Impact of trust in the government, political ideology and uncertainty communication on trust in COVID-19 related scientific information

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Abstract

Society and politicians rely on scientific knowledge when managing challenges such as the current COVID-19 pandemic. As important as the acquisition of scientific knowledge is the communication to society such that it is perceived as trustworthy and can be used to make informed decisions. Presently, we investigated how different factors such as communication source, uncertainty communication, prior trust in government, and political ideology influence the level of trust in COVID-19 related scientific information. We conducted a 2 (communicated uncertainty vs. no uncertainty communicated) x 3 (source: government vs. scientists vs. scientists via social media) between-subjects study. We manipulated the communication source and uncertainty communication in a message about the effectiveness rate of a booster shot. Additionally, we investigate the effects of trust in the government and political ideology. Results of the analysis showed no significant impact of communication source or uncertainty on the trust level in the message. However, high trust in the government and placing oneself in the more liberal/left continuum predicted higher trust levels in the communicated message. Therefore, our findings support prior research concerning trust in the government and political ideology. However, future research assessing another topic is needed to examine the effect of communication sources and uncertainty.

Keywords: Science communication, Communication source, Uncertainty, Political ideology, Trust in the Government, COVID-19 Booster shot

Impact of prior trust in the communication source, political ideology and uncertainty on trust in COVID-19 related scientific information

Currently, in the COVID-19 pandemic, people's daily lives have changed immensely by adhering to different measures to end the pandemic (Government of Germany, 2021; Government of the Netherlands, 2021; World Health Organization, 2021). Thus, presently, it becomes exceptionally apparent how crucial science is for the functioning of society. The acquisition of scientific knowledge is necessary for major challenges ranging from essential medical decision-making to climate change policies, and the current COVID-19 pandemic. Scientists are constantly researching and gaining knowledge about the new virus to understand how societies can manage the current pandemic. Subsequently, politicians rely on that scientific knowledge when deciding about policies to combat the virus. Hence, these decisions must be communicated to society (Burns et al., 2003).

With emerging demonstrations against the COVID-19 measures in several countries around the world and conspiracy theories about the origin of the virus, it is clear that people's perceptions of COVID-19 related information can differ enormously (Koerber, 2021). Especially when it comes to the COVID-19 vaccine, opinions vary (Dodd et al., 2021; Peretti-Watel et al., 2020; Tyson et al., 2020). Hence, the pandemic situation highlights the complexity and importance of science communication.

The current research will investigate the potential impacts of these opposing perceptions. More specifically, we will examine several factors that could influence individuals' trust in scientific information about the booster shot of the COVID-19 vaccine. We will examine how the communication source influences trust in the message and whether there is an effect of communicating uncertainty. We will be investigating a governmental source and scientific

sources. By considering the relationship between science and politics, we will be looking at how the general satisfaction and trust in the government influences the response to the communicated scientific information. Additionally, we will also be taking into account the political ideology. Therefore, this paper aims to investigate the following research question: What impact do different communication sources and communicated uncertainty have on people's trust in scientific information considering their prior trust in the government and political ideology?

Politicization of COVID-19 pandemic

Generally, scientific knowledge informs policies and decision-making by politicians. Still, politics decide what actions are taken and what is prioritized (not science). Prior research indicates a link between conservatism and a decreased prioritization of science funding (Rutjens et al., 2018). Hence, science and politics are dependent on each other ("Why nature needs to cover politics now more than ever ", 2020; Gauchat, 2012). In many essential challenges the world faces, such as the climate change debate and the current COVID-19 pandemic, this dependency can be recognized. Since the pandemic's start in March 2020, the news has been saturated with its information. This news is mostly communicated through politicians or political advisors. Who is conveying information about COVID-19 already impacts what information individuals receive (Sylvester, 2021). In the present context of COVID-19 related news, American Democrats focused more on informing about the threats to the public and their citizens, while Republican politicians emphasized businesses and economics (Green et al., 2020). Hence, what information one receives is already biased through the people who communicate it (Sylvester, 2021). Accordingly, politicians decide on resources and funding for science, and communicators of political parties decide on the content they disclose to the public (Sylvester, 2021). Therefore, since COVID-19 is such a highly politicized topic, we will be looking at the

influence of political ideology and prior trust in the government in communicating scientific information.

Prior trust in the government

When perceiving scientific information and forming an opinion about that information, unintended cognitive biases influence this process, such as the confirmation bias (Burns et al., 2003; Hart & Nisbet, 2012, Rutjens et al., 2018). The term explains the tendency of individuals to reject information that contradicts their prior belief and, similarly, accept information that confirms their belief (Oswald & Grosjean, 2017). Hence, the previous opinion about a particular topic influences the perception of topic-related information and, subsequently, trust in this information. Thus, denying scientific information about COVID-19 results in general skepticism about scientific findings around the same topic, including the vaccination (Oswald & Grosjean, 2017). Therefore, people's scientific beliefs should also be influenced by their prior trust in and opinion of the information source (Brewer & Ley, 2013; Fiske & Dupree, 2016). The influence of pre-existing attitudes can be observed in several contexts regardless of the group or organization it affects. For instance, people's prior distrust towards the US government during the Iraq war influenced their perception of misinformation about the war leading to more skepticism towards information they received (Lewandowsky et al., 2005). Furthermore, the interpretation of charitable behavior of a specific company was based on the pre-existing attitudes towards that company. More positive attitudes towards that company resulted in a more sociable interpretation of the behavior, while more negative attitudes resulted in a more egoistic interpretation (Bae & Cameron, 2006).

Hence, considering previous research findings and the interdependency of science and politics, we will expect that people who generally distrust their government are subsequently more distrusting towards any communicated scientific information.

Hypothesis 1

People who generally trust the government have more trust in the communicated message than people who do not trust the government regardless of the source transmitting the information.

Communication source

Furthermore, we manipulate the variable communication source (Fiske & Dupree, 2014). Since previous research of evidence communication emphasized the importance of the communication source, there might be a difference in reaction depending on whether the government or scientists are communicating the message (Fiske & Dupree, 2014). Previous research indicated that prior trust in the government predicted trust in a message of a governmental agency. However, prior trust in the government was not significantly related to trust in scientists or science media (Brewer & Ley, 2013). Therefore this means that due to the dependency of science and politics, we expect that there will be generally less trust in the message for people who have low trust in the government but moreover, there should be a difference expected whether scientists or the government communicates it. ("Why nature needs to cover politics now more than ever ", 2020; Gauchat, 2012). To investigate that, we will be looking at how participants´ perceptions of scientists and politicians differ (Brewer & Ley, 2013). An indication of how trustworthy individuals perceive a specific group of people gives the warmth-competence map (Fiske et al., 2002). It was found that scientists are perceived as highly competent, though medium in warmth, while politicians lower in competence and lower

in warmth (Fiske & Dupree, 2014). Hence, the slightly different perceptions of trustworthiness of these two groups make it very interesting to study in the context of COVID-19. Will expect higher trust in the message communicated by a scientific source than a governmental source.

Communicated Uncertainty

Moreover, especially due to the virus` novelty, there is much uncertainty around scientific knowledge regarding the pandemic. Hence, we will be investigating the effect of communicating scientific uncertainty on people's trust in the communicated information. There has been an ongoing debate about the impact of transparency on trust. On the one hand, transparency and disclosure of uncertainty are said to be among the main rules for science communication by creating a feeling of openness and involvement (Hood et al., 2006; Van der Linden & Marteau, 2020). Hence, communicating uncertainty within science communication is one form of being transparent (Brewer & Ley, 2013; Blastland et al., 2020). Regarding trust in a specific group, Hood et al. (2006) claimed that being transparent subsequently strengthens the trust in that certain group, consequently leading to more trust in a message communicated by that group.

However, recent research did not find any effect of transparency on trust in a certain group or subsequently in a specific message (Grimmelikhuijsen et al., 2013; Van der Bles et al., 2020). In fact, results indicated no increase in trust through communicating uncertainty. On the contrary, the communication of uncertainty slightly decreased trust in the communicated numbers and trust in the source (Van der Bles et al., 2020). In this study, verbal uncertainty was compared to numerical uncertainty, and it was found that for both dependent variables, trust in the number, as well as trust in the source, verbal communication of uncertainty, had a slightly larger effect than numerical communication of uncertainty (Van der Bles et al., 2020). In the

present study, uncertainty will be communicated both numerically and verbally simultaneously, resulting in either communicated uncertainty (verbal and numerical) or not communicated uncertainty around the number. Considering our first hypothesis and adding the effect of communication source and uncertainty, the following second hypothesis is expected:

Hypothesis 2

When COVID-19 information is communicated by the government and includes uncertainty, people who generally distrust their government are expected to have less trust in the message than information communicated by scientists and includes no uncertainty.

Political partisanship and ideology

Generally, prior research indicates tendencies between liberals and conservatives regarding their perception of scientific information. It has been determined that political ideology is an essential predictor in denying or accepting scientific information. In comparison to more liberal individuals, conservatives tend to be more skeptical towards scientific information, especially regarding climate change (Kahan et al., 2012; Lewandowsky et al., 2013). However, in the context of child vaccinations, political conservatism was not found to be a significant predictor. Therefore, the political conservatism's distrust in certain scientific information is not due to a general distrust in science but instead addresses only specific discussions (Rutjens et al., 2018; Rutjens et al., 2018).

The theory of Partisan Motivated Reasoning can explain this difference of perception between liberal and conservative people (Kahan, 2012). Generally, this theory distinguishes between two goals when receiving information. The first objective is to reach a specific conclusion in line with one's political views and partisanship. This type of goal is supported by the Social Identity Theory, which describes favoritism of information in line with their ingroup,

in this case, the corresponding party (Hogg, 2018). It has been found that political conservative people put a stronger emphasis on their ingroup's values and opinions than more liberal people (Graham et al., 2009; Rutjens et al., 2018). Furthermore, the second objective within Partisan Motivated Reasoning is to objectively conclude with no influence of subjective opinions and attitudes. However, the first goal is sometimes more active than the second when receiving information, which leads to accepting information that matches their partisan beliefs and political ideology (Kahan, 2012).

US-American researchers did examine the relationship between partisanship and belief about COVID-19 information. Sylvester (2021) found that a broader knowledge of correct beliefs about the coronavirus increased the intention of getting a COVID-19 vaccine. Generally, it was more liberal people who were better informed about the vaccine. Similarly, conservatism was one of the main predictors for conspiratorial beliefs in the context of COVID- 19 (Motta et al., 2020; Pickup et al., 2020; Uscinski et al., 2020). This research was conducted under the government of Donald Trump, whose strong republican opinions and influence on the media could have had an impact on these outcomes (Stecula, 2020). Therefore, in the present study, we will investigate whether these tendencies and differences between political conservative and liberal people can also be observed in the European context, namely Dutch and German residents.

Hypothesis 3

More political conservative people will have less trust in the communicated information than more political liberal people regardless of the source of information.

The current study

The current study aims to investigate the following research question: What impact will different communication sources and communicated uncertainty have on people's trust in scientific information, considering their prior trust in the government and political ideology? This will be done by using the current scientific topic of the booster shot of the COVID-19 vaccine. After being fully vaccinated, the vaccine's protection starts to fade, and after a booster shot, individuals should have the optimum protection against the virus again (Levin et al., 2021). Participants were asked to read a message about the COVID-19 Booster shot communicated by a governmental website, a scientific journal, or a Social Media Account of that scientific journal. As a second manipulation, uncertainty will be added or not. Furthermore, political ideology and prior trust in the government will be considered when analyzing the trust in the communicated effectiveness rate of the booster shot.

Method

Participants

A total of 464 participants completed the study. 257 were female (55.4%), 194 males (41.8%), 10 non-binary/diverse (2.2%) and three (0.6%) did not want to indicate their gender, with their age ranging from 18 to 72 (M = 30, SD = 11.93). We recruited participants through the researcher's social networks (n = 163) and via Prolific academic (n = 300) with their current residency in the Netherlands or Germany. Participants living in another country than Netherlands and Germany were excluded. Therefore a convenience sample was used. Moreover, we asked the people who were reached through the researcher's social networks to forward the link using a snowballing technique. On Prolific Academic, only people who indicated to live in the Netherlands and speak Dutch as their mother language or fluently were recruited. Participation was voluntary, and participants via Prolific academic were paid £1.- for completing the survey.

The others did not get any compensation. A power analysis for a 2x3 factorial design, using G*Power (Erdfelder et al., 2007), with a small effect size (d = .25), power .95, revealed a minimum of 251 participants was required.

Research Design and Procedure

The current study consisted of a 2 (no uncertainty vs. uncertainty) x 3 (government vs. scientists vs. scientists through social media) between-subjects design. That resulted in six conditions, to which participants were randomly assigned. The questionnaire was online and took around nine minutes to complete. Participants were told that the topic of the study is how people perceive scientific information in the news. After reading and agreeing to the informed consent, participants were asked about their country of residency with three answer options (*Netherlands, Germany, Other)*. Thus, depending on their answer, they were directed to one of the two available questionnaires, one for the people living in the Netherlands and one for the people living in Germany. Participants who indicated *"other"* countries were directed to the end of the survey.

Manipulation

Subsequently, participants were shown a short text about the effectiveness rate for a booster shot of the COVID-19 vaccine (Pfizer/Biontech). The six conditions were manipulated by changing the communication source and adding uncertainty or not. The variable of the communication source consisted of three levels: government, scientists, and scientists through social media. For the government, the Dutch/German government website's framework and layout were taken, and a created message was added to that layout. A fictitious magazine called "Dutch/German Journal for Medical Science" was invented for the scientific source. Finally, a Twitter post communicated by the "Dutch/German Journal for Medical Science" was invented

for the social media condition, stating the standardized message about the booster shot (Appendix A). The social media condition falls outside the present research's scope and will not be reported on. Depending on whether uncertainty was communicated or not, either only the effectiveness rate was stated, or a parenthesis was added: *(with some uncertainty around this number: the estimate is expected to be between 89.3% to 98.6%)*. Graphics of all six manipulated conditions are included in Appendix A. The standardized text we used was as follows, with the manipulations highlighted:

A recent ***report by the Dutch Ministry of Health [article in the Dutch Journal for Medical Science (NVMW)]*** *states that the protection against COVID-19 decreases over time after being vaccinated. This means that people* ***are [might be]*** *more susceptible to getting infected with the virus, though with less severe symptoms and a lower risk of hospitalization. A third vaccine dose, or "booster shot",* ***refreshes [could refresh]*** *immunity to similar levels as when first fully vaccinated. For example, with a booster shot of the Pfizer vaccine (Biontech) the effectiveness rate increases to* ***95.6% [(with some uncertainty around this number: the estimate is expected to be between 89.3% to 98.6%)],*** *which is equal to the effectiveness rate when first fully vaccinated. A boost in immunity is also expected for alternative brands of the COVID-19 vaccine.*

The stated effectiveness rate is based on a study about the Pfizer booster vaccine (Pfizer, 2021). After reading one of the six texts, all participants answered the following questions as described in the next section. At the end of the questionnaire, participants were debriefed on the actual purpose and details of the study.

Measures

Manipulation Check

A manipulation check containing two items was conducted shortly after reading the text. One item was an open question where the participants were asked to remember the estimated effectiveness rate of the booster shot communicated in the text. The second item was a multiple-choice question with four answer options (*Yes, No, I do not know, I do not remember)* asking if the messages people had read implied uncertainty or not.

Trust in the message

To assess trust in the message, we distinguished between three variables: trust in the communicated number, trust in the information itself, and trust in the communicator source. All items forming these dependent variables were assessed through 7-point Likert scales.

Trust in the number. The dependent variable of trust in the specific effectiveness rate consisted of three items (How reliable do you think this number is?*:* 1 = *Not reliable at all* to 7 = *Very reliable;* How trustworthy do you think this number is?*:* 1 = *Not trustworthy at all* to 7 = *Very trustworthy;* To what extent do you believe this number to be true?*:* 1 = *Not at all* to 7 = *Completely)* and was found to be highly reliable (*alpha* = .94).

Trust in the information. To assess the extent of trust in the communicated information two questions were asked (How much do you trust the information about efficacy of booster shots given in the message you have just read?*:* 1 = *Not at all* to 7 = *Completely;* How reliable do you think the information about the efficacy of booster shots given in the message you have just read is?*:* 1 = *Not reliable at all* to 7 = *Very reliable).* Due to high correlation (*r* = .85), these two items were combined into one variable, trust in the information.

Trust in the source. Furthermore, the dependent variable trust in the source consisted of two items (To what extent do you think the people who wrote this text are trustworthy: 1 = *Not trustworthy at all* to 7 = *Very trustworthy;* To what extent do you think the people who are

responsible for the numbers are trustworthy?*:* 1 = *Not trustworthy at all* to 7 = *Very trustworthy)* and the corresponding correlation coefficient is *r* =.75.

Additionally, in order to learn more about the general trust in the information and sources that were specifically used, a few more general questions were included (How much do you trust information about the efficacy of booster shots in general: 1 = *Not at all* to 7 = *Completely;* To what extent do you think government statistics are reliable?: 1 = *Not reliable at all* to 7 = *Very reliable;* To what extent do you think scientific statistics are reliable: 1 = *Not reliable at all* to 7 = *Very reliable).* These measures fall outside the present research scope and will not be reported on.

Perceived uncertainty

Apart from trust in the message, the perceived uncertainty was measured. The questions concerned the extent of perceived uncertainty around the specific effectiveness rate of the booster shot (To what extent do you think that this number is certain or uncertain*?:* 1 = *Very uncertain* to 7 = *Very certain;* How much uncertainty do you think there is about this number?*:* 1 = *No uncertainty at all* to 7 = *A lot of uncertainty).* Apart from the perceived uncertainty around the number, one item regarding the feeling of uncertainty after reading the number was included (How uncertain does this information make you feel?: 1 = *Not at all uncertain* to 7 = *Very uncertain).* Due to relatively high reliability (*alpha* = .71), these three items were combined into one dependent variable.

Prior belief about certain groups (feeling thermometer)

To assess people's prior beliefs and feelings towards particular groups of importance for the study (Civil servants, Scientists, Politicians, Journalists, Content creators on Social Media), we used a set of interval scales based on the warmth-competence map by Fiske et al. (2002).

Participants were asked how warm/positive or cold/negative they feel about these groups (0 = *very cold/negative* to 10 = *very warm/positive)* as well as how competent they perceive those groups (0 = *not competent at all* to 10 = *completely competent).*

Trust in the national government

Subsequently, participants had to indicate their opinions and prior beliefs about their national government to assess their general trust in the government. The items are based on questions of the European Social Survey (2012). The first item consisted of a set of statements (I trust the Dutch government.; I trust Dutch politicians.) where participants had to indicate how much they agree (1 = *Strongly disagree* to 7 = *Strongly disagree).* Furthermore, in four items, respondents were asked about their satisfaction with the national government (each with 1 = *very dissatisfied* to 7 = *Very satisfied)*. These included the way the government is doing its job (Thinking about the Dutch government, how satisfied are you with the way it is doing its job?), the effectiveness of democracy (On the whole, how satisfied are you with the way democracy works in the Netherlands?), the present state of the economy (On the whole, how satisfied are you with the present state of the economy in the Netherlands?), and the government's management of the coronavirus crisis (On the whole, how satisfied are you with how the government is managing the coronavirus crisis?). Furthermore, participants were asked to what extent they identify with the current governing parties (1 = *Not at all* to 7 = *A great deal).* Therefore, the variable trust in the national government consisted of seven items (*alpha* = .89). Additionally, participants were asked how interested they are in politics (1 = *Not at all interested* to 7 = *Very interested).*

Trust in Science

Additionally to asking about the general trust in the national government and the national politicians, these same statements were stated for scientists and scientific knowledge, where participants had to indicate their extent of agreement (I trust scientists.; I trust scientific knowledge with 1 = *Strongly disagree* to 7 = *Strongly disagree).* As well as the previous ones, these are based on questions of the European Social Survey (2012). These two items had a correlation of $r = .81$.

Political ideology

In order to assess the political ideology of participants, the liberal-conservative/left-right scale was used. Due to different use of terms in Germany and the Netherlands used for this continuum, the scale of the questionnaire for dutch residents ranged from 1 = *Very left* to 7 = *Very right* while the scale of the questionnaire for german residents ranged from 1 = *Very liberal* to 7 = *Very conservative.*

Perceived severity of COVID-19 pandemic

Additionally, three items about the perceived severity of the COVID-19 pandemic were included (Olagoke et al., 2020). One item was a statement (Coronavirus is a serious infection for me to contract. with 1 = *Strongly disagree* to 7 = *Strongly agree);* in the second item we asked if they are vaccinated or not (*Yes, No, Prefer not say)* and lastly, there was the opportunity to express thoughts regarding the COVID-19 pandemic through asking an open question (If you would like to express any personal thoughts about the current Covid-19 pandemic, you may do so below.).

Additional measures and demographics

Additionally, we included questions concerning participants' intention to act after reading the message. Furthermore, the survey included the Intolerance of Uncertainty scale (Carleton et

al., 2007), socioeconomic status and subjective social status (Goldman et al., 2006), assessment of psychological distress (Khubchandani et al., 2021) and questions concerning participants' social media usage. Detailed descriptions are presented in Appendix B. These measures fall outside the scope of the present research and will not be reported on further. The questionnaire ended with demographic questions about their age (What is your age?) and their gender (What is your gender?: *Male, Female, Non-binary/Diverse, Prefer not to say*).

Results

The data included 499 participants who agreed to the informed consent and proceeded with the questionnaire. Before doing the analyses, it was checked for missing values. We excluded all participants (36) who did not answer the items concerning our dependent variables (perceived uncertainty, trust in the number, trust in the information, trust in the source). Therefore, it resulted in a sample size of 463 participants. Since all participants filled out the survey independently and were placed in a random condition, the assumption of independence is met. Furthermore, the data were checked for normality, and homoscedasticity. The QQ-plots and Boxplots did indicate some violations of normality and homogeneity of variances, however, ANOVA is fairly robust against a large sample size (Appendix B). Moreover, due to the large sample the few outliers present in the data do not represent a problem for the analysis either (Appendix B).

Manipulation Check

Concerning the manipulation check, 184 participants out of the 233 who saw a message including uncertainty correctly reported that there was uncertainty communicated within the message (82.5%), 35 participants reported that there was no uncertainty communicated, 3 did not know (1.3%) and 11 participants did not remember (4.7%). Similarly, 155 participants out of the

230 who saw a message without uncertainty correctly reported that there was no uncertainty communicated (67.3%), 37 participants reported that there was uncertainty included (15.2%) , 11 participants did not know (4.8%) and 27 did not remember (11.7%). Therefore, it seems that the manipulation was successful.

Effect of Communication source and uncertainty

To test the effect of the manipulations (communication source and uncertainty) on perceived uncertainty and trust in the message, an Analysis of Variance (ANOVA) consisting of a 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) factorial design for each dependent variable was conducted.

Perceived uncertainty

The analysis revealed no significant main effects for either communication source ($F(2,457) = .31$, $p = .736$, $\eta^2 = .001$) nor uncertainty ($F(1, 457) = 3.060$, $p = .081$, $\eta^2 = .007$). There also was no significant interaction effect ($F(2,457) = .55$, $p = .579$, $\eta^2 = .002$). Therefore, the manipulation did not have a significant effect. However, there was a slight trend in more perceived uncertainty in the case of communicated uncertainty compared to no uncertainty communicated: participants who read a text in which uncertainty was communicated perceived the number to be slightly more uncertain ($M = 3.26$, $SD = 1.09$, 95% CI [3.12;3.40]) than participants who read a text without uncertainty ($M = 3.08$, $SD = 1.10$, 95% CI [2.94;3.23]).

Trust in the number, Trust in the message, Trust in the source

The analysis of the effects of communication source and communicated uncertainty did not reveal any significant effects on trust in the number, trust in the information or trust in the source (Table 1). This indicates that the communication source or uncertainty do not seem to influence the level of trust in the number, information nor source.

Table 1. *ANOVA Results for 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) design*

Effect	Trust in Number				Trust in Information				Trust in Source			
	df	*F*	*p*	η^2	*df*	*F*	*p*	η^2	*df*	*F*	*p*	η^2
Source	2	.71	.490	.003	2	.24	.790	.001	2	.194	.824	.001
Uncertainty	1	1.21	.272	.003	1	.28	.594	.001	1	.12	.733	.000
Source*Uncertainty	2	.16	.856	.001	2	.39	.673	.002	2	.31	.736	.001
Error	457				457				457			

Effect of Communication source and uncertainty with prior trust in the government added

Taking into account the prior trust in the government, we expected that people who indicated to have low trust in the government have generally less trust in the message than people indicated to have more trust in the government regardless of the source that is communicating the information. The variable prior trust in the government had a mean score of 4.02 (SD = 1.14) indicating that participants have rather high trust in their national government. In order to have almost equal group sizes, a median split was done (*Low Trust: 1 to 4.1; High Trust: 4.2 to 7)*. Overall, 239 participants indicated to have low trust in the government while 224 participants indicated to have high trust in the government.

A series of 2 (low trust in government vs. high trust in government) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) Analysis of Variance were conducted to test the influence of communication source, communicated uncertainty and prior trust in the government on trust in the number, trust in the information and trust in the source.

Trust in the number

After adding prior trust in the government to the model, the main effects of communication source and communicated uncertainty were still found to be not significant for trust in the number (Table 2). However, the analysis showed a significant main effect for the variable prior trust in the government on trust in the number (Table 2).

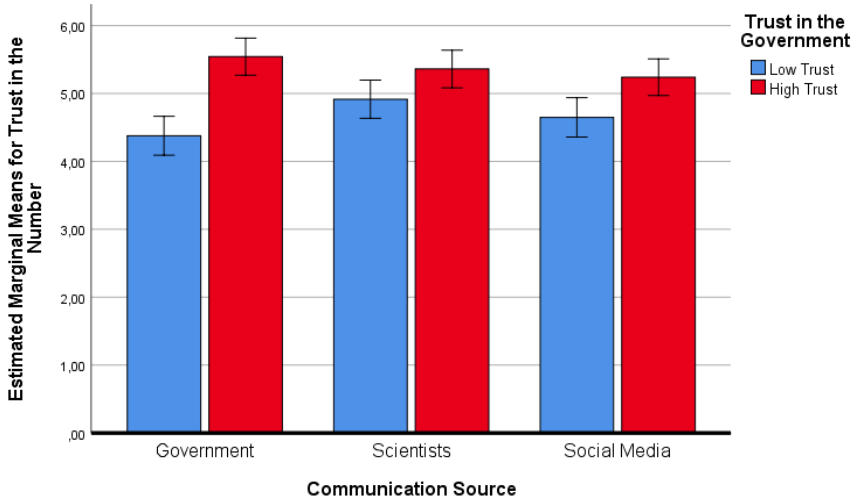
Table 2. *ANOVA Results for 2 (High vs. Low trust in the Government) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) design on Trust in the Number*

Effect	Trust in the Number			
	df	*F*	*p*	*η2*
Source	2	1.15	.316	.005
Uncertainty	1	2.94	.087	.006
Trust in Gov	1	39.94	<.001	.081
Source*Uncertainty	2	.43	.65	.002
Source*Trust in Gov	2	3.57	.03	.016
Uncertainty*Trust in Gov	1	.88	.35	.002
Source*Uncertainty*Trust in Gov	2	.001	.99	<.000
Error	451			

People with higher trust in the government had higher trust in the communicated number (M = 5.37, SD = .99, 95% CI [5.22;5.54]) compared to people with lower trust in the government (M = 4.66, SD = 1.46, 95% CI [4.48;4.81]). This main effect was qualified by an interaction effect between prior trust in the government and communication source (Table 2; Figure 1). For the participants who had low trust in the government, the analysis revealed highest levels of trust from the scientific source (M = 4.90, SD = 1.31, 95% CI [4.64;5.20]) and lowest trust in the message from the governmental source (M = 4.41, SD = 1.51, 95% CI [4.09;4.66]). Contrary, for participants who indicated to have high trust in the government, the analysis revealed highest

levels of trust from the governmental source (*M* = 5.52, *SD* = .92, 95% *CI* [5.27;5.82]) and lowest trust in the message from the scientific source (*M* =5.36, *SD* = 1.09, 95 % *CI* [5.09;5.64]).

Figure 1. *Marginal Means for Trust in the Number including the Predictors "Source" and "Trust in the Government"*

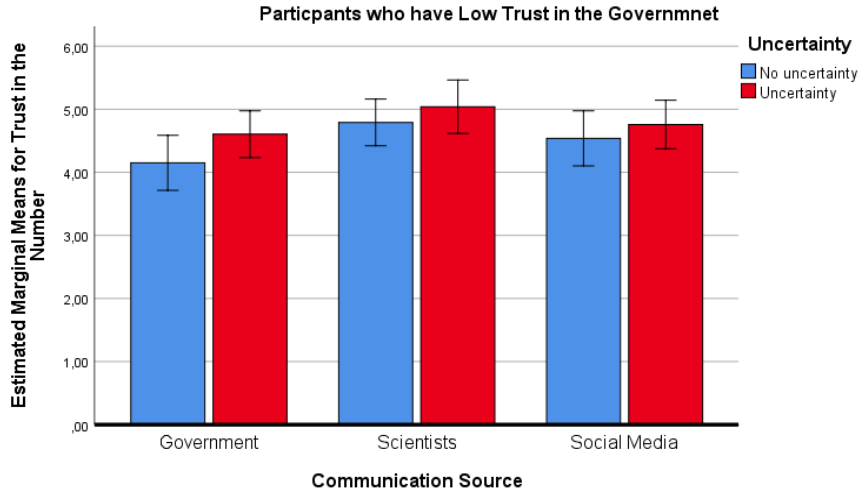


Note. Error bars represent the 95% Confidence Intervals.

There were no significant interactions between communication source and uncertainty, as well as uncertainty and trust in the government found. Furthermore, no significant three-way interaction between trust in the government, uncertainty and source was found (Table 2). However, there is an interesting trend that can be observed (Figure 2; Figure 3). Generally, participants tend to have slightly more trust in the number when uncertainty is communicated. This difference between communicating uncertainty or not is especially observable for participants who have low trust in the government compared to people having high trust in the message and for people who saw the governmental message compared to the scientific message. People who have low trust in the government, a larger difference between communicating uncertainty or not can be observed (Figure 2): Governmental source (M_{diff} = .45, SD_{diff} = .35); Scientific source (M_{diff} = .25, SD_{diff} = .29). Contrary, for participants with high trust in the

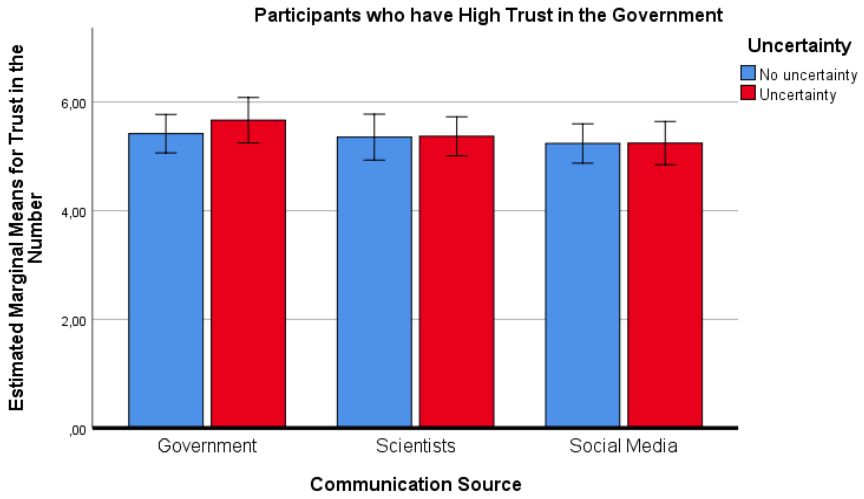
government, the difference between whether uncertainty is communicated or not does appear to have a smaller effect (Figure 3): Governmental source (M_{diff} = .25, SD_{diff} = .21); Scientific source (M_{diff} = .02, SD_{diff} = .79). However, regardless of trust in the government, the differences for the governmental source are higher than for the scientific source.

Figure 2. *Marginal means for Trust in the Number including the Predictors "Source" and "Uncertainty" for Participants with Low Trust in the Government*



Note. The error bars represent the 95% Confidence Intervals.

Figure 3. *Marginal means for Trust in the Number including Predictors "Source" and "Uncertainty" for Participants with High Trust in the Government*



Note. The error bars represent the 95% Confidence Intervals.

Trust in the information

Again, the study results showed a main effect for prior trust in the government on trust in the information (Table 3) with again, higher trust in the information for people who indicated to have high trust in the government (M = 5.62, SD = .93, 95% CI [5.47;5.76]) and lower levels of trust in the information for people who indicated to have low trust in the information (M = 4.88, SD = 1.37, 95% CI [4.72;5.03]).

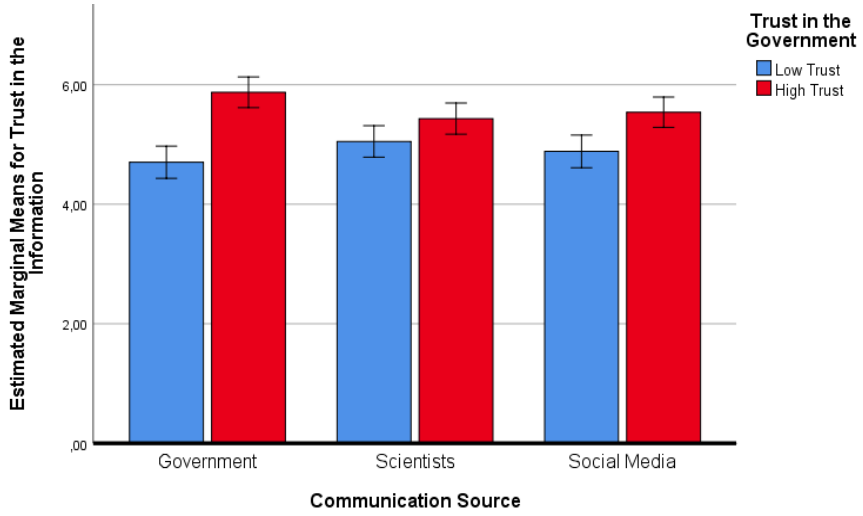
Table 3. *ANOVA Results for 2 (High vs. Low trust in the Government) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) design on Trust in the Information*

Effect	Trust in the Information			
	df	*F*	*p*	*η2*
Source	2	.16	.851	.001
Uncertainty	1	1.52	.219	.003
Trust in Gov	1	45.39	<.001	.091
Source*Uncertainty	2	.002	.998	<.001
Source*Trust in Gov	2	4.48	.012	.020
Uncertainty*Trust in Gov	1	1.39	.239	.003
Source*Uncertainty*Trust in Gov	2	.05	.952	<.001
Error	451			

The main effect of prior trust in the government was again qualified by an interaction effect (Table 3; Figure 4) between trust in government and communication source: people who had low trust in the government reported higher levels of trust in the information when it was reported by a scientific source (M = 5.05, SD = 1.29, 95% CI [4.79;5.32]) compared to a governmental source (M = 4.70, SD = 1.47, 95% CI [4.43;4.97]). On the other hand, people who

had high trust reported higher trust for the governmental source (*M* = 5.87, *SD* = .80, 95% *CI* [5.62;6.13]) than the scientific sources (*M* = 5.43, *SD* = 1.12, 95% *CI* [5.17;5.69]).

Figure 4. *Marginal Means for Trust in the Information including the Predictors "Source" and "Trust in the Government"*



Note. The error bars represent the 95% Confidence Intervals.

Trust in the source

The main effect of prior trust in the government was also significant for trust in the source (Table 4). Like the scores on the other dependent variables, participants who had more trust in the government reported higher levels of trust in the source (*M* = 5.75, *SD* = .92, 95% *CI* [5.60;5.90]) compared to participants with low trust in the government (*M* = 4.99, *SD* = 1.35, 95% *CI* [4.84;5.14]).

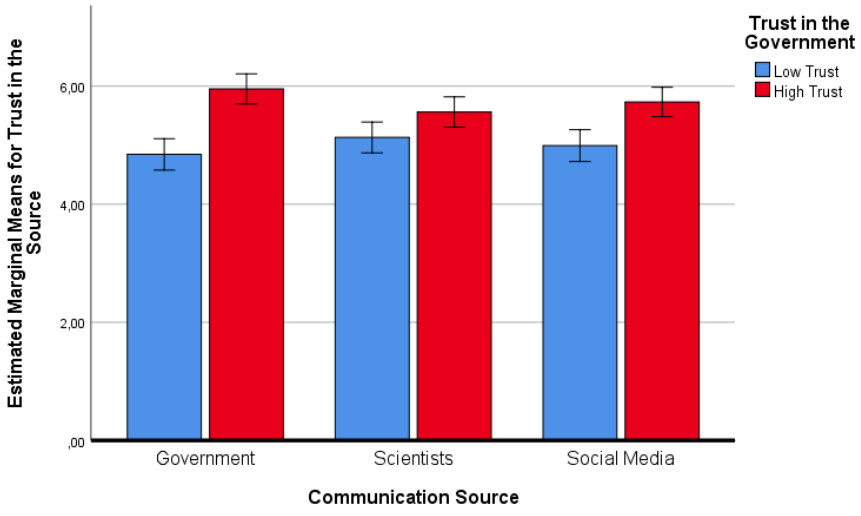
Table 4. *ANOVA Results for 2 (High vs. Low trust in the Government) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) design on Trust in the Source*

Effect	Trust in the Source			
	df	*F*	*p*	*η2*

Source	2	.08	.920	<.001
Uncertainty	1	1.06	.304	.002
Trust in Gov	1	49.47	<.001	.099
Source*Uncertainty	2	.13	.879	.001
Source*Trust in Gov	2	3.31	.038	.014
Uncertainty*Trust in Gov	1	1.12	.290	.002
Source*Uncertainty*Trust in Gov	2	.28	.759	.001
Error	451			

The interaction between communication source and prior trust in the government is also for the dependent variable trust in the source significant (Table 4; Figure 5): again, people with low trust in the government reported higher levels of trust in the information when it was communicated by a scientists (M = 5.13, SD = 1.33, 95% CI [4.87;5.39]) compared to the government (M = 4.85, SD = 1.31, 95% CI [4.58;5.11]). Contrary, people who had high trust reported higher trust for the governmental source (M = 5.95, SD = .84, 95% CI [5.70;6.21]) than the scientific sources (M = 5.56, SD = 1.08, 95% CI [5.30;5.82]).

Figure 5. *Marginal Means for Trust in the Source including the Predictors "Source" and "Trust in the Government"*



Note. The error bars represent the 95% Confidence Intervals.

The results of the analysis on all dependent variables, trust in the number, trust in the information and trust in the source, provide support for Hypothesis 1. Overall, people with higher trust in the government had higher levels of trust in the communicated message (number, information as well as source) regardless of the source of the message or whether uncertainty was communicated. Furthermore, the interaction effects do also partly support Hypothesis 2. We expected that the participants having low trust in the government, there will be less trust in the message when it is communicated by the government and uncertainty is communicated compared to scientists and no uncertainty is communicated. The results do support the difference between the sources, however, there is not less trust when uncertainty is communicated.

Effect of Communication source and uncertainty with political ideology added

Concerning political ideology and partisanship, we expected more conservative people to have less trust in the message compared to more liberal people regardless of the source. In order to define the two groups, a median split was done (*More Liberal: 1 to 2; More Conservative: 3 to 7).* Out of the 462 valid participants, 212 placed themselves in the liberal range of the scale (L) while 250 in the conservative range (C). Therefore, we conducted an Analysis of Variance with the inclusion of political ideology as an independent factor resulting in a 2 (More liberal/left vs. more conservative/right) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) factorial design. Results are presented in Table 5.

Table 5

ANOVA Results for 2 (Liberal/Left vs. Conservative/Right) x 2 (uncertainty added vs. no uncertainty added) x 3 (source: government vs. scientists vs. scientists via Social Media) design

Effect	Trust in the Number				Trust in the information				Trust in the Source			
	df	*F*	*p*	*η2*	*df*	*F*	*p*	*η2*	*df*	*F*	*p*	*η2*
Source	2	.58	.561	.003	2	.26	.768	.001	2	.16	.855	.001
Uncertainty	1	1.59	.208	.004	1	.61	.435	.001	1	.37	.543	.001
Political ideology	1	7.26	.007	.016	1	9.01	.003	.020	1	14.24	<.001	.031
Source*Uncertainty	2	.21	.809	.001	2	.24	.786	.001	2	.24	.787	.001
Source* Political ideology	2	1.02	.363	.004	2	.61	.542	.003	2	.45	.640	.002
Uncertainty* Political ideology	1	.31	.581	.001	1	2.75	.097	.006	1	2.45	.118	.005
Source*Uncertainty *Political ideology	2	.02	.980	.000	2	.26	.768	.001	2	.19	.822	.001
Error	450				450				450			

Trust in the number

Political ideology does have a significant main effect on trust in the number (Table 5). More conservative people had less trust in the number (M = 4.88, SD = 1.44, 95% CI [4.72;5.04]) than people who placed themselves in the more liberal part of the scale (M = 5.20, SD = 1.07, 95% CI [5.03;5.38]). However, there were no significant interactions present for trust in the number.

Trust in the information

Also for the trust in the information, political ideology is the only significant predictor in this model (Table 5). The mean for trust in the information of conservative people (M = 5.10, SD = 1.35, 95% CI [4.99;5.26]) was found to be lower than the mean score indicated by liberal people (M = 5.45, SD = 1.02, 95% CI [5.28;5.61]). No significant interactions were found for this dependent variable.

Trust in the source

Lastly, the analysis on trust in the source also revealed a main effect for political ideology, however also here, no other main effects were found (Table 5). As well as for the previous two dependent variables, people who placed themselves in the more conservative part of the scale had lower levels of trust (M = 5.20, SD = 1.31, 95% CI [5.05;5.35]) than the people who placed themselves in the more liberal part of the scale (M = 5.62, SD = 1.03, 95% CI [5.46;5.78]).

Furthermore, there were no significant interactions for trust in the source in this model.

ANCOVA with Political ideology as a continuous predictor

The scale was split around the median (Mdn = 3). That resulted in a liberal range going from *Very liberal* (1) to *Liberal* (2) while the more conservative range going from *Slightly liberal* (3) to *Very conservative* (7). Therefore, in order to use the scale as a continuous variable an ANCOVA with political ideology as a covariate was done additionally. This analysis showed significant results for political ideology as a covariate on all of the three subscales as well (Trust in the number: $F(1, 455) = 13.40$, $p < .001$, $\eta 2 = .029$; Trust in the information: $F(1, 455) = 19.04$, $p < .001$, $\eta 2 = .040$; Trust in the source: $F(1, 455) = 21.17$, $p < .001$, $\eta 2 = .044$).

The results are in line with our expectations, that people who placed themselves in the more conservative part of the scale had less trust in the message than people who placed themselves in the more liberal range regardless of the communication source or communicated uncertainty (Hypothesis 3).

Additional analysis

Perception of Scientists and Politicians

Using the warmth-competence scale (Fiske et al., 2002) we assessed how participants perceive scientists versus politicians. Scientists are perceived relatively high in warmth (M =

8.43, *SD* = 1.41) as well competence (*M* = 8.61, *SD* = 1.32). Contrary, politicians are perceived lower in warmth (*M* = 4.73, *SD* = 1.91) as well as competence (*M* = 5.12, *SD* = 1.97). Furthermore, the set of statements of the European Social Survey (2012) revealed that participants' trust in scientific and scientific knowledge is relatively high (*M* = 6.18, *SD* = .86).

Perception of COVID-19

The perception of the seriousness of COVID-19 is significantly related to the trust in the message regarding a booster shot. Correlations of the scale perceived seriousness of COVID-19 and all the three subscales were found to be significant at an alpha level of 0.05 (Trust in the number: $r = .309$, $p < .001$; Trust in the information: $r = .339$, $p < .001$; Trust in the source: $r = .320$, $p < .001$).

Discussion

The way science is communicated to society impacts society's trust in the message, which is crucial to make informed decisions. The present research aimed to investigate whether the communication source, communicated uncertainty, trust in the government, and political ideology influence the level of trust in communicated scientific information regarding the COVID-19 booster shot. The results showed that having higher trust in the government resulted in higher trust in the message. Identifying with a liberal/left political ideology was also associated with higher levels of trust in the COVID-19 related information. There was no significant difference whether the government or scientists were communicating the message or whether uncertainty was communicated or not. However, when interacting with the variable prior trust in government, a significant difference for the sources was found.

In accordance with the findings of the warmth-competence scale by Fiske & Dupree (2014), the participants of the present study did perceive scientists (*M(competence, warmth)* =

8.52) as more trustworthy than politicians (*M(competence, warmth)* = 4.93). Not only is their perception of trustworthiness higher for scientists, additionally, participants also indicated to have more trust in science (*M* = 6.18, *SD* = .86) than in the government (*M* = 4.02, *SD* = 1.14). However, these pre-existing attitudes towards these groups did not predict or influence trust level in the message communicated by either source. Evidently, science and politics are highly dependent on each other regarding many challenges, for example, climate change ("Why nature needs to cover politics now more than ever", 2020; Gauchat, 2012, Rutjens et al., 2018). Although individuals' perceptions of trustworthiness regarding scientists and politicians differ, the present study supports the idea that in the context of COVID-19 related information, participants do not differentiate between a scientific source and a governmental source when it comes to trust in the message. Hence, it seems that in the present context, the chosen topic (COVID-19) is of such great significance that the participants do not seem to get influenced by the source of information.

Nevertheless, after adding the variable prior trust in the government to the model, there were differences between the two communication sources present. The message communicated by a governmental source (Trust in the Number: *Mdiff* = 1.11, *SDdiff* = .17; Trust in the information: *Mdiff* = 1.17, *SDdiff* = .19; Trust in the source: *Mdiff* = 1.11, *SDdiff* = .18) in comparison with the message communicated by as scientific source (Trust in the Number: *Mdiff* = .46, *SDdiff* = .19; Trust in the information: *Mdiff* = .38, *SDdiff* = .19; Trust in the source: *Mdiff* = .43, *SDdiff* = .19) did yield a bigger difference in level of trust for people who had low trust in the government. It appears that the effect of the communication source only becomes significant through taking prior trust in the government into account. Depending on whether participants trust the government or not, the level of trust for the governmental source is more

extremely negative or more extremely positive compared to the trust in the scientific source. Thus, that could mean that low trust in the government subsequently enforces the distrust in politicians and consequently less trust in a governmental message. These findings support prior research findings that certain negative attitudes towards the government predicted more skepticism towards governmental messages, however are not significantly related to trust or skepticism in scientists (Brewer & Ley, 2013; Lewandowsky et al., 2005). Thus, this effect supports the hypothesis that the trustworthiness of the group does impact the trust level in a message communicated by that group. However, this has to be investigated in future research, including the variable prior trust in science.

Regarding uncertainty, we did observe an interesting trend. For people who indicated low trust in the government, there were higher levels of trust in both sources when uncertainty was communicated than when it was not communicated. This difference depending on uncertainty communication was not the case for people who indicated high trust in the government. Hence, people who generally distrust their government are more affected by uncertainty. One possible explanation for this is given by Bok (1997), who claims that one of the main reasons for society's mistrust of the government is lack of transparency. Societies` incorporation of knowledge of governmental processes should raise the trust level in the government (Cook et al., 2010). Thus, it could be assumed that individuals who focus more on transparency have rather low trust in government due to a lack of transparency. Therefore, these participants were more influenced by the communicated uncertainty and noticed it more. This observation is interesting regarding the ongoing debate about the effectiveness of uncertainty communication. However, since it is an observation with no significance, future research is needed to draw conclusions.

Moreover, political ideology appears to be a significant predictor for trust in the message of the COVID-19 booster shot. Prior research from Canada and the USA indicates conservatism as a predictor for skepticism towards and minimized trust in scientific information, including COVID-19 related information (Pickup et al., 2020, Stecula, 2020). Although the governmental systems and leading parties differ in terms of political orientation throughout the different studies and within our sample, there is generally support that conservatism is a predictor of skepticism in general. What was kind of contradicting to observe in our study was that the largest significant effect of political ideology occurred for the dependent variable trust in the source. Therefore, political ideology influences the trust in the source as a dependent variable. However, there is neither a main effect nor an interaction effect for the independent variable communication source present in this model. That could imply that in the context of COVID-19, these sources as predicting factors are not distinguished by participants.

Limitations and Future Directions

Certainly, this study also comes with a few limitations. First of all, the selection of the topic represents a considerable limitation of the study. When the study was designed, a potential booster shot of the COVID-19 vaccine was just speculation. During the study procedure, first booster shot campaigns were being realized, and people had the opportunity to get a shot. Due to the tremendous current relevance of the topic, most individuals probably inform themselves extensively about it. The influence of the communication source when perceiving information is especially significant when study participants do not have a broad knowledge of the communicated information (Brewer & Ley, 2013). Therefore, the insignificant results of the communication source on trust in the message in the present study could be attributed to pre-knowledge regarding the communicated topic.

Furthermore, the perception of the seriousness of the virus is positively related to the trust in the message. Hence, people who perceive the virus as more serious did indicate more trust in the communicated message regarding the booster shot, which highlights the topic-related limitation. Consequently, it would be interesting to do a similar study using a topic that is not as current as the COVID-19 vaccine booster shot.

Secondly, to have more participants, the study sample consists of both Dutch and German residents. Although both countries have different governments and, moreover, different approaches and campaigns for combating COVID-19, we analyzed all participants in one (Government of the Netherlands, 2021; Government of Germany, 2021). Therefore, it would be interesting to examine if there are differences for the two countries, especially since their governments differ: the German government can be placed in the more left/liberal continuum while the Dutch government is rather center/right. Due to unequal group sizes, it was not possible to make a robust comparison between these two countries of residence. Hence, it would be an interesting approach for future investigations. For instance, since conservative people emphasize more on the values and opinions of their ingroup than liberals, it would be interesting to investigate if that would lead to more trust in a conservative government and subsequently more trust in the message (Graham et al., 2009; Rutjens et al., 2018). Analysis focused on one country of residents would allow a more in- depth investigation and what role the government's political ideology plays. Hence, this would allow learning more about the relationship between prior trust in the government and political ideology within the analysis.

Conclusion

Taken together, the research demonstrates that science communication is undoubtedly complex. At the moment, we recognize how different societies perceive scientific information

around COVID-19 (Koerber, 2021). To prevent those opposing positions and perceptions around scientific findings it would be beneficial to know which factors could be influenced or manipulated easily, so individuals have more trust in communicated information. The observable trends regarding transparency and uncertainty could be an incentive for scientists and the government to disclose as much information as possible to society. However, our findings also indicate that the factors that significantly influence trust in the message are more complex than changing the source of communication or being transparent by disclosing uncertainty. Trust in the government and political ideology are the significant predictors that predict the trust level in scientific information. Trust, as a subjective belief and psychological state that is based on positive expectations and experiences and forms itself throughout time (Lewicki & Tomlinson, 2003), as well political ideology, a set of beliefs based on values and norms regarding the functioning of society (Erikson & Tedin, 2019), are both relatively stable and cannot be influenced by changing features of the message, the source or adding uncertainty to the text or not. Our findings highlight that these underlying factors that predict trust in a message are complex and relatively stable within individuals, making it challenging for scientists to find an answer on how to communicate scientific information to people so that they trust the information.

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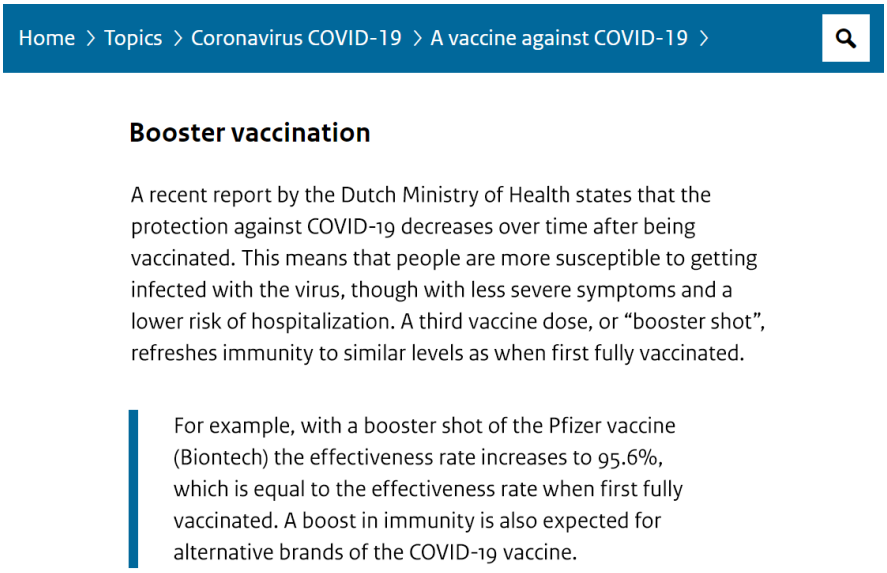
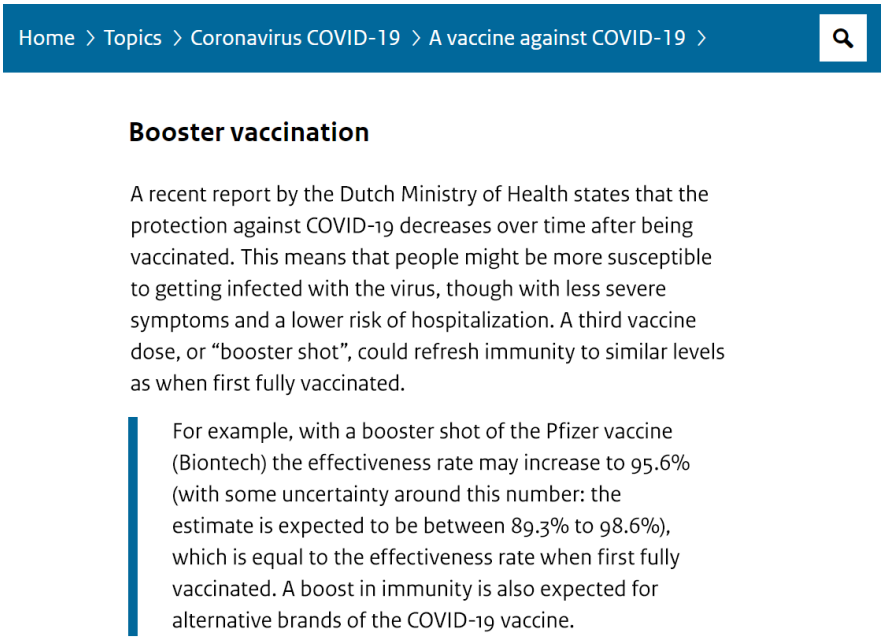
Appendix A

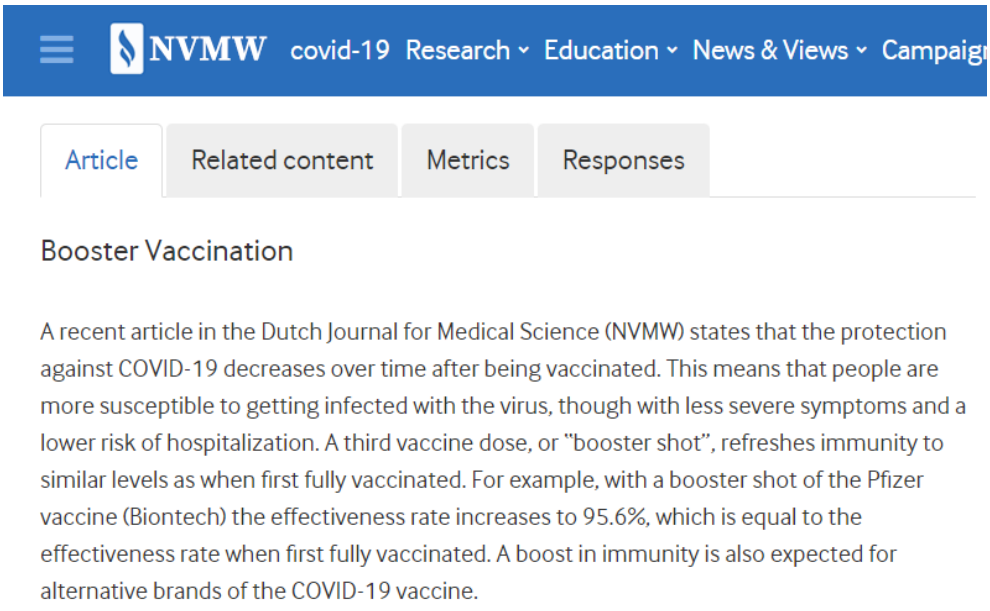
Graphics of the six manipulated conditions (english versions)



Graphic A1. Message communicated by the government with no uncertainty included.

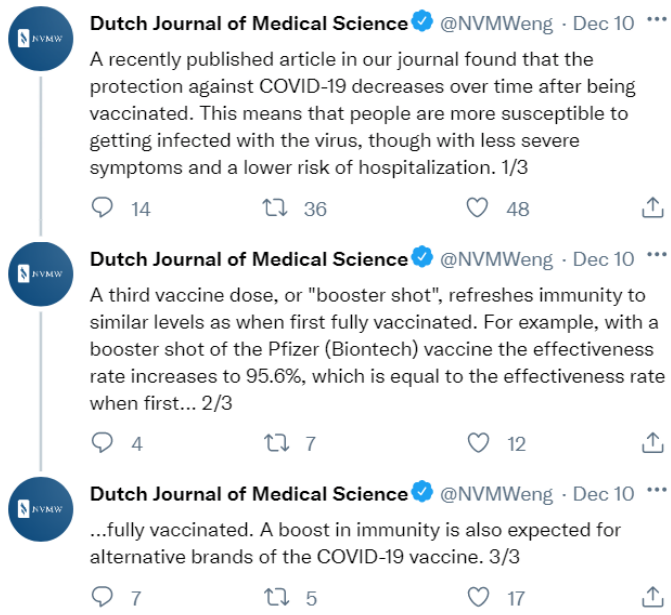


Graphic A2. Message communicated by the government with uncertainty included.

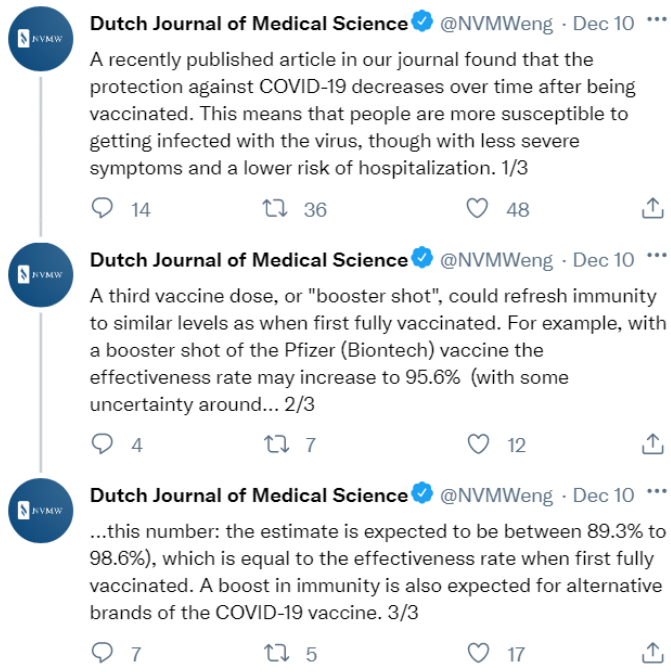


Graphic A3. Message communicated by scientists with no uncertainty included.

Graphic A4. Message communicated by scientists with uncertainty included.



Graphic A5. Message communicated by scientists through a Twitter post with no uncertainty included.



Graphic A6. Message communicated by scientists through a Twitter post with uncertainty included.

Appendix B

Detailed Description of additional measures included in the survey

Intention to act

The Intention to act, specifically in this context, getting the booster shot of the COVID-19 vaccine, was measured through a few items and could serve as another dependent variable. In order to assess intention to act two questions, one about the likelihood of getting a booster shot (If it were offered to you, how likely would you be to take a booster shot?: 1 = *not likely at all* to 7 = *extremely likely)* and if they would agree recommending to get a booster shot to a friend after reading this (1 = *completely disagree* to 7 = *Completely agree*), were asked. Furthermore, participants had to indicate to what extent they agree with certain statements and adhere to the COVID-19 measures that are recommended (I always wear a face mask when institutionally recommended.; I always adhere to the social distancing rules: both with 1 = *strongly disagree* to 7 = *strongly agree).*

Intolerance of uncertainty scale

In order to assess participants' feelings towards the future, the Intolerance of Uncertainty scale was used (Carleton, Norton, & Asmundson, 2007). The scale contains twelve statements (e.g. I should be able to organize everything in advance.) where participants were asked to indicate how characteristic the statements are for them (1 = *Not at all characteristic* to 5 = *Entirely characteristic for me).*

Psychological distress

Furthermore, in order to assess psychological distress, the PHQ-4 Scale (Khubchandani et al., 2021) was used. Participants had to indicate how often they were bothered with certain

problems in the past two weeks (e.g. Feeling down, depressed or hopeless: 1 = *Not at all* to 4 = *Almost everyday).*

Socioeconomic status and subjective social status

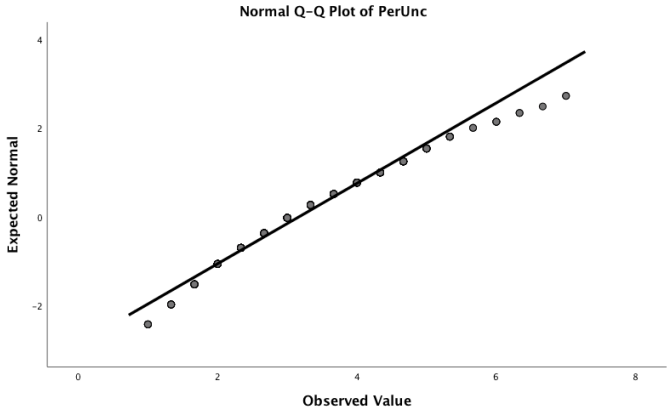
Subsequently, participants were asked a few questions regarding theit socioeconomic status based on questions from the European Social Survey (Educational Qualification, Employment Status*).* Additionally, they were shown an illustration of a ladder where at the top are people who are best off, regarding their job, education and money, and at the bottom are the people who are worst off (Goldman, Cornman & Cheng Chang, 2006). Participants had to indicate their Subjective Social Status by ranking where they think they stand on the ladder (0 = *bottom* to 10 = *top of the ladder).*

Social media usage

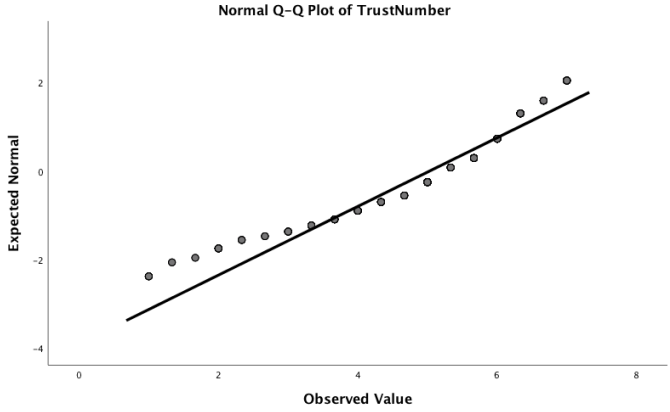
Lastly, participants' social media usage and feelings toward social media were assessed. That was assessed using four items (e.g. How often do you use these sites?: 1 = *Never, I do not have accounts* to 7 = *Multiple hours per day)* referring to platforms such as Facebook, Instagram, Twitter, Youtube, TikTok, Reddit, and Pinterest.

Appendix C

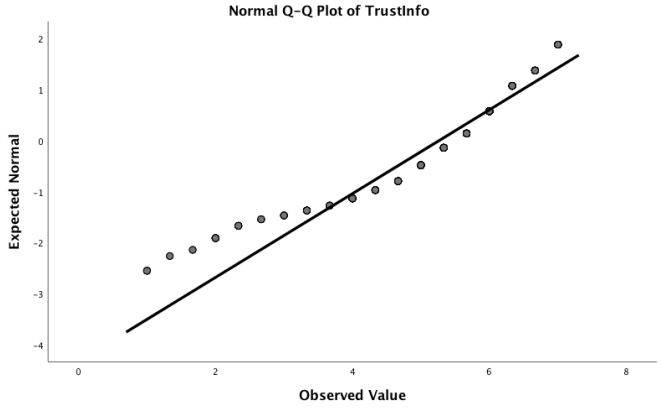
Assumptions Check



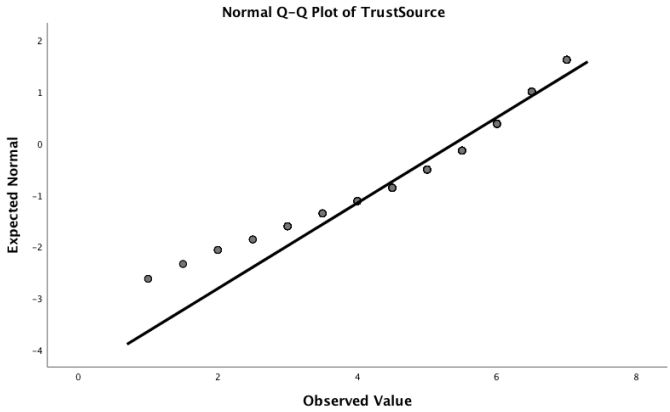
Graphic C1. QQ-Plot for Perceived Uncertainty



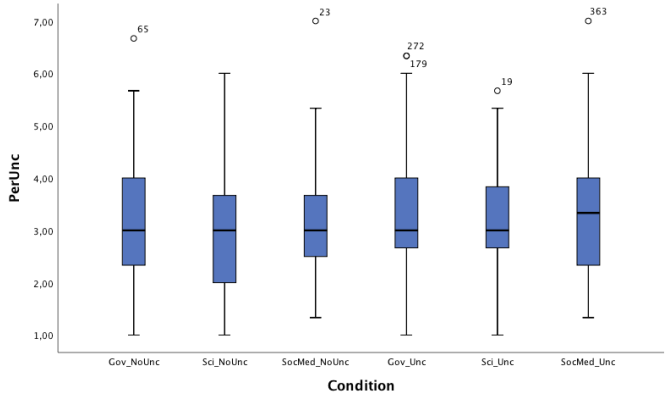
Graphic C2. QQ-Plot for Trust in the number



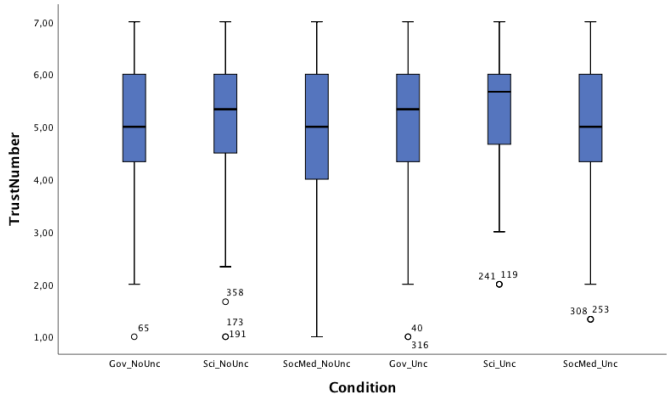
Graphic C3. QQ-Plot for Trust in the information



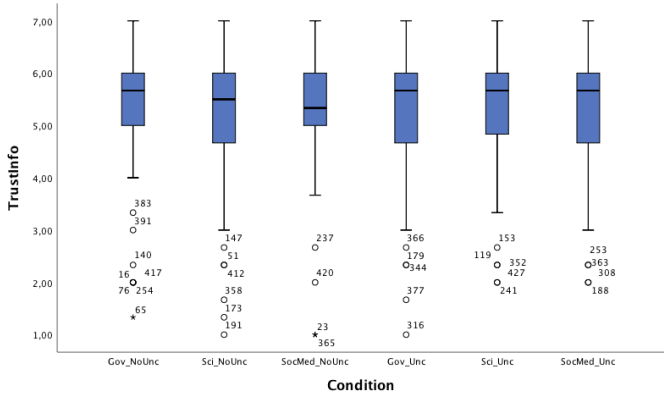
Graphic C4. QQ-Plot for Trust in the source



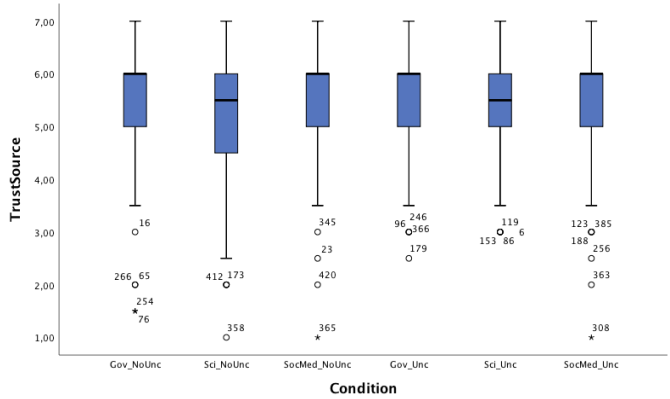
Graphic C5. Boxplot for Perceived Uncertainty



Graphic C6. Boxplot for Trust in the number



Graphic C7. Boxplot for Trust in the information



Graphic C8. Boxplot for Trust in the source