an online survey in Germany, which took place in November 2018. We used the *SoSciSurvey* [Leiner, 2017] online platform for data collection. Prior to the main study, a pilot test was carried out to ensure that the items were understandable, and the scales were internally consistent. The study was conducted online, following current standards for online experimentation [Reips, 2002]. Data was analysed with the open source *RStudio* statistics software (version 3.4.0, The R Foundation for Statistical Computing, 2017).

Participants were recruited by Consumerfieldwork GmbH using quota sampling for age, gender and educational background, representative for the German population.

The original dataset comprised 608 participants. 40 participants had missing values on the dependent variable and were therefore excluded from further analysis. The resulting data set comprised $N = 568$ participants (284 female, 283 male, 1 other) with a mean age of 49.3 years ($SD = 16.22$) ranging from 20 to 89.

Procedure

In a 3×3+1 between-subjects design, participants initially read an information text on climate change causes and impacts, as well as on SAI and its side effects. Afterwards, they were presented with artificial statements of either politicians from the German Bundestag, researchers at a climate conference, or participants of a citizens' jury that deliberated SAI. The statement either argued in favour of deployment, against deployment or for research but against the immediate deployment of SAI. Participants in the control group received neither a source description, nor a statement. They only read the information text and were asked directly to indicate their level of acceptance of SAI. At the end of the survey, all participants were de-briefed about the aim and design of the study. The sequence of the presented information text, treatment conditions and the elicitation of the variables is shown in Figure 1.

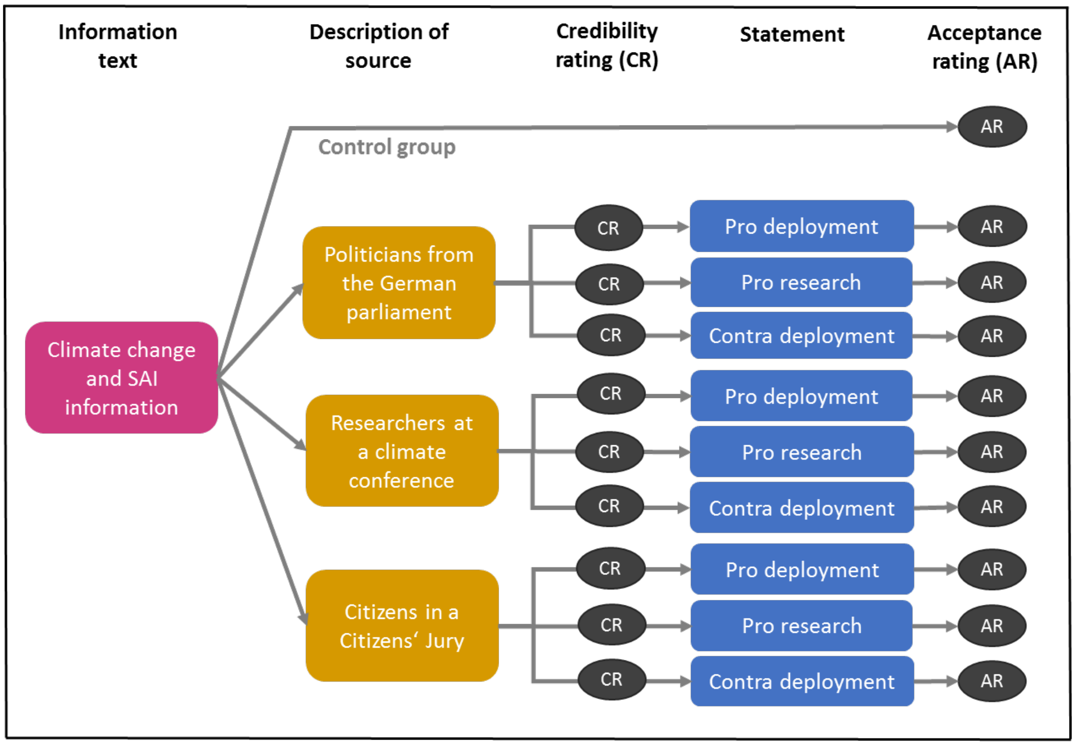

Figure 1. Study design: Sequence of information provision (colours) and measurement of variables (dark grey). The source was either politicians of a committee, researchers at a conference or participants of a citizens' jury, the statement argued either in favour of deployment, against deployment or in favour of research. The control group skipped the description of source, the source credibility rating and the statement by the source and directly rated acceptance of SAI.

Material

Climate change and SAI information. The presented text was developed following Merk et al. [2016] with a modified explanation of SAI. Basic information about the greenhouse effect and greenhouse gas emissions were provided, as well as current and future consequences of an ongoing global mean temperature rise. The 2°C target was presented together with the political, economic, and behavioural changes that would be necessary to stay below it. SAI and its main costs and benefits were explained (for the complete text see appendix A, the original texts and questions were presented in German). All experimental groups, including the control group read this information text.

Description of source. Participants in the experimental groups were then presented the description of one out of three possible sources: (1) Politicians, namely members of a committee of the German Bundestag, (2) researchers participating in an international climate conference and (3) informed citizens, taking part in a citizens' jury. Each source was introduced in a similar way with two sentences (see Table 1 and appendix B). Each participant only read one source description, the participants in the control group were not presented with any description of source.

Statement. The statements made by the sources argued either in favour of deployment of SAI (pro), against deployment (contra) or in favour of research (pro research). For the exact wording, see Table 1 and appendix C. Each participant only read one statement. The participants in the control group did not read any statement.

Table 1 shows the wording of the descriptions of the sources and the statements, which were presented to participants in the treatment groups.

Source credibility rating. The perceived ability of a message's source to provide accurate and truthful information [Tormala and Petty, 2004] was measured using 12 items in the form of statements mainly inspired by the semantic differentials identified by McCroskey and Teven [1999] and Eisend [2006]. The factor goodwill, measured by McCroskey and Teven [1999] was integrated into the factor trustworthiness. Thus, we focused on the two sub-components: trustworthiness (e.g. 'Concerning climate protection and SAI, I believe the scientists are honest') and competence (e.g. 'Concerning climate protection and SAI, I believe the citizens' jury is professional'). Items were answered on a visual analogue scale (VAS), ranging from 1 ('do not agree at all') to 101 ('fully agree') (for full item list and item analysis see appendix F and G).

Acceptance rating of SAI. Acceptance of SAI was measured using 12 items. Participants had to indicate their level of (dis-)agreement with 12 sentences about support, rejection, risks, or benefits of SAI. We used items on the narrow understanding of acceptance, behavioural intentions for political action related to the technology, as well as risk and benefit perception to get a broad assessment of SAI acceptance (e.g. 'I would demonstrate against the deployment of stratospheric aerosol injection'). Items were answered again on a VAS, ranging from 1 ('do not agree at all') to 101 ('fully agree').

Table 2 shows the distribution of participants across the nine treatment groups. The control group, consisting of 60 participants, did not receive any description of source or statement.

Table 1. Wording of the descriptions of the sources and the statements.
Note. Descriptions of sources and statements that were presented to the treatment groups. Every participant randomly received a combination of one of the source descriptions and one of the statements. The control group received neither a source description nor a statement.

Description of source	
Politicians	On 12 February 2018, members of the Climate Action Committee of the German Bundestag met in Berlin to discuss climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text. You are about to read an excerpt from a joint statement by the members of the Bundestag Committee on the classification of these risks.
Researcher	On 12 February 2018, renowned researchers from various environmental science disciplines met in Berlin to discuss climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text. You are about to read an excerpt from a joint statement by the members of the conference on the classification of these risks.
Citizens' jury	On 12 February 2018, German citizens met in Berlin for voluntary participation in a Citizens' jury* on climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text. You are about to read an excerpt from a joint statement by the participants of the Citizens' jury on the classification of these risks. *Citizens' juries consist of citizens who are randomly selected and work over a period of several days to help making decisions on specific issues. For this purpose, the participants receive the necessary information and an expense allowance. The results will be summarised in citizens' reports.
Statements	
Pro-SAI	The use of this measure [stratospheric aerosol injection] could have further, previously unknown negative consequences, but it is assumed that global warming can be slowed down quickly and effectively by this technology. We are therefore clearly in favour of the possible deployment of this measure in the future! (Extract from the joint statement of 12.02.2018)
Contra-SAI	It is assumed that global warming could be slowed down quickly and effectively with this measure [stratospheric aerosol injection], but the use of this technology can have further, previously unknown negative consequences. We are therefore clearly against the possible deployment of this measure in the future! (Extract from the joint statement of 12.02.2018)
Pro research-SAI	It is assumed that global warming could be slowed down quickly and effectively with this measure [stratospheric aerosol injection], but the use of this technology can have further, previously unknown negative consequences. We are therefore clearly in favour of further research. As long as no reliable results are available, however, we reject the possible deployment of this intervention in the future. (Extract from the joint statement of 12.02.2018)

Table 2. Number of participants in each experimental group.
Note. The control group consisted of 60 participants, total $N = 568$.

Statements	Politicians	Researcher	Citizens' jury	Control group	Sum
	Sources				
Pro-SAI	57	61	59	-	177
Contra-SAI	53	56	52	-	161
Pro research-SAI	59	57	54	-	170
Sum	169	174	165	60	

Table 3. Differences in acceptance of SAI between the statements.
Note. The factor statement was dummy coded with the control group as reference category, $N = 568$. B represents unstandardized OLS-regression coefficients, but coefficients have the same metric. $SE\ B$ are standard errors, t is the t-value. Adjusted $R^2 = .014$ ($p = .013$). $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	B	$SE\ B$	t	p
Intercept	54.04***	2.73	19.83	<.001
Pro-SAI	4.89	3.15	1.55	.122
Pro research-SAI	0.85	3.17	0.27	.788
Contra-SAI	−2.63	3.19	−0.82	.411

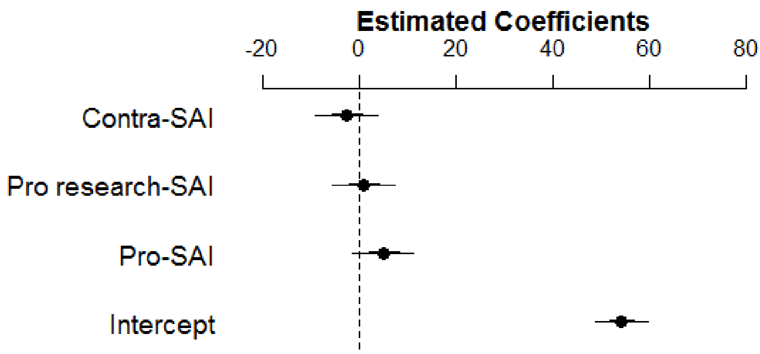

Figure 2. Coefficient plot of differences in acceptance of SAI between statements. The factor statement was dummy coded with the control group as reference category. $N = 568$. The deviation of the coefficients from the dotted line represents the difference of the coefficients from the reference category. The actual value of the reference category is plotted in the bottom row: Intercept.

Results

Differences in the SAI acceptance in the four statement conditions — pro-SAI, contra-SAI, pro research-SAI and the control group without a statement — were analysed using regression analyses. The results can be found in Table 3 and Figure 2. The factor statement was dummy coded with the control group serving as reference category. There was no significant difference of neither pro-SAI, pro research-SAI or contra-SAI compared to the control group. Calculating post hoc contrasts, we found a significant difference between the pro-SAI and the contra-SAI statement ($B = 7.52^{**}$, $SE\ B = 2.30$, $t = 3.27$, $p = .006$). The complete contrast table with all factor levels can be found in appendix E, Table 11.

Table 4. Full model with interaction of the factors source and statement without the control group.
Note. The factors statement and source were dummy coded with pro-SAI and politicians as reference category. Robust standard errors (*SE B*) were calculated. $N = 508$. Adjusted $R^2 = .009$ ($p = .113$). *$p < .05$. **$p < .01$. ***$p < .001$.

	B	*SE B*	*t*	*p*
(Intercept)	58.70***	2.97	19.78	<.001
Pro research-SAI	−4.98	3.93	−1.27	.205
Contra-SAI	−10.24*	4.36	−2.35	.019
Researcher	−0.13	4.41	−0.3	.976
Citizens' Jury	0.83	3.77	0.22	.827
Researchers * Pro research-SAI	0.66	5.83	0.11	.910
Researchers * Contra-SAI	3.18	6.34	0.5	.616
Citizens' Jury * Pro research-SAI	2.34	5.33	0.44	.661
Citizens' Jury * Contra-SAI	5.06	5.65	0.9	.371

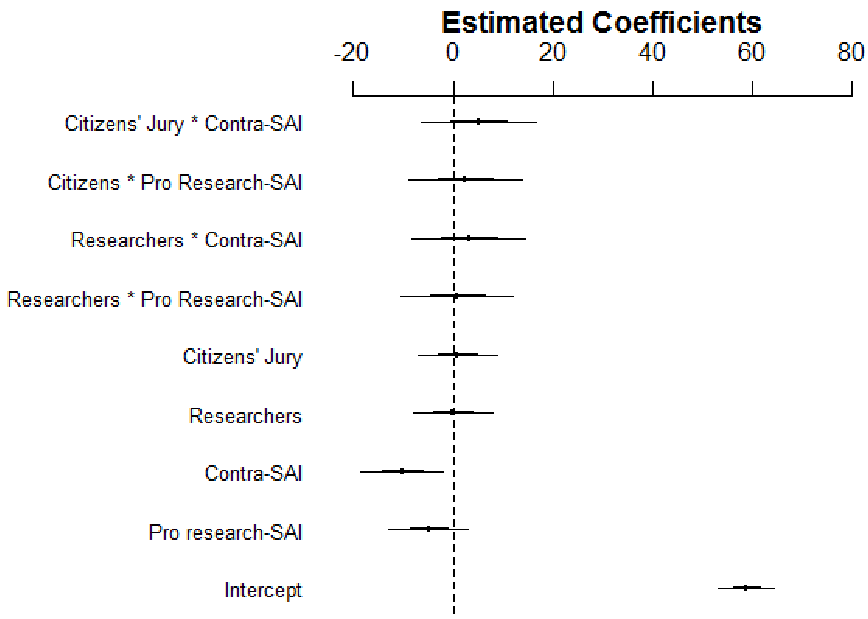

Figure 3. Coefficient plot of regression model with interactions. The factors statement and source were dummy coded with pro-SAI and politicians serving as reference category. The deviation of the coefficients from the dotted line represents the difference of the coefficients from the reference category. The actual value of the reference category is plotted in the bottom row: Intercept.

To analyse the interaction effect of the two factors statement and source we additionally calculated a multiple regression with interaction. Because the control group did not read a statement or a source description, the analysis was performed without the control group. Results are shown in Table 4 and Figure 3, again, both factors were dummy coded. For the factor statement the pro-SAI statement served as reference, for the factor source politicians served as reference category. We found no significant interaction between the factors. Figure 4 shows the deviation in the level of acceptance in the 9 treatment groups from the control group (the corresponding regression table is provided in appendix E, Table 12, the exact means of acceptance of SAI in the 10 groups can be found in appendix D, Table 9).

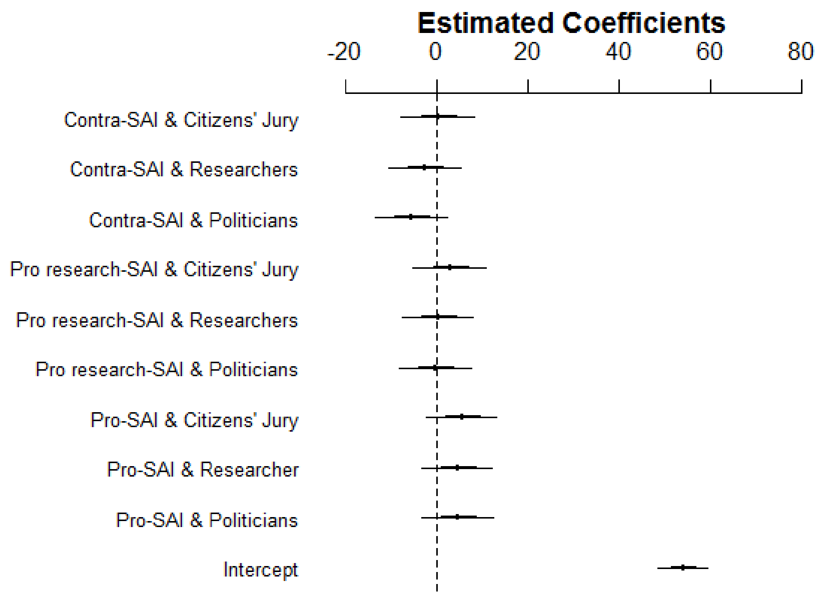

Figure 4. Coefficient plot of the 3 (statements) × 3 (sources) + 1 (control group) treatment groups. The 10 groups were dummy coded with the control group as reference category. N = 568. The deviation of the coefficients from the dotted line represents the difference of the coefficients from the reference category. The actual value of the reference category is plotted in the bottom row: Intercept.

Hypothesis 1 can thus only be partly accepted. There was a significant difference between the pro and contra-SAI conditions, but no statistically significant difference to the control group. The results indicate that participants adjusted their judgements to some extent, but they were not strongly influenced compared to the control condition where they received no statement.

Differences in perceived credibility between information sources

As hypothesised in H2, we found differences in the subscales trustworthiness (Table 5 and Figure 5) and competence (Table 6 and Figure 6) between the three sources. Trustworthiness was higher for researchers and the citizens' jury compared to politicians. Competence was judged higher for researchers than for citizens, who in turn had a higher mean than politicians (see appendix D, Table 10 for the exact means).

Accordingly, the participants perceived the sources of information as having varying degrees of credibility. Researchers were perceived as both highly trustworthy and competent, as were informed laypersons, who were, however, considered to be slightly less competent than the researchers. Politicians scored significantly worse on both variables. H2 can thus be accepted in part, as researchers were perceived as more competent and trustworthy than politicians and more competent than participants of a citizens' jury, but equally trustworthy as the citizens' jury.

The correlation between perceived competence and trustworthiness of the source (r = .834) and the internal consistency value of .974 (Cronbach's alpha) for the combined scale source credibility were high, therefore, we used the one-factor solution in our further analyses. The item-discrimination values ranged between .77 and .91, and the item-difficulty values were between .46 and .66.

Table 5. Regression results using perceived trustworthiness as the criterion.
Note. Adjusted $R^2 = .276$ ($p < .001$). $N = 508$. The factor source was dummy coded with researchers as reference category. Robust standard errors (*SE B*) were calculated. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	B	*SE B*	*t*	*p*
Intercept	64.76***	1.87	34.64	<.001
Politicians	−28.98***	2.65	−10.93	<.001
Citizens' Jury	2.09	2.39	0.88	.381

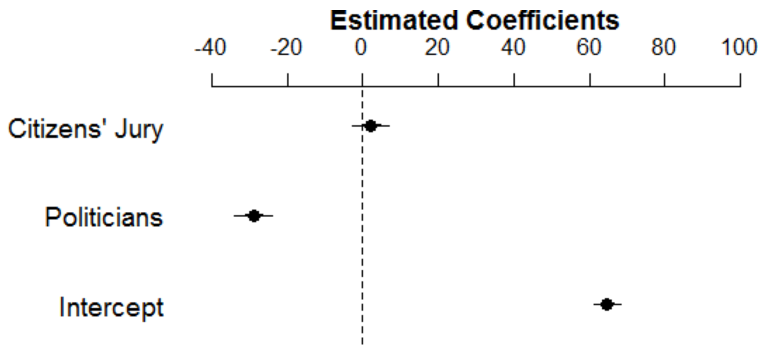

Figure 5. Coefficient plot of perceived trustworthiness and the factor source, which was dummy coded with researchers as reference category. The deviation of the coefficients from the dotted line represents the difference of the coefficients from the reference category. The actual value of the reference category is plotted in the bottom row: Intercept.

Table 6. Regression results using perceived competence as the criterion.
Note. Adjusted $R^2 = .21$ ($p < .001$). $N = 508$. The factor source was dummy coded with researchers as reference category. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	B	*SE B*	*t*	*p*
Intercept	65.1***	1.83	35.64	< .001
Politicians	−30.58***	2.6	−11.75	< .001
Citizens' Jury	−12.72***	2.62	−4.86	< .001

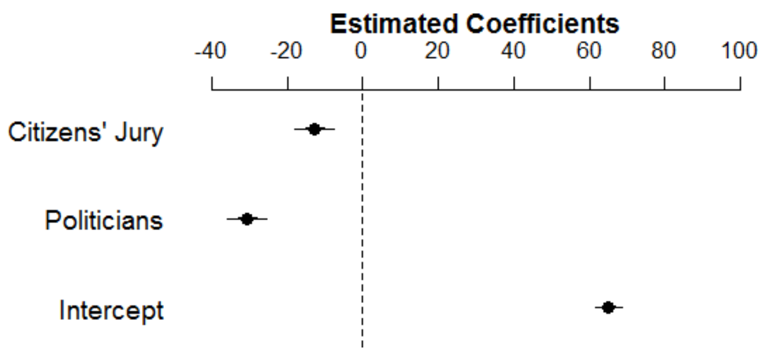

Figure 6. Coefficient plot of perceived competence and the factor source which was dummy coded with researchers as reference category. The deviation of the coefficients from the dotted line represents the difference of the coefficients from the reference category. The actual value of the reference category is plotted in the bottom row: Intercept.

The moderating role of source credibility on acceptance

To analyse the hypothesized effects of H1 and H3 in a joint model, we calculated a moderated regression with the factor statement (comprising the three levels pro-SAI, pro research-SAI and contra-SAI) and the moderator source credibility. We expected a significant interaction of statement and source credibility because a credible source making a positive statement about SAI influences the reader positively (in direction of greater acceptance) and we expected that credible source making a negative statement has an adverse impact on acceptance (in direction of less acceptance, i.e. they are more likely to reject SAI).

The level of source credibility differed substantially between politicians, researchers, and the citizens' jury, therefore the source credibility variable was standardised according to source-condition group means to make the interpretation in the regression easier. Acceptance of SAI was standardized, now having a mean of 0 and a standard deviation of 1. The factor statement was coded, using contrast coding to directly compare the planned contrast of the pro-SAI condition with the contra-SAI condition. We found a positive effect for source credibility, a small negative effect for the contra-SAI statement and no effect for the interaction (Table 7 and Figure 7). The control group did not receive any statement and did not assess the sources' credibility. Therefore, the control group was excluded from the model.

Table 7. Regression results of the influence of the statements on acceptance of SAI, moderated by source credibility.
Note. Adjusted $R^2 = .213$ ($p < .001$). $N = 508$. Moderated regression model with standardized acceptance of SAI and the group-mean standardized moderator source credibility. The factor statement was contrast coded directly comparing the levels pro-SAI and contra-SAI. Robust standard errors were calculated. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	B	$SE\ B$	t	p
Intercept	-0.007	0.039	-0.169	.866
Pro-SAI – Contra-SAI	-0.305^{**}	0.101	-3.021	.003
Source Credibility	0.442^{***}	0.045	9.938	<.001
Pro-SAI – Contra-SAI * Source Credibility	-0.12	0.112	-1.075	.282

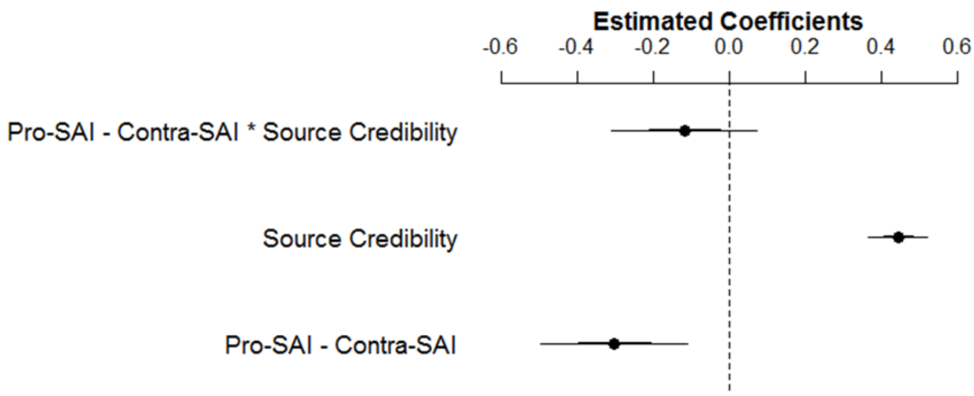

Figure 7. Coefficient plot of moderated regression. The factor statement was contrast coded to compare directly between the pro-SAI and contra-SAI statement and their interaction with source credibility on acceptance of SAI.

The results show that higher perceived source credibility led to higher acceptance ratings independent of the content of the source's statement, i.e. whether it was positive or negative. This is contrary to our hypothesis 3 that a negative statement from a highly credible source should have a stronger negative effect on acceptance compared to a statement by a less credible source and vice versa for a positive statement. Therefore, we further examined the relationship between source credibility and SAI acceptance by source and statement (see Table 8).

We found an interesting pattern that irrespective of the message content (pro-SAI, pro research-SAI or contra-SAI), there was a positive correlation between source credibility of politicians and researchers and the acceptance rating (Table 8, Figure 9). Even if the source made a negative statement about SAI, participants' acceptance of SAI was rather high when they thought the source was credible.

Table 8. Pearson correlation coefficients between source credibility and acceptance in the treatment groups.
Note. $N = 508$. Bonferroni corrected p-values. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	Politicians	Researcher	Citizens' jury
Pro-SAI	.549***	.691***	.259
Contra-SAI	.406*	.615***	.099
Pro research-SAI	.548***	.724***	.222

Figure 8 shows the relationship between source credibility and acceptance for the three sources. It indicates that there was a positive relationship for all sources. For the citizens' jury the relationship was weaker than for the two other sources. Figure 9 in turn shows the relationship between source credibility and acceptance for the three statements. Here, we can see that the relationship between source credibility and acceptance was slightly weaker after reading a contra-SAI statement compared to after reading a pro-SAI statement, as the regression line is slightly steeper for the latter. Yet, this difference does not reach statistical significance.

Hypothesis 3 can only be accepted for the pro-SAI condition, since source credibility increased the acceptance of SAI. As far as the contra-SAI condition is concerned, the second part of H3 must be rejected, because the expected negative correlation was not observed, but a significant positive correlation.

Discussion

Our study focussed on the influence of different statements about SAI from different sources and the moderating role of the perceived credibility of the respective source on laypeople's acceptance of SAI. We found that it made a difference whether a statement was in favour or against the deployment of SAI (**H1**). Participants had significantly lower acceptance ratings for SAI if they had read a framed statement arguing against the deployment, compared to a statement, supporting deployment. Nevertheless, the differences were smaller than expected and we did not find significant differences compared to a control group without information on sources and statements. This indicates, that despite the stated lack of knowledge — 74.12% indicated that they had never heard of SAI before this survey — participants were influenced only to a small extent by the actor's statement. This is encouraging, as it shows that laypeople cannot be manipulated easily by short, one-off messages. The source of information had in turn no effect

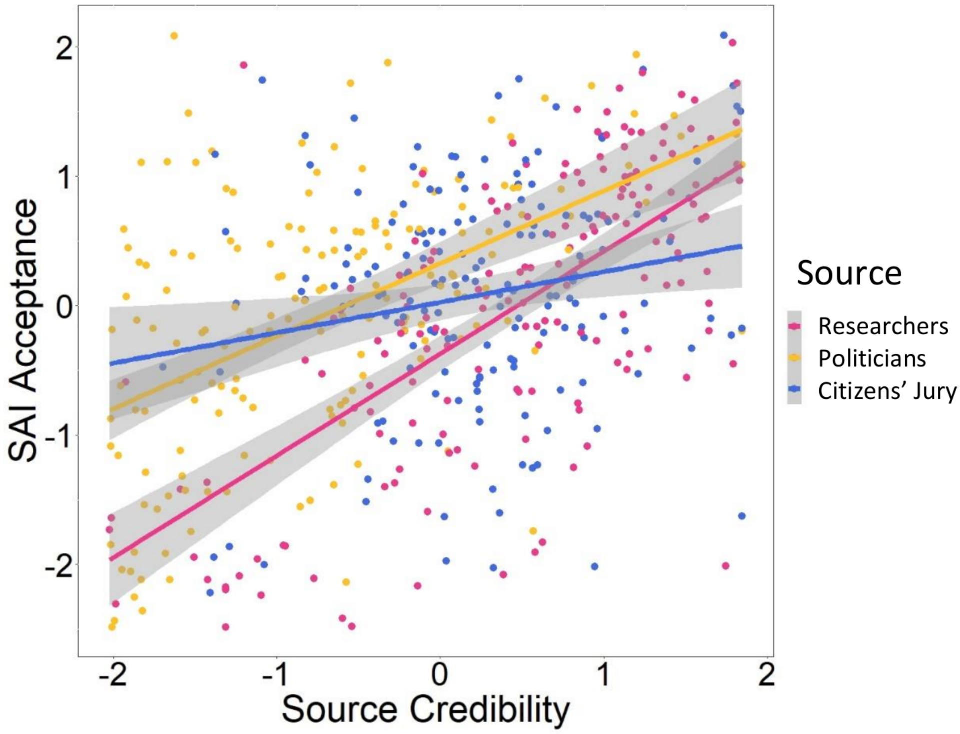

Figure 8. Relationship between source credibility and acceptance for the three sources. Pink dots (Researchers) represent participants who read the statement with the researchers as information source (r = .665, B = 0.788), yellow dots (Politicians) represent those who read the statement by the politicians (r = .516, B = 0.561), blue dots (Citizens' jury) represent participants who read the statement by the citizens' jury (r = .194, B = 0.235). The grey areas are confidence intervals.

on the acceptance rating, meaning that it made no difference whether the information came from politicians, researchers or a citizens' jury.

Thus, analysing differences in perceived source credibility (**H2**) we found that perceived trustworthiness was higher for researchers and citizens' juries compared to politicians and competence was judged highest for researchers followed by citizens' juries. Politicians ranked last in terms of mean perceived competence (see Figure 6). Our findings suggest that currently, people do rather not trust politicians about SAI. This could be due to the generally low public trust in politicians [Algan et al., 2017; Foster and Frieden, 2017]. Thus, politicians need to be aware of their status of trustworthiness within the debate and address the scepticism of the lay public mindfully. In contrast to this, researchers are perceived as trustworthy and competent and are therefore in the best position to communicate information about CE. This has interesting implications for science communication, because credibility in general is a necessary factor for scientists to be listened to at all and for laypersons to form their own opinion based on it [e.g. Bromme, 2020].

Participants of the citizens' jury were rated equally trustworthy as scientists concerning the topic of CE. The citizens' jury, which was used as a source of information in this study, is a relatively reputable source, as the participants were informed in detail about the topic. The extent to which this high level of attributed trust can also be transferred to less informed and structured citizens' initiatives

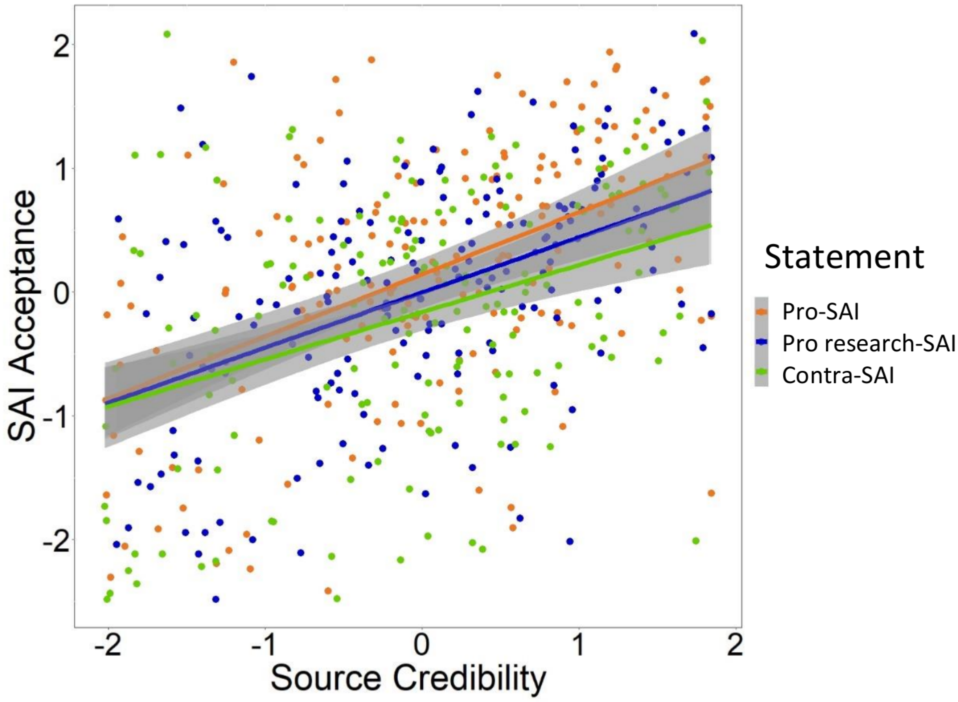

Figure 9. Relationship between source credibility and acceptance separately for the different statement conditions. Orange dots (Pro-SAI) represent participants who received a pro-SAI statement (r = .501, B = 0.501), blue dots (Pro research-SAI) represent those who received the pro-SAI research statement (r = .466, B = 0.445), and green dots (Contra-SAI) those who received the contra-SAI statement (r =.376, B = 0.381).

should be investigated in follow-up studies. In this case, directly manipulating the credibility of the source, for example, from uninformed internet forums to expert panels, would be an option.

In our survey, we found source credibility to be the most important predictor for the acceptance rating of the survey participants. Contrary to our assumption in **H3**, source credibility did not moderate the relationship between the statement and the acceptance of SAI to the degree that they are positively related in the pro-SAI condition and negatively related in the contra-SAI condition. Instead, we found positive correlations in the pro- as well as in the contra-SAI condition between source credibility and acceptance at least in the politician and the researcher condition. Even when CE actors stated their disagreement with SAI, people's acceptance of SAI was higher when they perceived the actor as credible.

The finding appeared more nuanced for participants that read a politician's or a researcher's statement, than for those who thought the statement came from informed citizens. One explanation for this is that participants might have assessed politicians and researchers to be more influential actors compared to the citizens' jury, as for both groups in both statement conditions the correlation between source credibility and acceptance was significantly positive. Recent research supports this finding, as Yeo, Binder, Dahlstrom and Brossard [2018] found, that authoritative sources like politicians or researchers had a significant impact on behavioural intentions, whereas an anonymous source had not. Though the citizens' jury was perceived as trustworthy, respondents did not adjust their acceptance rating based on its statement. This casts doubt on the effects of citizens' participation in policy-making on the general public's assessment of the resulting policy. However, our study did not focus on the perceived legitimacy and quality of policy-making. This should be addressed more thoroughly in future research.

An explanation for the positive correlation of source credibility and SAI acceptance in the contra-SAI condition is that there is a positive relationship between the two variables, which is caused by an underlying variable. Personality factors like general trust [Siegrist, Gutscher and Earle, 2005], trust in government [Brewer and Ley, 2013] and trait optimism might have influenced both variables positively [Siegrist, 2019]. More optimistic people might in general be more trusting towards actors and institutions including actors dealing with SAI. Sleeth-Keppler, Perkowitz and Speiser [2017] for example found that people who trusted in so-called formal communicators like Barack Obama or scientists also rated climate strategies as more effective. As Siegrist [2019] summarizes, various studies found a relationship between trust and the affect heuristic, when it comes to risk perception and acceptance of new technologies. Therefore, it is plausible that the affective reaction towards CE guides risk perception and acceptance on the one hand, but also trust and confidence in relevant actors on the other hand, as a common underlying variable.

Trumbo and McComas [2003] found a direct effect of the perceived credibility of state and industry on risk perception. They assessed the credibility of different sources in areas where there was concern about possible environmental causes for cancer, but where no official 'cancer cluster' existed at that time. Risk perception was measured with different variables capturing personal impact, control over exposure or concern about effects on future generations. The higher people rated the credibility of state health departments and involved industries the lower was their risk assessment of cancer rates. High credibility of citizen groups in turn predicted greater risk perception. They found that perceiving state and industry as high in credibility, while perceiving citizen groups as low in credibility led to heuristic processing which in turn led to lower risk perception. This can probably be transferred to our study, meaning that underlying variables like general trust and heuristic information processing influenced acceptance of SAI through risk perception.

We suggest that this positive correlation existed even before the participants read any statement. On this basis, our results are plausible: There was already a positive correlation between acceptance and credibility because of underlying variables, influencing the baseline assessment. The presented statement itself only marginally influenced this relation, which becomes slightly stronger if participants read a pro-SAI statement and weaker (but still positive) if they read a contra-SAI statement. The correlation coefficient was (descriptively but not statistically) smaller for the contra statement condition compared to the pro statement condition, indicating that people marginally adjust their acceptance level toward the statement. They are not completely swayed by just one statement.

This indicates that there is indeed some kind of moderating effect of the perceived credibility, but the basic assumption should be adapted regarding the existing relation of acceptance and credibility in general. If there is a positive correlation between acceptance and credibility before giving a statement, the presentation of a negative statement would weaken the relationship and a positive statement would increase it. This should be tested again for example in a longitudinal design with two or more measurement times. For science communication, this indicates that at the moment laypersons probably base their evaluation of such new technologies mainly on previous attitudes, values and underlying traits. Communicators should be aware of the possibility that message content might not be listened to.

Another influencing factor could have been perceived source-message congruency [Chew and Kim, 1994]. It is possible that participants expected politicians and scientists to speak in favour of deployment and were then surprised to read a negative statement. Perhaps this previous assumption was so strong that it overshadowed the content of the actual statement of the source or it was assumed that there are other scientists and politicians who are definitely in favour of deployment. This message-source expectation should be checked in follow-up investigations.

Limitations

Another explanation for the positive correlation between source credibility and acceptance in both statement conditions could be a methodological one: the positive assessment of the source as being credible was transferred to the evaluation of SAI due to sequence effects. This would mean that a positive evaluation might influence the next evaluation in a questionnaire even though unrelated topics are evaluated. Future research should repeat the analyses varying the position of the questions in the questionnaire to cancel out sequence effects.

Future analyses should control for the effects of the perceived power and influence of a source, trait optimism and generalized trust on the relationship between source credibility and acceptance.

Regarding the unexpected results for the impact of source credibility on acceptance in the positive and negative statement condition, it would have been helpful to analyse the relationship in comparison to a control group that had also been introduced to a source. For this 'improved' control group would have been able to shed light on the relationship without the influence of a framed statement. Future research should consider that.

The information sources in this study were fictitious and their description rather short, which might have made it difficult to assess their credibility. As we found significant differences in acceptance between the pro- and contra-SAI condition, we are confident that participants in general paid attention to the text, processed the statements correctly and reacted to differences in the wording. A next step to test our findings would be the experimental variation of source credibility. This for example could be done by introducing sources as leading experts, uninformed passer-bys interviewed on the street or lobbyists of an energy company.

Some of the analyses involved the comparison of 9 + 1 experimental groups, which led to a potential decrease in power. Using the power analysis tool G*Power (version 3.1.9.7), we calculated a sensitivity analysis for linear multiple regression[3]

[3]Test family: F-tests; Linear multiple regression: fixed model, R^2 deviation from zero

to find the minimal detectable effect size. With an estimated power of .80, an alpha level of .05, a sample size of $N = 568$ and 10 groups (including treatment and control groups), a small effect of $f^2 > .03$ could potentially be detected.

Conclusion

The debate about climate engineering (CE) will probably pose a great challenge to science communication and policy-making. It is therefore important to get insights into possible evaluations of information about such technologies and moreover of the source of that information using empirical investigations. In the debate, several main actors will play an important role in communication and decision-making processes. We identified three key players as researchers, policy-makers, and citizens' juries that participated in an engagement process. To get an insight into possible future evaluations of CE related statements, we assessed the influence of perceived source credibility on attitudes concerning stratospheric aerosol injection (SAI).

We found that acceptance of SAI was slightly higher for participants that read a positive statement about SAI deployment than for those that read a negative statement. This difference was smaller than expected. The levels of information and prior knowledge in the public are still low and we would assume that stable opinions on SAI are not yet prevalent. Thus, the statement of a possibly relevant source influenced acceptance to a small degree, however, the specific source (whether it was politicians, researchers or a citizens' jury) had no influence on acceptance. Even the statements from researchers, who were generally judged to be trustworthy and competent, had no specific influence on the opinion of the participants, just like the politicians' and the citizens' statements.

Moreover, we found an interesting pattern of positive correlations of source credibility and acceptance of SAI, independent of the sources' opinion. Even if important actors voiced their disapproval of SAI, participants accepted SAI to a higher degree when they had judged the respective source to be credible. Underlying variables like trait optimism or general trust may cause this relationship, by simultaneously raising credibility and acceptance.

Given the complex and highly uncertain nature of SAI, at the moment laypeople seem to evaluate this new technology heuristically, transferring a positive source evaluation to the acceptance of SAI. Even though the specific framing of the statements in our study had less impact than expected, CE is still a challenge for science communication. Researchers are perceived as both competent and trustworthy regarding the topic, which initially makes them suitable for communicating the uncertainties associated with CE. Here, however, a cautious approach is advisable and the low level of prior knowledge in society should be taken into account. It can be assumed that even if credible sources are used, the messages themselves may not be listened to.

A thoughtful and balanced information campaign would probably enable laypersons to form an opinion and, in a next step, to process the opinions of certain actors more systematically. These large-scale information campaigns accompanied by public dialogue and participation are needed to provide society with the opportunity to be heard instead of being presented with climate engineering as a fait accompli.

Acknowledgments

We would like to thank the anonymous reviewers for their helpful comments and valuable suggestions. The authors were part of the German Research Foundation's Priority Programme (SPP) 1689 Climate Engineering: Risks, Challenges, Opportunities?; within this programme their work was funded via the project "Trade-offs between Mitigation and Climate Engineering: an interdisciplinary approach" (TOMACE) [grant numbers: ER-267/2-1 and RE-2993/1-1].

Appendix A. Information text about climate change and SAI

Texts and items were originally presented in German and translated for the purpose of this paper.

A.1 Climate change and stratospheric aerosol injection

Causes and consequences of climate change. Sun rays warm the Earth and the Earth's atmosphere. Naturally occurring greenhouse gases in the atmosphere ensure that part of the heat is retained near the Earth's surface. This makes the Earth warm enough for people, animals and plants to live there. Since the beginning of industrialisation, the average temperature of the Earth has risen by about 1°C.

The reason for this global warming of the Earth is the high emission of greenhouse gases such as carbon dioxide (CO_2). Greenhouse gases are released, for example during the combustion of coal, oil or gas. Currently, there are much larger amounts of these greenhouse gases in the atmosphere than was the case just a few centuries ago. The larger these quantities become the more heat the greenhouse gases retain and thus the higher the temperature on Earth will be.

Even if 1°C initially does not sound like much, the effects of global warming on the climate and the environment can already be clearly determined. These temperature changes have a global impact on plants, animals and humans. The more greenhouse gases emitted, the more serious the changes will be in the future. If we continue like this, the average temperature on Earth could rise so much that increased storms, floods, droughts or heat waves would cause very high costs and much suffering.

The 2-degree target. In order to mitigate the consequences of climate change, almost all countries in the world have agreed that global warming should be limited to well below 2°C. The aim is to reduce the temperature rise of the Earth's atmosphere to a minimum of 2°C. To achieve this, greenhouse gas emissions must be reduced globally. This means, for example that by 2050 there will no longer be any coal-fired power plants worldwide. Instead, renewable energies would have to be further expanded. A tax on CO_2 emissions would have to be politically enforced. Industry as we know it today will change radically. Every individual would also have to face changes, as we would have to significantly reduce our energy consumption. In concrete terms, this means, for example, much less traveling, heating and meat consumption.

Stratospheric aerosol injection as a technology against climate change. Even if international efforts to reduce greenhouse gas emissions are successful and there will be drastic changes in the coming decades, global warming is likely to be significantly above 2°C. For this reason, more attention is being paid to so-called stratospheric aerosol injection, which is intended to systematically influence the Earth's temperature.

In this measure, small particles (e.g. sulphur particles) are distributed by aircraft in high air layers. These particles reflect part of the sunlight into space before it can warm up the Earth. As a result, less sunlight reaches the Earth's surface and the Earth's temperature is lowered. This method is relatively inexpensive and can be applied quickly.

However, the layer of particles would have to be renewed every year for many decades. If the distribution of the sulphur particles is stopped suddenly or too early, the temperature would rise again within a short time. How much the temperature then rises depends on two factors: how much the temperature has been ystematically reduced and how much greenhouse gases we have emitted in the meantime. In addition, the effects and side effects of the spreading of sulphur particles have so far been little researched. Possible side effects include damages to the ozone layer and changes in precipitation rates in most regions. There could also be political and social conflicts over the use, the effects and how much the temperature should be reduced.

Appendix B. Description of source

B.1 Politicians

On 12 February 2018, members of the Climate Action Committee of the German Bundestag met in Berlin to discuss climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text.

You are about to read an excerpt from a joint statement by the members of the Bundestag Committee on the classification of these risks.

B.2 Researcher

On 12 February 2018, renowned researchers from various environmental science disciplines met in Berlin to discuss climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text.

You are about to read an excerpt from a joint statement by the members of the conference on the classification of these risks.

B.3 Citizens' Jury

On 12 February 2018, German citizens met in Berlin for voluntary participation in a Citizens' jury* on climate protection measures. Together they discussed the current status of strategies for dealing with climate change. Among the strategies discussed was the measure "stratospheric aerosol injection", which has just been presented to you in the information text.

You are about to read an excerpt from a joint statement by the participants of the Citizens' jury on the classification of these risks.

*Citizens' juries consist of citizens who are randomly selected and work over a period of several days to help making decisions on specific issues. For this purpose, the participants receive the necessary information and an expense allowance. The results will be summarised in citizen reports.

Appendix C. Statement by source

C.1 Pro-SAI deployment

[. . .]

The use of this measure [stratospheric aerosol injection] could have further, previously unknown negative consequences, but it is assumed that global warming can be slowed down quickly and effectively by this technology.

[. . .]

We are therefore clearly in favour of the possible deployment of this measure in the future!

[. . .]

(Extract from the joint statement of 12.02.2018)

C.2 Contra-SAI deployment

[. . .]

It is assumed that global warming could be slowed down quickly and effectively with this measure [stratospheric aerosol injection], but the use of this technology can have further, previously unknown negative consequences.

[. . .]

We are therefore clearly against the possible deployment of this measure in the future!

[. . .]

(Extract from the joint statement of 12.02.2018)

C.3 Pro research-SAI

[...]

It is assumed that global warming could be slowed down quickly and effectively with this measure [stratospheric aerosol injection], but the use of this technology can have further, previously unknown negative consequences.

[...]

We are therefore clearly in favour of further research. As long as no reliable results are available, however, we reject the possible deployment of this intervention in the future.

[...]

(Extract from the joint statement of 12.02.2018)

Appendix D. Mean values for acceptance of SAI and source credibility

Table 9. Mean acceptance ratings for Solar Aerosol Injection (SAI) for all treatment groups. *Note*. The acceptance rating scale ranged from 1 (completely against) to 101 (completely in favour). The mean values for the control group was $M = 54.04$ ($SD = 17.86$).

	Politicians	Researchers	Citizens' Jury
Pro	M = 58.7 (SD = 22.21)	M = 58.57 (SD = 25.29)	M = 59.52 (SD = 17.71)
Contra	M = 48.45 (SD = 23.07)	M = 51.5 (SD = 23.95)	M = 54.34 (SD = 19.51)
Research	M = 53.71 (SD = 19.56)	M = 54.24 (SD = 21.09)	M = 56.88 (SD = 20.04)

Table 10. Mean rating of perceived trustworthiness, competence and source credibility for the different sources.
Note. Source credibility is the overall mean, consisting of the two components trustworthiness and competence.

	Politicians	Researchers	Citizens' Jury
Trustworthiness	M = 35.79 (SD = 24.36)	M = 64.76 (SD = 24.59)	M = 66.85 (SD = 18.98)
Competence	M = 34.53 (SD = 25.47)	M = 65.1 (SD = 24.44)	M = 52.38 (SD = 22.22)
Source credibility	$\boldsymbol{M}$ **= 35.16** (SD = 24.03)	$\boldsymbol{M}$ **= 64.93** (SD = 23.78)	$\boldsymbol{M}$ **= 59.62** (SD = 18.85)

Appendix E. Contrast table and regression model with all treatment groups

Table 11. Contrast table of the levels of the factor statement.
Note. Post hoc contrasts to indicate differences between the four different factor levels. $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Contrast	B	$SE\ B$	t	p
Control – Pro-SAI	−4.89	3.15	−1.55	.408
Control – Pro research-SAI	−0.86	3.17	−0.27	.993
Control – Contra-SAI	2.63	3.19	0.82	.843
Pro SAI – Pro research-SAI	4.03	2.27	1.78	.284
Pro SAI – Contra-SAI	7.52**	2.30	3.27	.006
Pro research – Contra-SAI	3.48	2.32	1.5	.438

Table 12. Differences in SAI acceptance between the control group and the 9 treatment groups.
Note. Because residuals suffered from heteroscedasticity, robust standard errors ($SE\ B$) were calculated. $N = 568$. The treatment factor was dummy coded with the control group serving as reference category. Adjusted $R^2 = .014$ ($p = .013$). $^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

	B	$SE\ B$	t	p
Intercept	54.04***	2.33	23.24	< .001
Pro SAI & Politicians	4.66	3.77	1.24	.217
Pro SAI & Researchers	4.53	4.1	1.13	.259
Pro SAI & Citizens' Jury	5.48	3.29	1.67	.096
Pro research & Politicians	−0.33	3.47	−0.09	.925
Pro research & Researchers	0.2	3.65	0.06	.956
Pro research & Citizens' Jury	2.84	3.6	0.79	.432
Contra SAI & Politicians	−5.59	3.96	−1.41	.158
Contra SAI & Researchers	−2.54	3.98	−0.64	.523
Contra SAI & Citizens' Jury	0.3	3.59	0.08	.933

Appendix F. Item analysis

Table 13. Acceptance of SAI (N = 568, including control group).
Note. Mean inter-item-correlation = .465; Cronbach's $\alpha = .913$.

Row	Missings	Mean	SD	Skew	W(p)	Item Difficulty	Item Discrimination	α if deleted
E101_01	0.00%	45.39	29.58	0.04	0.95 (0.000)	0.45	0.768	0.9
E101_02	0.00%	78.47	28.16	-1.38	0.78 (0.000)	0.78	0.539	0.91
E101_03	0.00%	42.31	30.25	0.23	0.93 (0.000)	0.42	0.656	0.905
E101_04	0.00%	51.76	27.21	-0.19	0.96 (0.000)	0.51	0.681	0.904
E101_05	0.00%	52.13	30.05	-0.19	0.95 (0.000)	0.52	0.748	0.901
E101_06	0.00%	50.45	30.17	-0.12	0.95 (0.000)	0.5	0.787	0.899
E101_07	0.00%	56.49	33.09	-0.28	0.92 (0.000)	0.56	0.745	0.901
E101_08	0.00%	41.26	29.41	0.28	0.95 (0.000)	0.41	0.587	0.908
E101_09	0.00%	71.42	31.38	-0.91	0.84 (0.000)	0.71	0.555	0.91
E101_10	0.00%	63.67	30.11	-0.52	0.92 (0.000)	0.63	0.609	0.907
E101_11	0.00%	34.53	26.58	0.43	0.93 (0.000)	0.34	0.555	0.91
E101_12	0.00%	72.98	30.52	-1.03	0.83 (0.000)	0.72	0.573	0.909

Table 14. Perceived trustworthiness (N = 508).
Note. Mean inter-item-correlation = .815, Cronbach's α = .963.

Row	Missings	Mean	SD	Skew	W(p)	Item Difficulty	Item Discrimination	α if deleted
SC01_01	0.00%	46.52	29.09	0.09	0.96 (0.000)	0.46	0.786	0.967
SC01_04	0.00%	66.47	26.58	-0.79	0.93 (0.000)	0.66	0.811	0.964
SC01_07	0.00%	55.7	29.44	-0.29	0.95 (0.000)	0.55	0.941	0.95
SC01_09	0.00%	55.78	29.15	-0.27	0.96 (0.000)	0.55	0.946	0.95
SC01_10	0.00%	54.79	29.55	-0.24	0.96 (0.000)	0.54	0.928	0.952
SC01_11	0.00%	55.55	31.13	-0.28	0.94 (0.000)	0.55	0.892	0.956

Table 15. Perceived competence (N = 508).
Note. Mean inter-item-correlation = .818; Cronbach's α = .964.

Row	Missings	Mean	SD	Skew	W(p)	Item Difficulty	Item Discrimination	α if deleted
SC04_01	0.00%	50.52	29.1	-0.07	0.96 (0.000)	0.5	0.902	0.956
SC04_03	0.00%	50.98	29.29	-0.04	0.96 (0.000)	0.5	0.908	0.955
SC04_04	0.00%	48.53	28.82	-0.02	0.96 (0.000)	0.48	0.879	0.958
SC04_06	0.00%	55.89	29.13	-0.28	0.96 (0.000)	0.55	0.852	0.961
SC04_07	0.00%	51.57	30.19	-0.1	0.96 (0.000)	0.51	0.901	0.956
SC04_08	0.00%	47.31	30.36	0.06	0.95 (0.000)	0.47	0.869	0.959

Table 16. Source credibility (N = 508).
Note. Mean inter-item-correlation = .757; Cronbach's α = .974.

Row	Missings	Mean	SD	Skew	W(p)	Item Difficulty	Item Discrimination	α if deleted
SC01_01	0.00%	46.52	29.09	0.09	0.96 (0.000)	0.46	0.815	0.973
SC01_04	0.00%	66.47	26.58	-0.79	0.93 (0.000)	0.66	0.773	0.973
SC01_07	0.00%	55.7	29.44	-0.29	0.95 (0.000)	0.55	0.88	0.971
SC01_09	0.00%	55.78	29.15	-0.27	0.96 (0.000)	0.55	0.889	0.971
SC01_10	0.00%	54.79	29.55	-0.24	0.96 (0.000)	0.54	0.909	0.97
SC01_11	0.00%	55.55	31.13	-0.28	0.94 (0.000)	0.55	0.869	0.971
SC04_01	0.00%	50.52	29.1	-0.07	0.96 (0.000)	0.5	0.856	0.972
SC04_03	0.00%	50.98	29.29	-0.04	0.96 (0.000)	0.5	0.869	0.971
SC04_04	0.00%	48.53	28.82	-0.02	0.96 (0.000)	0.48	0.884	0.971
SC04_06	0.00%	55.89	29.13	-0.28	0.96 (0.000)	0.55	0.912	0.97
SC04_07	0.00%	51.57	30.19	-0.1	0.96 (0.000)	0.51	0.842	0.972
SC04_08	0.00%	47.31	30.36	0.06	0.95 (0.000)	0.47	0.792	0.973

Appendix G. Items (translated from German)

Table 17. Items used for analysis (translated from German).

Variable, item	*Response scale*
Source credibility — Trustworthiness	*"I don't agree at all (1) - "I agree completley" (101)*
Concerning climate protection and stratospheric aerosol injection...	
...I trust the Bundestag Committee / *Researchers* / *Citizens' Jury*.	
...I think that the Bundestag Committee / *Researchers* / *Citizens' Jury* has good intentions.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be honest.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be sincere.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be trustworthy.	
...I think that the Bundestag Committee / *Researchers* / *Citizens' Jury* acts in the best interest of the population.	
Source credibility — Competence	*"I don't agree at all (1) - "I agree completley" (101)*
Concerning climate protection and stratospheric aerosol injection...	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be competent.	
...I think that the Bundestag Committee / *Researchers* / *Citizens' Jury* can assess the situation well.	
...I think that the Bundestag Committee / *Researchers* / *Citizens' Jury* is able to make a judgement that is satisfactory for all parties concerned.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be reliable.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be professional.	
...I consider the Bundestag Committee / *Researchers* / *Citizens' Jury* to be experienced.	
Acceptance of SAI	*"I don't agree at all (1) - "I agree completley" (101)*
I am a supporter of the stratospheric aerosol injection measure.	
I think stratospheric aerosol injection should be further researched.	
I would vote for a party that supports the use of stratospheric aerosol injection.	
I believe stratospheric aerosol injection to be effective.	
Stratospheric aerosol injection should be used to combat climate change.	
The possible deployment of stratospheric aerosol injection gives me hope.	
I reject the use of stratospheric aerosol injection.	
The possible deployment of stratospheric injection worries me.	
I would demonstrate against the deployment of stratospheric aerosol injection.	
I consider stratospheric aerosol injection immoral.	
I think that stratospheric aerosol injection involves many risks.	
I reject further research into the stratospheric aerosol injection measure.	
Uncertainty	*"I don't agree at all (1) - "I agree completley" (101)*
I have no clear opinion about stratospheric aerosol injection.	
I do not know how to think about the possible use of stratospheric aerosol injection.	
Overall, I am very unsure about my opinion of stratospheric aerosol injection.	
Prior knowledge	*- "Heard a lot about it" - "Heard little about it" - "Never heard of it before"*
Have you ever heard about SAI before?	

References

Ackerman, T., Armstrong, T., Barrett, S., Burns, W., Caldeira, K., Frumhoff, P. C., Hamburg, S., Hayhoe, K., Keith, D., Light, A., Long, J., Loy, F., MacCracken, M., MacMartin, D., Morgan, M. G., Nicholson, S., Parson, E. A., Robock, A., Sarewitz, D., Schrag, D. P., Swanson, C., Titley, D. W., Victor, D. G. and Winickoff, D. (2017). *Letter to the Honorable Lamar Smith, Andy Biggs and Randy Weber*. URL: https://www.desmogblog.com/sites/beta.desmogblog.com/files/House-Geoengineering-Geoengineering-Hearing-1.pdf.

Algan, Y., Guriev, S., Papaioannou, E. and Passari, E. (2017). 'The European Trust Crisis and the Rise of Populism'. *Brookings Papers on Economic Activity* 2017 (2), pp. 309–400. https://doi.org/10.1353/eca.2017.0015.

Anshelm, J. and Hansson, A. (2014). 'Battling Promethean dreams and Trojan horses: Revealing the critical discourses of geoengineering'. *Energy Research & Social Science* 2, pp. 135–144. https://doi.org/10.1016/j.erss.2014.04.001.

— (2016). 'Has the grand idea of geoengineering as Plan B run out of steam?' *The Anthropocene Review* 3 (1), pp. 64–74. https://doi.org/10.1177/2053019615614592.

Asayama, S., Sugiyama, M. and Ishii, A. (2017). 'Ambivalent climate of opinions: Tensions and dilemmas in understanding geoengineering experimentation'. *Geoforum* 80, pp. 82–92. https://doi.org/10.1016/j.geoforum.2017.01.012.

Baatz, C. (2016). 'Can We Have It Both Ways? On Potential Trade-Offs Between Mitigation and Solar Radiation Management'. *Environmental Values* 25 (1), pp. 29–49. https://doi.org/10.3197/096327115x14497392134847.

Bell, D., Gray, T. and Haggett, C. (2005). 'The 'Social Gap' in Wind Farm Siting Decisions: Explanations and Policy Responses'. *Environmental Politics* 14 (4), pp. 460–477. https://doi.org/10.1080/09644010500175833.

Bellamy, R., Chilvers, J. and Vaughan, N. E. (2016). 'Deliberative Mapping of options for tackling climate change: Citizens and specialists 'open up' appraisal of geoengineering'. *Public Understanding of Science* 25 (3), pp. 269–286. https://doi.org/10.1177/0963662514548628.

Bellamy, R. and Lezaun, J. (2017). 'Crafting a public for geoengineering'. *Public Understanding of Science* 26 (4), pp. 402–417. https://doi.org/10.1177/0963662515600965.

Bellamy, R., Lezaun, J. and Palmer, J. (2017). 'Public perceptions of geoengineering research governance: An experimental deliberative approach'. *Global Environmental Change* 45, pp. 194–202. https://doi.org/10.1016/j.gloenvcha.2017.06.004.

Braun, C., Merk, C., Pönitzsch, G., Rehdanz, K. and Schmidt, U. (2018). 'Public perception of climate engineering and carbon capture and storage in Germany: survey evidence'. *Climate Policy* 18 (4), pp. 471–484. https://doi.org/10.1080/14693062.2017.1304888.

Brewer, P. R. and Ley, B. L. (2013). 'Whose Science Do You Believe? Explaining Trust in Sources of Scientific Information About the Environment'. *Science Communication* 35 (1), pp. 115–137. https://doi.org/10.1177/1075547012441691.

Bromme, R. (2020). 'Informiertes Vertrauen: Eine psychologische Perspektive auf Vertrauen in Wissenschaft'. In: Wissenschaftsreflexion. Interdisziplinäre Perspektiven zwischen Philosophie und Praxis. Ed. by M. Jungert, A. Frewer and E. Mayr. Paderborn, Germany: Mentis Verlag, pp. 105–134.

Brucks, M. (1985). 'The Effects of Product Class Knowledge on Information Search Behavior'. *Journal of Consumer Research* 12 (1), p. 1. https://doi.org/10.1086/209031.

Buck, H. J. (2018). 'Perspectives on solar geoengineering from Finnish Lapland: Local insights on the global imaginary of Arctic geoengineering'. *Geoforum* 91, pp. 78–86. https://doi.org/10.1016/j.geoforum.2018.02.020.

Bürgerforum Climate Engineering (2018). *Bürgergutachten zum Bürgerforum „Climate Engineering — eine Möglichkeit gegen den Klimawandel?“* URL: https://www.spp-climate-engineering.de/buergerforum.html?file=files/ce-projekt/media/download%5C_PDFs/BF-Gutachten.pdf.

Burns, E. T., Flegal, J. A., Keith, D. W., Mahajan, A., Tingley, D. and Wagner, G. (2016). 'What do people think when they think about solar geoengineering? A review of empirical social science literature, and prospects for future research'. *Earth's Future* 4 (11), pp. 536–542. https://doi.org/10.1002/2016ef000461.

Caldeira, K. and Keith, D. W. (2010). 'The need for climate engineering research'. *Issues in Science and Technology* 27 (1), pp. 57–62.

Carnegie Climate Governance Initiative (2019). *The Need to Govern Climate-Altering Technologies: C2G and its Approach*. URL: https://www.c2g2.net/wp-content/uploads/20191001-C2G-Approach.pdf.

Chebat, J.-C., Limoges, F. and Gélinas-Chebat, C. (1998). 'Limits of the Effects of Advertisement Framing: The Moderating Effects of Prior Knowledge and Involvement'. *Advances in Consumer Research* 25 (1), pp. 324–333.

Chew, F. and Kim, S. (1994). 'Using Concept Mapping to Go Beyond the Source Credibility Model in Assessing Celebrity-Message Congruence'. Paper presented at annual meeting of the Association for Education in Journalism and Mass Communication, Atlanta, GA. URL: https://files.eric.ed.gov/fulltext/ED372452.pdf.

Convention on Biological Diversity (2010). *Decision adopted by the conference of the parties to the convention on biological diversity at its tenth meeting, X/33. Biodiversity and climate change*. URL: https://www.cbd.int/doc/decisions/cop-10/cop-10-dec-33-en.pdf.

Converse, P. E. (1970). 'Attitudes and non-attitudes: Continuation of a dialogue'. In: The quantitative analysis of social problems. Ed. by E. R. Tufte. Reading, MA, U.S.A.: Addison-Wesley, pp. 168–189. https://doi.org/10.1037/e685262012-124.

Corner, A., Parkhill, K. and Pidgeon, N. (2011). 'Experiment Earth? Reflections on a public dialogue on geoengineering'. *Understanding Risk Working Paper*. 11–02.

Corner, A., Parkhill, K., Pidgeon, N. and Vaughan, N. E. (2013). 'Messing with nature? Exploring public perceptions of geoengineering in the UK'. *Global Environmental Change* 23 (5), pp. 938–947. https://doi.org/10.1016/j.gloenvcha.2013.06.002.

Corner, A. and Pidgeon, N. (2015). 'Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering'. *Climatic Change* 130 (3), pp. 425–438. https://doi.org/10.1007/s10584-014-1148-6.

Crutzen, P. J. (2006). 'Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?' *Climatic Change* 77 (3-4), pp. 211–220. https://doi.org/10.1007/s10584-006-9101-y.

Curato, N. and Böker, M. (2016). 'Linking mini-publics to the deliberative system: a research agenda'. *Policy Sciences* 49 (2), pp. 173–190. https://doi.org/10.1007/s11077-015-9238-5.

Eagly, A. H. and Chaiken, S. (1993). The Psychology of Attitudes. Orlando, FL, U.S.A.: Harcourt Brace Jovanovich College Publishers.

Eisend, M. (2006). 'Source Credibility Dimensions in Marketing Communication — A Generalized Solution'. *Journal of Empirical Generalisations in Marketing* 10 (2).

Fischhoff, B. (2013). 'The sciences of science communication'. *Proceedings of the National Academy of Sciences* 110 (Supplement 3), pp. 14033–14039. https://doi.org/10.1073/pnas.1213273110.
Foster, C. and Frieden, J. (2017). 'Crisis of trust: Socio-economic determinants of Europeans' confidence in government'. *European Union Politics* 18 (4), pp. 511–535. https://doi.org/10.1177/1465116517723499.
Grewal, D., Gotlieb, J. and Marmorstein, H. (1994). 'The Moderating Effects of Message Framing and Source Credibility on the Price-Perceived Risk Relationship'. *Journal of Consumer Research* 21 (1), p. 145. https://doi.org/10.1086/209388.
Gunderson, R., Stuart, D. and Petersen, B. (2019). 'The Political Economy of Geoengineering as Plan B: Technological Rationality, Moral Hazard, and New Technology'. *New Political Economy* 24 (5), pp. 696–715. https://doi.org/10.1080/13563467.2018.1501356.
Guterres, A. (10th August 2018). *Secretary-General's remarks on climate change*. URL: https://www.un.org/sg/en/content/sg/speeches/2018-09-10/remarks-climate-change.
Horton, J. B., Keith, D. W. and Honegger, M. (2016). *Implications of the Paris agreement for carbon dioxide removal and solar geoengineering. Cambridge: Harvard Project on Climate Agreements*. URL: https://keith.seas.harvard.edu/files/tkg/files/horton_et_al._-_2016_-_implications_of_the_paris_agreement_for_carbon_dio.pdf.
Hovland, C. I., Janis, I. L. and Kelley, H. H. (1953). 'Communication and Persuasion'. In: Psychological Studies of Opinion Change. New Haven, CT, U.S.A.: Yale University Press.
Howlett, M. and Kemmerling, A. (2017). 'Calibrating climate change policies: the causes and consequences of sustained under-reaction'. *Journal of Environmental Policy & Planning* 19 (6), pp. 625–637. https://doi.org/10.1080/1523908x.2017.1324772.
Huffman, W. E., Rousu, M., Shogren, J. F. and Tegene, A. (2007). 'The effects of prior beliefs and learning on consumers' acceptance of genetically modified foods'. *Journal of Economic Behavior & Organization* 63 (1), pp. 193–206. https://doi.org/10.1016/j.jebo.2005.04.019.
Huttunen, S. and Hildén, M. (2014). 'Framing the Controversial'. *Science Communication* 36 (1), pp. 3–29. https://doi.org/10.1177/1075547013492435.
IPCC (2018). *Summary for Policymakers*. Geneva, Switzerland. URL: https://www.ipcc.ch/sr15/.
Ipsos MORI (2016). *Veracity Index 2015*. London, U.K. URL: https://www.ipsos.com/sites/default/files/ct/news/documents/2019-11/trust-in-professions-veracity-index-2019-slides.pdf.
Jin, H. J. and Han, D. H. (2014). 'Interaction between message framing and consumers' prior subjective knowledge regarding food safety issues'. *Food Policy* 44, pp. 95–102. https://doi.org/10.1016/j.foodpol.2013.10.007.
Jones, L. W., Sinclair, R. C. and Courneya, K. S. (2003). 'The Effects of Source Credibility and Message Framing on Exercise Intentions, Behaviors, and Attitudes: An Integration of the Elaboration Likelihood Model and Prospect Theory1'. *Journal of Applied Social Psychology* 33 (1), pp. 179–196. https://doi.org/10.1111/j.1559-1816.2003.tb02078.x.
Juvan, E. and Dolnicar, S. (2014). 'The attitude–behaviour gap in sustainable tourism'. *Annals of Tourism Research* 48, pp. 76–95. https://doi.org/10.1016/j.annals.2014.05.012.

Kahan, D. M., Jenkins-Smith, H., Tarantola, T., Silva, C. L. and Braman, D. (2015). 'Geoengineering and Climate Change Polarization'. *The ANNALS of the American Academy of Political and Social Science* 658 (1), pp. 192–222. https://doi.org/10.1177/0002716214559002.

Keith, D. (2013). A Case for Climate Engineering. Cambridge, MA, U.S.A: The MIT Press. https://doi.org/10.7551/mitpress/9920.001.0001.

Keith, D. W. and Irvine, P. J. (2016). 'Solar geoengineering could substantially reduce climate risks-A research hypothesis for the next decade'. *Earth's Future* 4 (11), pp. 549–559. https://doi.org/10.1002/2016ef000465.

Kim, S.-B. and Kim, D.-Y. (2014). 'The Effects of Message Framing and Source Credibility on Green Messages in Hotels'. *Cornell Hospitality Quarterly* 55 (1), pp. 64–75. https://doi.org/10.1177/1938965513503400.

Klamer, A. and Leonard, T. C. (1994). 'So what's an economic metaphor?' In: Natural images in economic thought. Ed. by P. Mirowski. Cambridge, U.K.: Cambridge University Press, pp. 20–51.

Kollmuss, A. and Agyeman, J. (2002). 'Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior?' *Environmental Education Research* 8 (3), pp. 239–260. https://doi.org/10.1080/13504620220145401.

Kumkale, G. T., Albarracín, D. and Seignourel, P. J. (2010). 'The Effects of Source Credibility in the Presence or Absence of Prior Attitudes: Implications for the Design of Persuasive Communication Campaigns'. *Journal of Applied Social Psychology* 40 (6), pp. 1325–1356. https://doi.org/10.1111/j.1559-1816.2010.00620.x.

Lang, J. T. and Hallman, W. K. (2005). 'Who Does the Public Trust? The Case of Genetically Modified Food in the United States'. *Risk Analysis* 25 (5), pp. 1241–1252. https://doi.org/10.1111/j.1539-6924.2005.00668.x.

Lee, C.-J., Scheufele, D. A. and Lewenstein, B. V. (2005). 'Public attitudes toward emerging technologies'. *Science Communication* 27 (2), pp. 240–267. https://doi.org/10.1177/1075547005281474.

Leiner, D. J. (2017). *SoSci Survey (Version 2.6. 00)*. Computer software. URL: https://www.soscisurvey.de.

Liu, L., Bouman, T., Perlaviciute, G. and Steg, L. (2019). 'Effects of trust and public participation on acceptability of renewable energy projects in the Netherlands and China'. *Energy Research & Social Science* 53, pp. 137–144. https://doi.org/10.1016/j.erss.2019.03.006.

Long, J. C. and Cairns, R. (2019). 'Is it necessary to research solar climate engineering as a possible backstop technology'?' In: Contemporary Climate Change Debates: A Student Primer. Ed. by M. Hulme. Abingdon, U.K.: Routledge, pp. 109–123.

Luokkanen, M., Huttunen, S. and Hildén, M. (2014). 'Geoengineering, news media and metaphors: Framing the controversial'. *Public Understanding of Science* 23 (8), pp. 966–981. https://doi.org/10.1177/0963662513475966.

Mahajan, A., Tingley, D. and Wagner, G. (2019). 'Fast, cheap, and imperfect? US public opinion about solar geoengineering'. *Environmental Politics* 28 (3), pp. 523–543. https://doi.org/10.1080/09644016.2018.1479101.

McCroskey, J. C. and Teven, J. J. (1999). 'Goodwill: a reexamination of the construct and its measurement'. *Communication Monographs* 66 (1), pp. 90–103. https://doi.org/10.1080/03637759909376464.

Mercer, A. M., Keith, D. W. and Sharp, J. D. (2011). 'Public understanding of solar radiation management'. *Environmental Research Letters* 6 (4), p. 044006. https://doi.org/10.1088/1748-9326/6/4/044006.

Merk, C., Klaus, G., Pohlers, J., Ernst, A., Ott, K. and Rehdanz, K. (2019). 'Public perceptions of climate engineering: Laypersons' acceptance at different levels of knowledge and intensities of deliberation'. *GAIA - Ecological Perspectives for Science and Society* 28 (4), pp. 348–355. https://doi.org/10.14512/gaia.28.4.6.

Merk, C. and Pönitzsch, G. (2017). 'The Role of Affect in Attitude Formation toward New Technologies: The Case of Stratospheric Aerosol Injection'. *Risk Analysis* 37 (12), pp. 2289–2304. https://doi.org/10.1111/risa.12780.

Merk, C., Pönitzsch, G. and Rehdanz, K. (2016). 'Knowledge about aerosol injection does not reduce individual mitigation efforts'. *Environmental Research Letters* 11 (5), p. 054009. https://doi.org/10.1088/1748-9326/11/5/054009.

Michels, A. (2011). 'Innovations in democratic governance: how does citizen participation contribute to a better democracy?' *International Review of Administrative Sciences* 77 (2), pp. 275–293. https://doi.org/10.1177/0020852311399851.

Ming, T., de_Richter, R., Liu, W. and Caillol, S. (2014). 'Fighting global warming by climate engineering: Is the Earth radiation management and the solar radiation management any option for fighting climate change?' *Renewable and Sustainable Energy Reviews* 31, pp. 792–834. https://doi.org/10.1016/j.rser.2013.12.032.

National Research Council (U.S.) (2015). Climate Intervention: Reflecting Sunlight to Cool Earth. Washington, D.C., U.S.A.: National Academies Press. https://doi.org/10.17226/18988.

Niemeyer, S. (2014). 'Scaling up Deliberation to Mass Publics: Harnessing Minipublics in a Deliberative System'. In: Deliberative mini-publics. Involving citizens in the democratic process. Ed. by K. Grönlund, A. Bächtiger and M. Setälä. Colchester, U.K.: ECPR Press, pp. 177–201.

Nisbet, M. C. and Scheufele, D. A. (2009). 'What's next for science communication? Promising directions and lingering distractions'. *American Journal of Botany* 96 (10), pp. 1767–1778. https://doi.org/10.3732/ajb.0900041.

Petty, R. E. and Cacioppo, J. T. (1986). Communication and persuasion: Central and peripheral routes to attitude change. New York, NY, U.S.A.: Springer-Verlag. https://doi.org/10.1007/978-1-4612-4964-1.

Petty, R. E. and Wegener, D. T. (1998). 'Attitude change: Multiple roles for persuasion variables'. In: The handbook of social psychology. Ed. by D. T. G. adn S. T. Fiske and G. Lindzey. 1st ed. New York, U.S.A.: McGraw-Hill, pp. 323–390.

Pigliucci, M. and Boudry, M. (2011). 'Why Machine-Information Metaphors are Bad for Science and Science Education'. *Science & Education* 20 (5–6), pp. 453–471. https://doi.org/10.1007/s11191-010-9267-6.

Pornpitakpan, C. (2004). 'The Persuasiveness of Source Credibility: A Critical Review of Five Decades' Evidence'. *Journal of Applied Social Psychology* 34 (2), pp. 243–281. https://doi.org/10.1111/j.1559-1816.2004.tb02547.x.

Priest, S. H. (2001). 'Misplaced faith: communication variables as predictors of encouragement for biotechnology development'. *Science Communication* 23 (2), pp. 97–110. https://doi.org/10.1177/1075547001023002002.

Reips, U.-D. (2002). 'Standards for Internet-Based Experimenting'. *Experimental Psychology* 49 (4), pp. 243–256.
https://doi.org/10.1026//1618-3169.49.4.243.

Robock, A., Jerch, K. and Bunzl, M. (2008). '20 reasons why geoengineering may be a bad idea'. *Bulletin of the Atomic Scientists* 64 (2), pp. 14–59.
https://doi.org/10.1080/00963402.2008.11461140.

Robock, A., Marquardt, A., Kravitz, B. and Stenchikov, G. (2009). 'Benefits, risks, and costs of stratospheric geoengineering'. *Geophysical Research Letters* 36 (19).
https://doi.org/10.1029/2009gl039209.

Sanz-Menéndez, L. and Cruz-Castro, L. (2019). 'The credibility of scientific communication sources regarding climate change: A population-based survey experiment'. *Public Understanding of Science* 28 (5), pp. 534–553.
https://doi.org/10.1177/0963662519840946.

Scheer, D. and Renn, O. (2014). 'Public Perception of geoengineering and its consequences for public debate'. *Climatic Change* 125 (3-4), pp. 305–318.
https://doi.org/10.1007/s10584-014-1177-1.

Schipperges, M., Holzhauer, B. and Scholl, G. (2018). *Umweltbewusstsein und Umweltverhalten in Deutschland 2016. Vertiefungsstudie: Sozial-ökologischer Wandel — Anschlussfähigkeit und Engagement-Potenziale*. Dessau-Roßlau, Germany.
URL: https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/umweltbewusstsein_deutschland_2016_bf.pdf.

Shepherd, J. G. (2012). 'Geoengineering the climate: an overview and update'. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 370 (1974), pp. 4166–4175.
https://doi.org/10.1098/rsta.2012.0186.

Siegrist, M. (2000). 'The Influence of Trust and Perceptions of Risks and Benefits on the Acceptance of Gene Technology'. *Risk Analysis* 20 (2), pp. 195–204.
https://doi.org/10.1111/0272-4332.202020.

— (2019). 'Trust and Risk Perception: A Critical Review of the Literature'. *Risk Analysis*. https://doi.org/10.1111/risa.13325.

Siegrist, M., Gutscher, H. and Earle, T. C. (2005). 'Perception of risk: the influence of general trust, and general confidence'. *Journal of Risk Research* 8 (2), pp. 145–156.
https://doi.org/10.1080/1366987032000105315.

Sleeth-Keppler, D., Perkowitz, R. and Speiser, M. (2017). 'It's a Matter of Trust: American Judgments of the Credibility of Informal Communicators on Solutions to Climate Change'. *Environmental Communication* 11 (1), pp. 17–40.
https://doi.org/10.1080/17524032.2015.1062790.

Sternthal, B., Phillips, L. W. and Dholakia, R. (1978). 'The Persuasive Effect of Source Credibility: A Situational Analysis'. *Public Opinion Quarterly* 42 (3), p. 285. https://doi.org/10.1086/268454.

Terwel, B. W., Harinck, F., Ellemers, N. and Daamen, D. D. L. (2009). 'Competence-Based and Integrity-Based Trust as Predictors of Acceptance of Carbon Dioxide Capture and Storage (CCS)'. *Risk Analysis* 29 (8), pp. 1129–1140.
https://doi.org/10.1111/j.1539-6924.2009.01256.x.

Tormala, Z. L. and Petty, R. E. (2004). 'Source Credibility and Attitude Certainty: A Metacognitive Analysis of Resistance to Persuasion'. *Journal of Consumer Psychology* 14 (4), pp. 427–442.
https://doi.org/10.1207/s15327663jcp1404_11.

Trumbo, C. W. and McComas, K. A. (2003). 'The Function of Credibility in Information Processing for Risk Perception'. *Risk Analysis* 23 (2), pp. 343–353.
https://doi.org/10.1111/1539-6924.00313.

Umweltbundesamt (2011). Geo-Engineering - wirksamer Klimaschutz oder Größenwahn? URL: https://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4125.pdf.
UNFCCC (2015). *Adoption of the Paris Agreement*. FCCC/CP/2015/L.9/ Rev.1. URL: https://unfccc.int/sites/default/files/english_paris_agreement.pdf.
Union of Concerned Scientists (2019). *UCS Position on Solar Geoengineering February 2019*. URL: https://www.ucsusa.org/sites/default/files/attach/2019/gw-position-Solar-Geoengineering-022019.pdf.
Weingart, P. and Guenther, L. (2016). 'Science communication and the issue of trust'. *JCOM* 15 (05), C01. https://doi.org/10.22323/2.15050301.
Wibeck, V., Hansson, A., Anshelm, J., Asayama, S., Dilling, L., Feetham, P. M., Hauser, R., Ishii, A. and Sugiyama, M. (2017). 'Making sense of climate engineering: a focus group study of lay publics in four countries'. *Climatic Change* 145 (1-2), pp. 1–14. https://doi.org/10.1007/s10584-017-2067-0.
Wilson, E. J. and Sherrell, D. L. (1993). 'Source effects in communication and persuasion research: A meta-analysis of effect size'. *Journal of the Academy of Marketing Science* 21 (2), pp. 101–112. https://doi.org/10.1007/bf02894421.
Yeo, S. K., Binder, A. R., Dahlstrom, M. F. and Brossard, D. (2018). 'An inconvenient source? Attributes of science documentaries and their effects on information-related behavioral intentions'. *Journal of Science Communication* 17 (02), A07. https://doi.org/10.22323/2.17020207.
Young, W., Hwang, K., McDonald, S. and Oates, C. J. (2010). 'Sustainable consumption: green consumer behaviour when purchasing products'. *Sustainable Development* 18, pp. 20–31. https://doi.org/10.1002/sd.394.
Zhang, Y. and Buda, R. (1999). 'Moderating Effects of Need for Cognition on Responses to Positively versus Negatively Framed Advertising Messages'. *Journal of Advertising* 28 (2), pp. 1–15. https://doi.org/10.1080/00913367.1999.10673580.

Authors

Geraldine Klaus recently finished her PhD at the Center for Environmental Systems Research (CESR), an interdisciplinary research institute of the University of Kassel. She holds a master's degree in psychology with a special focus on environmental psychology. Her research focused on lay persons' perceptions of climate engineering technologies and mitigation strategies. Within the project TOMACE (trade-offs between mitigation and climate engineering), she conducted psychological experiments to assess information processing and attitude formation. She is currently working in study program coordination.
E-mail: geraldine.klaus@uni-kassel.de.

Lisa Oswald is a PhD researcher and research associate at the Data Science Lab of the Hertie School in Berlin. She graduated from the University of Oxford with an MSc in Social Data Science and from the University of Kassel, Germany, with a BSc and MSc in Psychology. She worked as student research assistant for the TOMACE (trade-offs between mitigation and climate engineering) project at the Center for Environmental Systems Research in Kassel. E-mail: lisa.oswald@t-online.de.

Andreas Ernst holds a chair of Environmental Systems Analysis/Environmental Psychology and is one of the directors of the Center for Environmental Systems Research (CESR) at the University of Kassel, Germany. He is also one of the directors of the university's Competence Center for Climate Mitigation and Adaptation (CliMA). Trained as a cognitive and environmental psychologist, he has been responsible for a number of interdisciplinary national and international research projects. E-mail: ernst@usf.uni-kassel.de.

Christine Merk is a senior researcher in the research center Global Commons and Climate Policy at the Kiel Institute for the World Economy. One of her main research interests are the trade-off decisions laypeople make between conventional mitigation and the deployment of climate engineering technologies. Her survey experiments use concepts from the psychology of risk perception to learn more about reactions to novel technologies like Carbon Capture and Storage, carbon dioxide removal or stratospheric aerosol injection.
E-mail: Christine.Merk@ifw-kiel.de.

How to cite

Klaus, G., Oswald, L., Ernst, A. and Merk, C. (2021). 'Effects of opinion statements on laypeople's acceptance of a climate engineering technology. Comparing the source credibility of researchers, politicians and a citizens' jury'. *JCOM* 20 (01), A03. https://doi.org/10.22323/2.20010203.

© The Author(s). This article is licensed under the terms of the Creative Commons Attribution — NonCommercial — NoDerivativeWorks 4.0 License.
ISSN 1824-2049. Published by SISSA Medialab. jcom.sissa.it